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QUICK FACTS

The School

The Naval Postgraduate School is America's national security research university. The mission of the University is to provide high-quality, relevant and unique advanced education and research programs that increase the combat effectiveness of the Naval Services, other Armed Forces of the U.S. and our partners, to enhance our national security.

The Campus

Located in Monterey, California on the Pacific Ocean, 120 miles south of San Francisco, the Naval Postgraduate School campus covers 627 acres of land. The site, home to NPS since 1951, houses state-of-the-art laboratories, numerous academic buildings, an award-winning library, government housing and impressive recreational facilities.

The Students

The student body consists of officers from all branches of the U.S. uniformed services, civilian employees of the federal, state and local governments, as well as officers and civilians from 47 foreign countries. A limited number of defense contractors and enlisted personnel are also enrolled. Selection for graduate education at NPS is based upon outstanding professional performance, promotion potential, and a strong academic background.

The Faculty

Drawn from a broad array of educational institutions, the faculty represent a prestigious collection of scholars, the majority of whom are civilians. Faculty interaction with students is high and every class is taught directly by a faculty member. All tenure and tenure-track faculty hold a doctoral degree. Other faculty are credentialed experts in their fields of study.

The Degrees

The Naval Postgraduate School confers the following advanced degrees: Master of Arts Degree, Master of Business Administration, Master of Science Degree, Engineer's Degree, Doctor of Philosophy, and Doctor of Engineering.

For more information on admission, contact:

Naval Postgraduate School
Admissions Office
1 University Circle, He-022
Monterey, CA 93943

Telephone: (831) 656-3093 / DSN 756-3093

e-mail: grad-ed@nps.edu

Catalogs:

The online edition of the School's catalog is updated quarterly and located at:
www.nps.edu/Academics/Admissions/Registrar/Academic Catalog

DISTINGUISHED ALUMNI AND FACULTY ROSTER

Distinguished Alumni and Hall of Fame

NPS Hall of Fame

The Naval Postgraduate School Hall of Fame is a place reserved for the School's most notable alumni and friends, recognizing their achievements and attainment of positions at the highest levels of public service. NPS' Hall of Fame members have made the greatest contributions to society, their nations and to the Naval Postgraduate School.

The following individuals have received Hall of Fame awards:
· Mr. Walt Havenstein (Present 30 Nov 2012)
· Admiral Eric T. Olson, USN (Ret.) (Presented 30 Nov 2012)
· Admiral Stanley Arthur (Ret.) (Presented 2 Dec 11)
· Dr. Jack London (Presented 2 Dec 11)
· Vice Admiral Pat Tracey (Ret) (Presented 3 Dec 10)
· Admiral T. Joe Lopez (Ret) (Presented 3 Dec 10)
· Vice Admiral Tom Hughes (Ret) (Presented 3 Dec 10)
· General Apichart Penkitti (Presented 30 July 10)
· Admiral Michael G. Mullen (Ret) (Presented 11 Aug 09)
· General Michael W. Hagee (Ret) (Presented 23 May 09)
· Honorable Dan Albert (Presented 23 Feb 07)
· Admiral Wayne E. Meyer (Ret) (Presented 23 Feb 06)
· Admiral James D. Watkins (Ret) (Presented 20 Apr 05)
· General John A. Gordon (Ret) (Presented 16 Sep 04)
· Admiral Henry Mauz (Ret) (Presented 19 Nov 03)
· Vice Admiral Arthur Cebrowski (Ret) (Presented 13 Jan 03)
· Professor Pao Chuen Lui (Presented 28 Mar 02)
· The Honorable James Roche, Captain (Ret) (Presented 27 Sep 01)
· The Honorable Thomas White (Presented 27 Sep 01)

Learn more about our NPS Hall of Fame recipients at www.nps.edu/Alumni/hof.html.

Distinguished Alumni Award Program

The Naval Postgraduate School recognizes our alumni whose outstanding accomplishments and contributions have made a significant impact upon our nation, its military force, and the world. The following individuals have been recognized as some of NPS' standout alumni and have been presented with NPS Distinguished Alumni awards.

The following individuals have received Distinguished Alumni awards:
· General Keith Alexander, USA
· Admiral Stanley Arthur, USN (Ret)
· Colonel Walter H. Augustin, USMC (Ret)
· Captain Jeffrey Bacon, USN (Ret)
· Vice Admiral Roger F. Bacon, USN (Ret)
· Vice Admiral Phillip Balisle, USN (Ret)
· Rear Admiral Stanley Bozin, USN
· Rear Admiral Michael A. Brown, USN
· Vice Admiral Nancy E. Brown, USN
· Captain Daniel W. Bursch, USN (Ret)
· Dr. Todd Calhoun
· Vice Admiral Arthur Cebrowski, USN (Ret)
· Commander Sandra K. Chachula, USN (Ret)
· Rear Admiral Philip J. Coady Jr., USN (Ret)
· Rear Admiral Dan W. Davenport, USN
· Rear Admiral Patrick W. Dunne, USN (Ret)
· Gordon Eubanks
· Vice Admiral Mark E. Ferguson, III, USN
· Captain Stephen Frick, USN (Ret)
· Rear Admiral James B Greene Jr. USN (Ret)
· Vice Admiral Lee F. Gunn, USN (Ret)
· Rear Admiral Charles S. Hamilton II, USN
· Rear Admiral Cecil E. Haney, USN
· Rear Admiral Elizabeth A. Hight, USN
· Colonel David Hilmers, USMC (Ret)
· Captain Sam Houston, USN (Ret)
· Vice Admiral Thomas J. Hughes, USN (Ret)
· Captain Wayne P. Hughes, Jr., USN (Ret)
· Vice Admiral Harvey E. Johnson, Jr., USCG (Ret)
· Rear Admiral John M. Kelly, USN (Ret)
· Lieutenant General Richard S. Kramlich, USMC (Ret)
· Vice Admiral William Landay III, USN
· Lieutenant Commander Marvin Langston, USN (Ret)
· Captain Donald M. Layton, USN (Ret)
· Lieutenant General Chan Lee, ROKAF
· Vice Admiral Michael A. LeFever, USN
· Vice Admiral Keith W. Lippert, USN (Ret)
· CAPT Michael Lopez-Alegria, USN (Ret)
· Professor Pao Chuen Lui (Ret)
· Rear Admiral Archer M. Macy, Jr., USN
· Rear Admiral Michael Mathis, USN (Ret)
· Vice Admiral Justin McCarthy SC, USN
· Rear Admiral Timothy J. McGee, USN
· Admiral William H. McRaven, USN
· Rear Admiral Wayne Meyer, USN (Ret)
· Admiral Michael Mullen, USN (Ret)

- Lieutenant Colonel Carlos Noriega, USMC (Ret)
- Vice Admiral Eric T. Olson, USN
- Captain Alan Poindexter, USN
- Vice Admiral John Scott Redd, USN (Ret)
- Captain Kenneth Reightler, Jr., USN (Ret)
- The Honorable James Roche, Captain, USN (Ret)
- Rear Admiral Conrad J. Rorie, USN (Ret)
- CDR Carter "Buzz" Savage, USN (Ret)
- Captain Dylan Schmorrow, USN
- Captain Winston Scott, USN (Ret)
- Rear Admiral Kenneth Slaght, USN (Ret)
- Vice Admiral Stanley Szemborski, USN
- Rear Admiral Jan Tighe, USN
- Rear Admiral David Titley, USN
- Vice Admiral Patricia A. Tracey, USN (Ret)
- Lieutenant General Thomas R. Turner, USA (Ret)
- Lieutenant General Michael A. Vane, USA
- General William S. Wallace, USA (Ret)
- The Honorable Thomas White, Secretary of the Army
- COL Jeff Williams, USA (Ret)
- Rear Admiral Edward Winters III, USN
- Captain Janice Wynn, USN
- Captain John A. Zangardi, USN (Ret)

Distinguished Professors

"Distinguished Professor" is an honorary title conferred upon certain faculty members in recognition of meritorious scholarly accomplishments and sustained, significant contributions to the educational mission of the Naval Postgraduate School. Their research or scholarly contributions while at the Naval Postgraduate School have had a significant impact on their fields of expertise.

Agrawal, Brij
Mechanical and Aerospace Engineering

Ball, Robert (Emeritus)
Mechanical and Aerospace Engineering

Brown, Gerald
Operations Research

Bruneau, Thomas (Emeritus)
National Security Affairs

Butler, John T.
Electrical and Computer Engineering

Chang, Chih Pei
Meteorology

Chiu, Ching-Sang
Oceanography

Chu, Peter C.
Oceanography

Colson, William
Physics

Crittenden, Eugene (Emeritus)
Physics

Denning, Dorothy
Defense Analysis

Denning, Peter
Computer Science

Elsberry, Russell (Emeritus)
Meteorology

Euske, Kenneth J.
Business and Public Policy

Fuhs, Allen (Emeritus)
Mechanical and Aerospace Engineering

Gaver, Donald (Emeritus)
Operations Research

Giet, George (Emeritus)
Electrical and Computer Engineering

Haderlie, Eugene (Emeritus)
Oceanography

Haegel, Nancy
Physics

Healey, Anthony (Emeritus)
Mechanical and Aerospace Engineering

Jacobs, Patricia A.
Operations Research

Kinney, Gilbert (Emeritus)
Physics

Kwon, Young W.
Mechanical and Aerospace Engineering

Lewis, Peter (Emeritus)
Operations Research

Looney, Robert
National Security Affairs

Loomis, Jr., Herschel H.
Electrical and Computer Engineering

Marshall, Kneale (Emeritus)
Operations Research

Marto, Paul (Emeritus)
Mechanical and Aerospace Engineering

McNelley, Terry (Emeritus)
Mechanical and Aerospace Engineering

Montgomery, Michael T.
Meteorology

Morgan, Michael
Electrical and Computer Engineering

Netzer, David (Emeritus)
Mechanical and Aerospace Engineering

Owen, Guillermo
Mathematics

Platzer, Max (Emeritus)
Mechanical and Aerospace Engineering

Porch, Douglas
National Security Affairs

Powers, John (Emeritus)
Electrical and Computer Engineering

Renard, Robert (Emeritus)
Meteorology

Sarpkaya, Turgut (Emeritus)
Mechanical and Aerospace Engineering

Schrady, Dave (Emeritus)
Operations Research

Shin, Young (Emeritus)
Mechanical and Aerospace Engineering

Thornton, Edward (Emeritus)
Oceanography

Washburn, Alan (Emeritus)
Operations Research

Wood, R. Kevin
Operations Research

Yun, Xiaoping
Electrical Engineering

THE NAVAL POSTGRADUATE SCHOOL

The School

To meet its advanced educational requirements, the Navy has a unique academic institution at the Naval Postgraduate School (NPS) with specially tailored academic programs and a distinctive organization tying academic disciplines to naval and joint war fighting applications.

The student body consists of officers from all branches of the U.S. uniformed services, officers and civilians from 47 other countries and civilian employees of the federal government as well as state and local governments. A limited number of defense contractors and enlisted personnel are also enrolled. Selection for graduate education at NPS is based on outstanding professional performance, promotion potential, and a strong academic background. Students receive graduate degrees as a result of successful completion of programs designed primarily to prepare them for future career assignments. Degrees are awarded on the basis of the same high academic standards that prevail at other accredited institutions.

As an academic institution, NPS emphasizes study and research programs that are relevant to the Navy's interests, as well as the interests of other branches of the Department of Defense (DoD). The programs are designed to accommodate the unique requirements of the military, defense department and other federal agencies, including requirements for Defense Acquisition Certification.

Mission

The Naval Postgraduate School is America's national security research university. The mission of the University is to provide high-quality, relevant and unique advanced education and research programs that increase the combat effectiveness of the Naval Services, other Armed Forces of the U.S. and our partners, to enhance our national security.

Vision

As a naval defense-oriented research university, the Naval Postgraduate School will operate as a geographically distributed educational system that provides a broad range of high-quality graduate education in support of national and international security. Chartered originally to focus on science and technology, NPS has evolved from a single engineering department at the U.S. Naval Academy into an institution that serves naval, defense and national security related interests by providing current and future readiness, advances in technology, and educational and operational programs that directly support all facets of national defense and homeland security.

Accreditation

WASC

The Accrediting Commission for Senior Colleges and Universities of the Western Association of Schools and Colleges (WASC) accredits the Naval Postgraduate School.

EAC of ABET

In addition to regional accreditation, the Graduate School of Engineering and Applied Science's Electrical, Mechanical, Systems and Astronautical Engineering degree programs are accredited by the Engineering Accreditation Commission (EAC) of ABET, http://www.abet.org.

Dept of Electrical Engineering

Master of Science in Electrical Engineering

Dept of Mechanical and Aerospace Engineering

Master of Science in Mechanical Engineering

Master of Science in Astronautical Engineering

Dept of Systems Engineering

Master of Science in Systems Engineering

Master of Science in Systems Engineering (Distributed Learning)

AACSB

The Graduate School of Business and Public Policy programs are accredited by the Association to Advance Collegiate Schools of Business (AACSB).

NASPAA

The Master of Business Administration program is accredited by the National Association of Schools of Public Affairs and Administration (NASPAA).

Degrees Conferred

Meeting the highest academic standards, the curricula are tailored to address defense and national security requirements and are developed within the framework of classical academic degrees.

Master of Arts

· Identity Management and Cyber Security

- Security Studies
- Management (Financial)

Master of Business Administration
- Master of Business Administration
- Executive Master of Business Administration
- Financial Management (Energy Specialty)

Master of Cost Estimating and Analysis

Master of Computing Technology

Master of Engineering

Master of Engineering Acoustics

Master of Science
- Applied Cyber Operations
- Applied Mathematics
- Applied Physics
- Applied Science (Acoustics)
- Applied Science (Operations Research)
- Applied Science (Physical Oceanography)
- Applied Science (Signal Processing)
- Astronautical Engineering*
- Combat Systems Technology
- Computer Science
- Computer Engineering
- Contract Management
- Cyber Systems and Operations
- Defense Analysis
- Electrical Engineering*
- Engineering Acoustics
- Engineering Science
- Engineering Systems
- Human Systems Integration
- Information Operations
- Information Systems and Operations
- Information Technology Management
- Information Warfare Systems Engineering
- Management
- Mechanical Engineering*
- Meteorology
- Meteorology and Physical Oceanography
- Modeling Virtual Environments and Simulation
- Network Operations
- Operations Research
- Physical Oceanography
- Physics
- Product Development
- Program Management
- Remote Sensing Intelligence
- Software Engineering
- Space Systems Operations
- Systems Engineering*
- Systems Engineering Analysis

- Systems Engineering Management
- Systems Technology

Master of Systems Analysis

Master of Science in Engineering Science
- Aerospace Engineering

Engineer
(Typically requires one year of study beyond the master's degree)
- Astronautical Engineer*
- Electrical Engineer
- Mechanical Engineer

Doctor of Philosophy
- Applied Mathematics
- Applied Physics
- Astronautical Engineering
- Computer Science
- Electrical Engineering*
- Engineering Acoustics
- Information Sciences
- Mechanical Engineering*
- Meteorology
- Modeling, Virtual Environments and Simulation
- Operations Research
- Physical Oceanography
- Physics
- Security Studies
- Software Engineering
- Systems Engineering

Doctor of Engineering
- Astronautical Engineering
- Engineering Acoustics
- Mechanical Engineering

*Apart from institutional accreditation, the Graduate School of Engineering and Applied Science's Electrical, Mechanical, Systems and Astronautical Engineering degree programs are accredited by the Engineering Accreditation Committee of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – telephone: (410) 347-7700.

Board of Advisors

The Board of Advisors is composed of distinguished professionals who are eminent authorities in the field of academia, business, national defense and the defense industry, management, leadership, and research and analysis. The Board meets to assess the effectiveness with which the Naval Postgraduate School is accomplishing its mission and evaluates its future plans. Board Members shall be appointed on an annual basis by the Secretary of

Defense, and shall serve terms of four years. Following their initial four-year tour, Board Members may, at the discretion of the President, Naval Postgraduate School, be considered for additional terms on the Board. The Board meets at least once a year.

Federal:

Federal members serve by virtue of their position.

David S. Fadok, MG, USAF	Commander, Air University
Raymond C. Fox, MG, USMC	Commanding General, Training & Education Command
Matthew L. Klunder, RADM, USN	Chief, Office of Naval Research
Gregg F. Martin, MG, USA	Commandant, Army War College
Scott R. Van Buskirk, VADM, USN	Chief of Naval Personnel/ Deputy Chief of Naval Operations (Manpower, Personnel, Training and Education

Non-Federal:

Walter Anderson	President, Novium Learning
Honorable Michael Bayer	President & CEO, Dumbarton Strategies
Honorable Jack Borsting, Ph.D.	Professor and Dean Emeritus, University of Southern California
Robert Fossum, Ph.D. (Ret.)	Independent Consultant
David E. Frost, VADM, USN (Ret.)	President, Frost & Associates
Lee Gunn, VADM, USN (Ret.)	President, Institute for Public Research, CNA Corp
Timothy J. Keating, ADM, USN (Ret)	Independent Consultant
E Jan Kehoe	Professor at Walden University
Elisabeth Pate-Cornell, Ph.D.	Professor and Chair, Stanford University
Honorable G. Kim Wincup	Independent Consultant

The Board of Advisors website is at: http://www.nps.edu/Administration/BoardofAdvisors/new boa.html

Administration

The President of the Naval Postgraduate School is the academic coordinator for all graduate education programs in the Navy. The President administers fully-funded graduate educational programs at the Naval Postgraduate School, other service graduate schools and civilian universities.

Leadership

President (Interim)

Jan E. Tighe, Ph.D.
RDML, USN

Provost and Academic Dean

Douglas A. Hensler, Ph.D.

Chief Of Staff

Deidre McLay, CAPT, USN

Administration

Dean of Graduate School of Engineering and Applied Science
Philip A. Durkee, Ph.D.

Dean of Graduate School of Operational and Information Sciences
Gordon McCormick, Ph.D.

Dean of School of International Graduate Studies
James Wirtz, Ph.D.

Dean of Graduate School of Business and Public Policy
William R. Gates, Ph.D.

Dean of Research
Jeffrey D Paduan, Ph.D.

Dean of Students
Tom MacRae, CAPT, USN

Vice Provost for Academic Affairs
O. Douglas Moses, Ph.D.

University Librarian
Eleanor Uhlinger

Chief Information Officer
Christine M. Haska, Ph.D.

Administrative Staff

Director of Academic Planning (Acting)
Paula Jordanek, CAPT, USN (Ret.)

Director of Academic Administration and Registrar
P. Michael Andersen

Director of for Center for Educational Design, Development, and Distribution (CED3)
Tom Mastre

Director of Programs
Andrea H. Cameron, Ph.D.
CDR, USN

Director of International Programs
Herbert G. Roser, Col, USMC (Ret.)

Director of Institutional Research and Assessment
R. Frances Horvath, Ph.D.

Director of Admissions
Susan G. Dooley, Lt Col, USMC (Ret)

Academic Organization

The Naval Postgraduate School has four graduate schools as well as several research and education institutes and centers. Academic departments and faculty are organized within four schools. Institutes and centers provide groups of faculty an additional structure for collaborative and interdisciplinary teaching and research activities. The Naval Postgraduate School also has a number of interdisciplinary committees and groups that oversee and advise education programs.

Graduate School of Business and Public Policy

Organizations and Management Academic Area
Acquisition Management Academic Area
Financial Management Academic Area
Operations and Logistics Management Academic Area
Manpower and Economics Academic Area
Enterprise and Information Management Academic Area
Global Public Policy Academic Group
Defense Resources Management Institute

Graduate School of Engineering and Applied Sciences

Electrical and Computer Engineering Department
Physics Department
Applied Mathematics Department
Oceanography Department
Meteorology Department
Mechanical and Aerospace Engineering Department
Space Systems Academic Group
Systems Engineering Department
Undersea Warfare Academic Group
Engineering Acoustics Academic Committee

Graduate School of Operational and Information Sciences

Computer Science Department
Cyber Academic Group
Information Sciences Department

Operations Research Department
Defense Analysis Department

School for International Graduates Studies

National Security Affairs Department
International Graduate Programs Office
Defense Resources Management Institute
Center for Civil-Military Relations
Center for Homeland Defense and Security
Center for Contemporary Conflict
Center for Stabilization and Reconstruction Studies

Research Institutes

In addition to the Schools, the Naval Postgraduate School includes the following research centers and interdisciplinary institutes that combine education and research.

Cebrowski Institute for Innovation and Information Superiority

www.nps.edu/cebrowski

In a world dominated by distributed communication networks, the Cebrowski Institute for Innovation and Information Superiority facilitates cross-discipline studies in how information processes and technologies can strengthen national security. Main areas of concentration are hastily formed networks, network centric operations, cross-sector collaborations, worldwide consortium for the grid (W2COG), mobile devices and communications, information operations, counterterrorism and irregular warfare, information assurance, information security, and the skills of innovation. The Institute operates as a federation of research centers and projects serving a community of students and faculty.

Wayne E. Meyer Institute of Systems Engineering

www.nps.edu/research/meyer

The Meyer Institute conducts a program of systems research dedicated to the understanding of systems for defense applications. Research programs conducted by the Meyer Institute respond primarily to the needs of military sponsors. Current thrusts include Warfighting Capability Engineering, Enterprise Systems Engineering, Model Based Systems Engineering, and System of Systems Engineering & Integration.

The Meyer Institute also provides support for the education of officers of all services, including international students. This educational focus is on Engineering Leadership, addressing the development of professional

engineering knowledge, skills, and abilities as competent and proficient engineering leaders, and the development of engineering leaders throughout the Department of Defense who are strategic system thinkers.

MOVES Institute

www.movesinstitute.org

The Modeling, Virtual Environments, and Simulation Institute is the nation's Institute for Defense Modeling and Simulation focusing on enhancing the operational effectiveness of our joint forces and our allies by providing superior training and analysis products, education, and exemplary research. The Institute manages graduate degree programs in Modeling and Simulation in support of all the services and our allies. The Institute's research focus is in the areas of combat modeling, visual simulation, training and human systems, intelligent agents, and adaptive systems.

Center for Executive Education

www.nps.edu/academics/centers/cee/

The Center for Executive Education is exclusively dedicated to enhancing the knowledge and understanding of leaders within the Department of Navy and Department of Defense and those who are in partnership with the leaders who will be making critical decisions affecting the nation's readiness in this complex and rapidly changing environment. Tailored courses in executive education for leaders and their staffs are available and may be delivered on campus or at the requesting command's location. CEE spaces are also available for executive symposiums and off-site conferences. Please contact the CEE by calling (831) 656-3334 or visiting our website.

International Graduate Programs Office

The International Graduate Programs Office is responsible for the cultural, social and academic integration of the international community. The office is charged with interacting with outside agencies, military and civilian to accomplish the goals of the Joint Security Cooperation Education and Training (JSCET) Program and the Field Studies Program (FSP). Additionally, it is responsible for the International Sponsor Program and acts as the Command Sponsor to the International Executive Committee.

Since 1954, over 5,300 International officers and government sponsored civilians from over 100 countries have graduated from NPS. Many have gone on to achieve positions of prominence within their military services, governments, and private industry. The International Program at NPS serves as an integral link in establishing the long-term military-to-military relationships between our U.S. and international officers. The International Graduate Programs Office sponsors the following courses:

IT1500 Informational Program Seminar for International Officers (4-0)
Provides international students with an awareness and functional understanding of internationally recognized human rights and the American democratic way of life. Areas of emphasis introduced during the seminar include civil-military relations, human rights, relationships in a democratic society, and a comparative look at the U.S. free enterprise system.

IT1600 Communication Skills for International Officers (3-0)
Provides the opportunity to enhance English speaking and listening skills by taking part in organized oral exercises, group discussions, and instructional briefings on a variety of subjects. The course addresses pronunciation by incorporating language software programs to improve speaking. Building reading and writing skills is part of the course but not the main focus.

IT1700 Academic Writing for International Officers (3-0)
IT1700 prepares international students for the task of writing a thesis or research paper for an American institution of higher-education. The course deals with Change Description the rhetorical styles of an academic paper and, to that end, examines appropriate organization, content, audience consideration, voice, and source citation. Students produce both in-class and out-of-class work. The course also covers strategies for thesis preparation. Analysis and discussion of sample articles and essays-by published professionals and by the class members-are important elements of the D learning experience. So is a vigorous dedication to the writing process, which includes pre-writing, writing, revision, and proofing. For these reasons, students should expect to devote to the course up to six (6) hours each week over and above the three (3) hours of class contact time.

The point of contact for requests to the International Graduate Programs office is:

Gary Roser, Col, USMC (Ret.)
Assistant Dean of the School of International Graduate Studies
Commercial: (831) 656-2186

DSN 756-2186
Fax: (831) 656-3064
Website: www.nps.edu/Adminsrv/IGPO/index.html

Library

Dudley Knox Library contributes to learning, research and teaching, anytime and anywhere, through relevant and evolving collections, tools, services, and spaces designed for NPS patrons of today and tomorrow. The Library provides patrons in Monterey or at remote locations with: a portal to open-access and limited distribution (to SECRET) information; physical and virtual places for individual and group study, research and learning; and a tailored mix of traditional and progressive library services delivered by friendly, knowledgeable staff and supported by intuitive, seamless technology interfaces.

The Library website is the gateway to carefully selected scholarly information such as print and electronic books, databases, journals maps, NPS dissertations/theses/reports, faculty publications, and much more. Librarians have created topical bibliographies, instructional tutorials, and research guides pertinent to the military and national defense needs of NPS faculty, students (resident and distance learners), and staff. Off-campus remote access to licensed e-resources is available to authorized users 24 hours a day, 7 days a week. Patrons can also request materials from other libraries and many of these items are delivered to a website portal that is accessible 24/7.

The Library collection includes: more than 175,000 full-text online books and journals; approximately 518,000 print volumes; about 500,000 microforms; access to more than 140 online databases; plus special collections and archives that include: NPS historical archives, the Christopher Buckley, Jr. collection of naval and maritime history books, and selected maps. The Library is a selective depository for government documents and information distributed through the Federal Depository Program. The Restricted Resources and Services library provides staff, collections, and services in support of limited distribution and classified needs, including: limited/classified documents; research and instruction assistance; online catalog; research support services; classified network access; and secure conference facility with audio visual display capabilities.

For more information, please visit www.nps.edu/library.

Information Technology and Communication Services

The ITACS (Information Technology and Communication Services) organization incorporates all communication services, telephone support, and network support into the core computing functions that have been provided by the Naval Postgraduate School since 1953. Website: www.nps.edu/Technology.

Accounts

All faculty, students, staff, and contractors of the Naval Postgraduate School may have a network access account. Upon written request, users with a legitimate academic need can also get a Unix or a Mainframe account. All computer accounts are for official use only, for the sole and private use of the account holder. All new resident students, faculty, staff, and contractors must check in at the Office of Student Services in the basement of Herrmann Hall to register in the "Python" Student Information System and to get a computer account. Student Services is located in Herrmann Hall, Room 039. Phone (831) 656-3815.

Software Availability

Many different software programs are installed and supported by ITACS. A few of these products are site licensed and can be installed at home for those with valid NPS accounts. The software currently available can be found at the software download page: www.nps.edu/Technology/SoftwareLib/index.htm.

Virus Protection

All e-mail messages are scanned for viruses and for prohibited executable attachments on the exchange servers. Although anti-virus programs are remotely administered to on campus systems by the Technology Assistance Center ("TAC"), users are responsible for keeping non-NPS systems that connect to the network clean of viruses. Anti-virus software is available for installation on home computers at the software download page: www.nps.edu/Technology/SoftwareLib/index.htm.

Wireless Computing

For wireless-capable laptops that need to connect to the NPS wireless network, please visit the TAC self-help site at http://wiki.nps.edu/tac. As always, if further assistance is needed, please bring the laptop to the TAC in Ingersoll Hall, Room 151.

GENERAL ACADEMIC INFORMATION

Course Codes

Courses are designated by an alphanumeric symbol consisting of two letters and four numbers. The first two letters designate the academic department, committee or group that offers the course and are defined as follows:

Course Prefix	Academic Group Name	Dept or Academic Group Prefix	Administered by
AE	Mechanical and Aerospace Engineering	MAE	GSEAS
CC	Information Sciences	IS	GSOIS
CS	Computer Science	CS	GSOIS
CY	Cyber Academic Group	CAG	GSOIS
DA	Defense Analysis	DA	GSOIS
EC	Electrical and Computer Engineering	EC	GSEAS
EO	Electrical and Computer Engineering	EC	GSEAS
FL	National Security Affairs	NS	SIGS
GB	GSBPP	GB	GSBPP
GE	GSBPP	GB	GSBPP
GP	Global Public Policy Academic Group	GP	GPPAG
IO	Information Sciences	IS	GSOIS
IS	Information Sciences	IS	GSOIS
IT	International Programs Office (IPO)	INT	IPO
IW	Information Sciences	IS	GSOIS
MA	Mathematics	MA	GSEAS
ME	Mechanical and Aerospace Engineering	MAE	GSEAS
MN	GSBPP	GB	GSBPP
MO	Mathematics	MA	GSEAS
MR	Meteorology	MR	GSEAS
MS	Mechanical and Aerospace Engineering	MAE	GSEAS
MV	Modeling, Virtual Environments and Simulation	MOVES	GSOIS
MX	Mechanical and Aerospace Engineering	MAE	GSEAS
NS	National Security Affairs	NS	SIGS
NW	Naval War College (NW)	NW	NW
OA	Operations Research	OR	GSOIS
OC	Oceanography	OC	GSEAS
OS	Operations Research	OR	GSOIS
PC	Physics	PH	GSOIS
PH	Physics	PH	GSEAS
SE	Systems Engineering	SE	GSEAS
SI	Systems Engineering	SE	GSEAS
SO	Defense Analysis	DA	GSOIS
SS	Space Systems	SP	GSEAS
SW	Computer Science	CS	GSOIS
TS	Mechanical and Aerospace Engineering	MAE	GSEAS
UW	Undersea Warfare	USWAG	GSEAS

Course Credit Value

Following the course designator are two numbers in parentheses separated by a hyphen, which indicate the hours of instruction per week in the classroom and in the laboratory, respectively. When calculating quarter-hours for the credit value of the course, laboratory hours are assigned half the value shown. Thus a (3-2) course, having

three hours lecture and two hours of laboratory, will be assigned a credit value of four-quarter-hours.

Courses are assigned numbers in accordance with their level of academic credit:

0001-0999	No credit
1000-1999	Lower division college credit (Freshman - Sophomore Level)
2000-2999	Upper division college credit (Junior - Senior level)
3000-3999	Graduate credit
4000-4999	Graduate credit

Course Descriptions

For the most up to date course descriptions, access the online catalog at www.nps.edu/admissions/catalog/. The online catalog is updated online quarterly.

Requirements for the Master of Arts Degree and the Master of Science Degree

The master's degree may be awarded for successful completion of a curriculum which has the approval of the Academic Council as meriting the degree. Such curricula shall conform to current practice in accredited institutions and shall contain a well-defined major.

General Naval Postgraduate School minimum requirements for the master's degree are as follows:
· 32 quarter-hours of graduate level credits of which at least 20 quarter-credits must be earned from NPS*.
· A thesis or its equivalent is required.

*NPS generally allows a maximum of 12 graduate-level, quarter-credits to be transferred for purposes of earning a graduate degree. However, an additional 12 quarter-credits may be transferred from the Air Force Institute of Technology (AFIT) in Dayton, Ohio. This is in addition to the normal transfer allowed (12), bringing the total to a maximum of 24 quarter-credits transferable from AFIT to NPS. Permission to transfer a specific course to serve as a substitute for a degree requirement will be determined by the Department Chairman or equivalent person responsible for nominating candidates for degrees at NPS and must be pre-approved in a coherent plan of study for the student. Regardless of transfer credits allowed, all NPS master's degrees still require at least 20 quarter-credits be earned directly from NPS.

To be eligible for the master's degree, the student must attain a minimum average quality point rating of 3.00 in all of the 3000 and 4000 level courses in his/her curriculum a 2.75 in all courses of the curriculum.

Thesis Format Requirements

The Thesis/Dissertation/MBA Project Report and Joint Applied Project Preparation Manual provides formatting and procedural guidance for preparing and processing electronic thesis/dissertation/reports at the Naval Postgraduate School. It covers both unclassified and classified theses/reports. All references to "theses" also refer to Dissertations, MBA Professional Reports and Joint Applied Projects. The document is on the web at www.nps.edu/research/documents/thesis_prep_manual.doc

Dual Degree Programs

Students who wish to pursue a dual degree program must satisfy QPR and other curricular/departmental requirements, as set forth in the Academic Policy Manual.

A dual degree program is one in which a student pursues two distinct master's degrees simultaneously. Any program which can lead to the award of two master's degrees is, in its entirety, a *special program* that must be approved by the Academic Council.

A student is qualified to enter a dual degree program if the Program Officer and Academic Associate certify that the student possesses a Total Quality Point Rating (TQPR) which is at least 3.75 and in the top 25% of the TQPRs of the students in the last four graduating sections of his/her curriculum.

The special dual degree program will be terminated if the student does not maintain a performance which places him within the top 50% of each program. The Program Officers and Academic Associates will monitor the student's performance each quarter and will report to the Academic Council if such a performance is not being maintained.

The program which leads to two graduate degrees must satisfy the requirements of both degrees. Course validations early in the program will allow the student to take the additional 3000 and 4000 level courses as required for the dual degree program.

A single thesis may be used to satisfy the requirements of both departments provided it shows relevance to and mastery of both fields, is permitted by the policy of both departments, and is co-advised by a member of each Department.

The dual degree program must satisfy the enrollment limitations cited in the Academic Policy Manual. If a student requires waivers for enrollment limitations, the request for waiver must be included in the application for the special program.

The Academic Council requires a written endorsement of the dual degree program from the student's sponsor or a written attestation by a Department Chair, Academic Associate, or Program Officer that the sponsor has been

notified of the student's proposal and approves of the program.

Educational Skill Requirements

The majority of NPS curricular programs are developed based on Education Skill Requirements (ESRs). Education Skill Requirements define the fundamental concepts required in the graduate education curriculum as directed by each curriculum sponsor and Subject Matter Expert (SME). These ESRs represent the criteria essential for successful performance in billets requiring each subspecialty.

The Program Officers and academic staff at the Naval Postgraduate School coordinate biennial curriculum reviews with the curriculum sponsors for each curriculum. These reviews are conducted to ensure that the ESRs are current and relevant to the needs of the military, that programs meet the knowledge, skill and competencies of the ESRs, and that the changing needs of the sponsors are reflected in each curriculum. The ESRs for each curriculum offered at Naval Postgraduate School are included in this catalog at the end of each curriculum listing as applicable.

Curriculum content is continually updated to maintain pace with changes in each field of study. The Naval Postgraduate School Program Officers and faculty maintain a continuous dialogue with curriculum sponsors and Subject Matter Experts. These dialogues culminate in the biennial curriculum reviews. Curriculum sponsors and SMEs are active in each curriculum in areas such as providing current and relevant material and speakers for classes, forwarding potential thesis topics that are of interest to the military, and providing opportunities and financial support for student experience tours and travel.

These partnerships between the Naval Postgraduate School and the curriculum sponsors ensure that the educational needs of each subspecialty community are continually met through relevant education in each curriculum at NPS.

Half-Quarter Math Refresher

This is a sequence of courses developed specifically to provide a refresher of subject material pertinent to the curriculum to be studied. The number and types of courses, which comprise the technical refresher, are developed by the Program Officer and Academic Associate for the student's primary curriculum. The purpose of the technical refresher is to reacquaint students with technical material and at the same time help them build good study habits.

The Six-Week Math Refreshers begin during the first half or second half of the quarter and typically consist of:

Math Refresher I (first half of quarter)
MA1113
MA1115

Math Refresher II (last half of quarter)
MA1114
MA1116

Prospective students are encouraged to contact the Program Officer regarding the specifics of their particular Six-Week Technical Refresher course sequence.

Technical Refresher Quarter

This is a sequence of courses developed by the Program Officer and the Academic Associate to better prepare incoming students for entering a technical curriculum.

This course sequence is designed for prospective students who:

1. have an Academic Profile Code (APC) that indicates a deficiency in mathematics and/or scientific and technical subject matter (i.e., their APC does not qualify them for direct entry to a technical curriculum), or

2. in completing their review of the prospective student's academic record, the Program Officer and Academic Associate have concluded that sufficient time has expired since the student's most recent college experience and as such, the student would benefit from the Technical Refresher Quarter.

For some students, this may also include courses from the Six-Week Math Refresher.

The refresher sequence is normally twelve weeks in length; however, there are occasions when a student may be assigned two quarters of refresher prior to entering a technical curriculum.

Typical course sequences for refresher quarters are shown in these examples:

Space Systems Operations
MA1113
MA1114
PH1001
PH1102

Operations Analysis
MA1113
MA1114
MA1025
OA1600

Mechanical Engineering
EC1010
MA1113
MA1114
PH1121

Computer Science
CS1100
MA2025
MV1000
NW3230

Prospective students are encouraged to contact the Program Officer regarding the specifics of their particular refresher course sequence.

Grading

Student academic performance is evaluated in terms of quality points assigned to the letter grade achieved in a course. Based on the level of achievement associated with each letter grade, the corresponding quality point values range from a maximum of 4 to a minimum of 0 as follows:

Grade	Point Value
A	4
A-	3.7
B+	3.3
B	3
B-	2.7
C+	2.3
C	2
C-	1.7
D+	1.3
D	1
X	0

Letter designations for which no quality points are assigned are given as follows:

I	Incomplete
W	Withdrew
N	Un-graded
P	Pass
F	Fail
T	Thesis Research

Incomplete Grade: A grade of "I" grade is given when an identifiable portion of the course remains unaccomplished at the end of the quarter. One additional quarter is granted to submit the delinquent work. If the "I" is not removed within the twelve weeks following the end of the term in which it was assigned, it becomes an "X."

Pass/Fail Grade: Courses may be designated for "P" and "F" grading when approved by the Academic Department and the Academic Council. A student in a degree program who wishes to take courses not in his or her normal program may also elect to take them in the Pass/Fail mode. Approval must be granted by the student's cognizant Program Officer and Department Chairman. It is the responsibility of the student to exercise the P/F option by informing the instructor in writing at the time of enrollment that a P/F grade is desired. A copy of the approval request shall be forwarded to the Registrar. Students electing to receive the P/F grade in letter graded courses may not apply the hours toward the degree and curriculum requirements of any program.

Thesis Research Grade: A grade of "T" indicates that satisfactory progress is being made on thesis work (XX 0810), dissertation work (XX 5810), or on a project (XX 4090), but evaluation depends on completion of the research, thesis, dissertation or project, at which time the instructor, Academic Department, or Academic Council shall change the "T" grade to one reflecting the Pass/Fail evaluation.

Quality Point Rating (QPR)

When the quarter-hour credit of a course is multiplied by the point value of the student's grade, a quality point value for the student's work in the course is obtained. Example: A student receives a grade of B in a course with three hours lecture and two hours lab. The course credit value of four quarter-hours is multiplied by the point value assigned to the grade of B, resulting in 12.0 quality points for the course.

The sum of the quality points for all courses divided by the sum of the quarter-hour credit of these courses gives a weighted numerical evaluation of the student's performance, termed the *Quality Point Rating* (QPR). A student achieving a QPR of 3.0 has maintained a "B" average in all courses undertaken with a proper weight assigned for course hours.

Withdrawing from a Course

A student may withdraw from a course up to the end of the second week of the quarter without any record of it showing on the transcript. Subsequent withdrawals may be made up to the end of the eighth week of the quarter, but a grade of "W" is entered for the course on the transcript. No withdrawals can be made after the eighth week.

Course Registration and Credit

Each student must be registered in each course in which he/she is a candidate for credit not later than the tenth school day the quarter (holidays excluded). No student will receive credit for a course unless registration in that course has been approved by one of the following: the student's Program Officer or Academic Associate, the Chairman of his/her doctoral committee or the Vice Provost for Academic Affairs.

Repetition of Courses

A student may repeat a course for the purpose of improving a grade provided such course repetition is offered by the Naval Postgraduate School. Approval must be granted by both the Program Officer and the Department or Group Chairman concerned and the Registrar is to be notified.

For record purposes, both the original and the repeated courses are to be shown on the transcript. For Quality Point Rating computation, the credit hours of the course shall be counted once, using the grade received from the most recent time that the student enrolled in the course.

Overload

Without special permission, a student may enroll for no more than 17 total credit hours or more than four 3000 level and/or 4000 level courses per quarter.

A student may enroll in more than 17 and less than 21 total credit hours with explicit permission of the Vice Provost for Academic Affairs and for more than 21 hours only with explicit permission of the Provost.

If an established degree program's course matrix includes a quarter with more than 17 hours, the students in the program need not apply for a course enrollment limitation waiver. This limit is automatically waived in these cases.

Auditing

Eligible persons will be allowed to audit courses on a space-available basis with the approval of the professor teaching the course. When approval is obtained to audit, students may attend classes, but they have no entitlement to submit papers, questions, or tests for grading nor consume the instructor's time outside of class. Auditors will receive no grade for the course, no credit toward graduation, and no formal recognition of accomplishment for courses they have audited.

Credit by Examination

The award of credit solely on the basis of examination for any 1000 or 2000 level course is permissible. Grades for such courses shall be awarded on a Pass/Fail basis.

Validation

A student with the appropriate background may validate a course that is required for his/her curriculum. Validation will allow the student to omit that course from the program of study; however, no credit will be granted for a course that has been validated. The basic purpose of course validation is to make optimal use of the student's time at the Naval Postgraduate School. Every validation must be justified by documented evidence of prior work in the area of the course to be validated.

The validation of a course must be approved in writing by the Chairman of the department offering the course or a designated representative. Specific criteria for validation (e.g., review of the student's transcripts or examination on the material of the course) are left to the discretion of the cognizant Department Chairman.

After validating one or more courses, it may be possible for a student to complete the program in less than the maximum time allowed.

Veteran's Benefits

For the purpose of determining eligibility for veteran's benefits, full-time enrollment is a minimum of ten credit hours per academic quarter. Both lecture and lab credit hours are applicable to the minimum full load.

Transfer of Credits

Upon entry to the Naval Postgraduate School, each student's academic record will be evaluated for possible transfer of credit or for exemption from portions of the curricular program by validation of course work previously completed. Students may utilize knowledge gained through self-study or experience of service-related education to seek validation. They may also take a departmental examination to gain credit for curricular courses.

Twelve hours of graduate-level courses previously completed may be accepted for transfer credit. These include graduate-level courses taken after completion of the baccalaureate degree and those taken in the last term before award of the baccalaureate if certified to be in excess of degree requirements.

NPS generally allows a maximum of 12 graduate-level, quarter-credits to be transferred for purposes of earning a graduate degree. However, an additional 12 quarter-credits may be transfer from the Air Force Institute of Technology (AFIT) in Dayton, Ohio. This is in addition to the normal transfer allowed (12), bringing the total to a maximum of 24 quarter-credits transferable from AFIT to NPS. Permission to transfer a specific course to serve as a substitute for a degree requirement will be determined by the Department Chairman or equivalent person responsible for nominating candidates for degrees at NPS and must be pre-approved in a coherent plan of study for the student. Regardless of transfer credits allowed, all NPS master's degrees still require at least 20 quarter-credits be earned directly from NPS.

Questions on transfer credit should be directed by letter to the appropriate curricular Academic Associate as listed in this catalog.

Academic Counseling

The Naval Postgraduate School provides academic counseling services to assist officers in developing individual educational plans. Officers who have chosen specific curricula or who have been selected or detailed for graduate education in programs at Naval Postgraduate School, are advised to contact the appropriate Program Office listed in the Program Offices and Programs section of this catalog. Other prospective students seeking general information about the curricula offered at the school or the fully-funded graduate education selection process are advised to contact the Director of Admissions (Code 01C3), Naval Postgraduate School, or telephone (831) 656-3093, DSN 756-3093, e-mail: grad-ed@nps.edu.

Medical and Operational Military Absences

The academic record of a student may be deleted completely for a given term when the student is absent for a portion of the term for medical or operational reasons. The transcript will show, "Excused for the term for medical reasons" or "for operational military reasons." The student shall not be permitted to delete only a portion of the courses for this reason. The grade "W" shall be used when it is necessary to withdraw from only a part of the student's program. Such excusals shall be requested by the Program Officer and approved by the Vice Provost for Academic Affairs.

Honor Code

NPS students are expected to uphold the highest standard of honesty and integrity and must follow the academic honor code at all times. Plagiarism, fraud, cheating, and verbal or written misrepresentation constitute violations of the Academic Honor Code. Instructor-authorized group activities/projects should rightly acknowledge the efforts of all respective participants. Unless faculty clearly state that consultation/cooperation in an assignment or course is permissible, all work must be exclusively from the student(s) listed on the document for all graded work. Any restrictions placed by the instructor on the materials that may be used by a student in preparation for and performance of all graded work, must be followed.

While no single list can identify and define all types of academic honor code standards, the following are cited as examples of unacceptable behavior:

1. **Cheating** - Using unauthorized notes, study aids, or information on an examination; looking at another student's paper during an examination; altering a graded work after it has been returned, then resubmitting it for re-grading; allowing another person to do one's work and submitting it under one's own name; taking a longer time period than was authorized to complete a take-home exam.
2. **Plagiarism** - Submitting material that in part or whole is not entirely one's own work without attributing those same portions to their correct source. Student shall ensure all references are properly cited.
3. **Fabrication** - Falsifying or inventing any information, data, or citation.
4. **Obtaining an Unfair Advantage** - Gaining access to examination materials prior to the time authorized by the instructor; unauthorized collaboration on an academic assignment; possessing, using or circulating previously given examination materials where those materials clearly indicate that they are to be returned to the instructor at the conclusion of the examination.

Appropriate disciplinary action may include disenrollment, fitness report comments, and/or a letter to appropriate government agencies or official service branches. Individuals suspecting Academic Honor Code violations are required to inform the appropriate academic/curricular officials.

Grievance Procedures

Complaints of discrimination and sexual harassment require the continual attention of the President on how they are handled by the chain of command. A complaint consists of issues or concerns related to race, religion, sex, national origin, age, or retaliation brought to the attention of the proper authority related to the known, suspected, or probable offense under the Uniform Code of Military Justice (UCMJ), a violation of civil law, or other inappropriate conduct. A complaint may be made orally or in writing with the Command Deputy Equal Opportunity Officer or Dean of Students.

The procedures an individual must follow to present a complaint are divided into three categories:

1. Informal
2. Formal
3. Alternative avenues

All procedures for each of these courses of action are located in the NPS Military Equal Opportunity Policy Guidance and Discrimination Grievance Procedure Manual available from the Office of the Dean of Students.

Transcript Requests

To request a copy of your transcript please visit the Registrar's website at http://www.nps.edu/Academics/Admissions/Registrar/Transcripts/Transcripts.html.

If you have any questions or concerns please call or e-mail the Registrar's Office at (831) 656-2591 or registrar@nps.edu.

Recent graduates: Please note that it takes approximately 90 days after graduation for your diploma and final transcripts to be generated.

ADMISSIONS

For admission to either a degree or a non-degree program, whether on campus or by distance learning, the minimum qualification is a regionally accredited baccalaureate degree with appropriate preparation for the proposed program. Each program has its own admissions criteria. The Academic Profile Code (APC) is only one element of the admissions criteria used to evaluate applicants for admission to NPS. The school requires submission of official transcripts covering all college work (undergraduate and graduate) completed to date. It is recommended that applicants apply and submit all required materials at least six months prior to the estimated arrival date, or corresponding graduate education selection board. Any delay in the arrival of necessary documentation to include official transcripts will impede the evaluation for admissions.

Master's Program Admissions

A candidate entering any master's degree program must possess a baccalaureate degree from a regionally accredited institution - or in the case of foreign students, a recognized institution - with a minimum grade point average of 2.2 on a 4.0 system, of which 75 semester hours/112 quarter hours must be letter-graded.

If the candidate does not possess an undergraduate degree, the following are standards for admission to a program leading to a graduate degree:

1. A minimum of 75 semester hours/112 quarter hours of letter-graded undergraduate work must have been completed at regionally accredited institution with an average grade of "B." Any course with a "C-" grade or lower will not be counted in the total. Courses which have been duplicated on various transcripts should be counted only once in arriving at the number of semester hours to be credited.
2. The general education requirements prescribed for the Naval Postgraduate School baccalaureate degree must be satisfied as specified in the Academic Policy Manual.
3. No more than 20 semester hours may be credited for work done in non-degree granting service schools.
4. Final approval of the applicant will be made by the appropriate academic unit Chair.

All applicants must submit an online application at http://www.nps.edu/Academics/Admissions/ApplyOnline/ApplyNow.html to be considered for entry into any NPS program. All undergraduate and graduate work to date

(degree and non-degree) is required for academic evaluation. Please print the confirmation page displayed upon submission of the completed application. It contains further instructions regarding transcripts. Failure to comply with the instructions will delay the processing of the application.

U.S. Naval Officers

Selection for the Navy's fully funded graduate education program is based on outstanding professional performance, promotion potential and a strong academic background. Officers interested in this program should contact their assignment officers to determine professional qualification status. All applications for APC calculation should be initiated at http://www.nps.edu/Academics/Admissions/ApplyOnline/ApplyNow.html.

Upon determination of academic qualification (by NPS), individuals are eligible for assignment. Officers who are professionally qualified but lack academic qualifications should contact the Director of Admissions at admissions@nps.edu for information on ways to improve their academic backgrounds.

U.S. Army Officers

Army officers applying to NPS should request an Academic Profile Code (APC) evaluation online at http://www.nps.edu/Academics/Admissions/ApplyOnline/ApplyNow.html for the purpose of pre-screening prior to applying to Army Advanced Civil Schooling (ACS). Requesting an APC review in advance of applying to an ACS training agency will assist in the selection process and will expedite the formal NPS admissions process after an officer has been selected by the Army. Officers interested in fully funded education at NPS should provide their training agencies a copy of their NPS conditional acceptance letter when submitting their ACS applications.

Army officers applying for admission to the Department of National Security Affairs must include scores from the Graduate Record Examination, taken within five years of the date of application.

U.S. Air Force Officers

Selection for the Air Force's fully funded graduate education program (assigned to AFIT as a full-time student wherein all tuition costs are paid by the Air Force) is based upon professional performance, promotion potential, and academic background. Interested Air Force officers must contact their assignment team at Air Force Personnel Center (AFPC) to determine professional qualification status and potential AFIT-sponsored

graduate education opportunities available in their career fields. Air Force officers wishing to apply for an AFIT-sponsored graduate program must make their desires known to AFPC and follow AFPC application procedures.

To determine eligibility for an NPS curriculum, Air Force officers should apply online at http://www.nps.edu/Academics/Admissions/ApplyOnline/ApplyNow.html, requesting an Academic Profile Code (APC) evaluation for the purpose of pre-screening from the NPS Admissions Office prior to applying to AFPC. Officers should submit a copy of their NPS conditional acceptance letters along with their AF Form 3849 application to AFPC and also maintain a copy in their personal records for future use if selected.

Air Force officers applying for admission to the Department of National Security Affairs must include scores from the Graduate Record Examination, taken within five years of the date of application.

U.S. Marine Corps Officers

NPS opportunities for Marine Corps officers fall under two categories: 1) Special Education Program (SEP) and 2) International Affairs Officer Program.

The Marine Corps holds selection boards for both programs that are announced annually by a MARADMIN message. Marine officers interested in these programs should consult the latest MARADMIN for board details and contact HQMC, MMOA-3 for any additional questions. Prospective applicants should also discuss the timing of NPS attendance with the Career Counseling Branch at HQMC. All Marine Corps officers must apply to NPS for academic eligibility at http://www.nps.edu/Academics/Admissions/ApplyOnline/ApplyNow.html as well as applying to HQMC per the appropriate MARADMIN.

U.S. Coast Guard Officers

Each year, a message is promulgated by the USCG canvassing USCG program managers to nominate officers for graduate education. If you are interested, read the Education and Training Manual on the USCG intranet and speak with your program manager.

Military and Civilian Staff of NPS, Tenant and Local Commands

NPS, tenant command staff and staff of local commands, such as Defense Language Institute (DLI), Monterey Institute of International Studies (MIIS), National Oceanic and Atmospheric Administration (NOAA), and Defense Manpower Data Center (DMDC) are permitted to attend classes on a space available basis. "Local command" is defined as located on the Monterey Peninsula. Employees of a local command may enroll in up to two classes per quarter with written approval from their supervisors and prospective academic associate. NPS employees are guided by the Civilian Academic Development Program NAVPGSCOLINSTRUCTION 12410.1A.

Most staff students seeking official admission into NPS require some time to establish which degrees they want to pursue. It is recommended that such students use the first two quarters (or up to four classes) to decide on a degree program before completing the application for admission.

In order for a degree to be granted, a staff member must be formally accepted and admitted to a degree program. This formal acceptance and admittance can only come from the Director of Admissions. All applications must be submitted online. Please note that even after being formally admitted, staff members are still required to register for classes through the Registrar's office on a space available basis. The Staff/Employee Registration form can be found at the Registrar's office and online. The forms must be submitted each quarter to the Registrar's office during the Add/Drop period, which typically begins in the last two-weeks of the preceding quarter and ends on the tenth school day of the new quarter (holidays excluded).

There is no longer a requirement to submit paperwork to the Academic Council for approval of a staff matrix. Once a student has been accepted, the Admissions Office will send an acceptance letter to the applicant and have the Registrar's office register the student into the approved curriculum.

International Students

Military officers and government civilian employees from other countries may be admitted to most curricula. The procedures for application are available from the Security Assistance Office or Defense Attaché Office of the U.S. Embassy, the MLO, MAAG, OMC or ODC, as appropriate. Correspondence must be processed through official channels; requests from individual prospective students should not be sent directly to the School.

All candidates must satisfy the curriculum academic standards, as described in this catalog. International candidates from non-English speaking countries will also be required to validate their fluency in English through the Test of English as a Foreign Language (TOEFL). Minimum TOEFL score required for direct entry to NPS is 83 IBT (Internet Based Test and 560 Written Test. Candidates for PhD Programs or Accelerated Programs need to score at least 100 on the IBT. Waivers will be considered on a case by case basis for scores between 90 and 100 based on the overall application package. (For candidates applying for entry into the Department of National Security Affairs, an IBT score of 90 is required.) If a candidate fails to achieve the 83 IBT or 560 Written score, but does achieve a score of 70 IBT or 523 Written or higher, he/she is eligible to attend the TOEFL Preparatory

ADMISSIONS

Academic Writing Course, MASL P177022 (16 weeks) at the Defense Language Institute in San Antonio, Texas.

The only countries exempted from TOEFL testing are those countries who are exempted from all ECL testing requirements as determined by the Defense Security Cooperation Agency (DSCA) Policy memorandum 11-67 dtd 27 Dec 11 (Antigua, Australia, Bahamas, Barbados, Belgium, Belize, Brunei, Canada, Dominica, Grenada, Guyana, India, Ireland, Jamaica, Malta, Mauritius, Netherlands, New Zealand, Norway, Singapore, St. Kitts, St. Lucia, St. Vincent, Trinidad, and the United Kingdom).

When applying for a TOEFL exam, the NPS identification code is 4831. This code should be included on the registration application so a copy of the results can be sent directly to NPS. TOEFL test results are valid for two years from the test date and must be valid when the student reports to NPS. Questions regarding available programs or admission procedures should be directed to Code 04IGP, 1 University Circle, Rm B-047, Naval Postgraduate School, Monterey, CA 93943-5025. Telephone: (831) 656-2186 or e-mail from this website: www.nps.edu/Adminsrv/IGPO/index.html.

Civilian Employees of U.S. Government

A civilian who is an employee of, or sponsored by, an agency of the United States Federal Government may be admitted for study upon request and sponsorship of the agency. Federal civilian employees are not required to pursue the curricula designed for officer-students as described in this catalog but instead determine, with the guidance from the assigned Academic Associates, the combination of courses that will best meet their needs.

A civilian who is expecting agency sponsorship should apply online requesting evaluation for admission at least six months prior to expected commencement of studies. A completed application should indicate the desired curriculum and degree intentions and be accompanied by a complete set of official transcripts of all previous college work to date (degree and non-degree). GRE and/or GMAT scores are required for consideration for admission to any doctoral program.

All official supporting documents should be directed to the Director of Admissions, Naval Postgraduate School, 1 University Circle, He-022, Monterey, CA 93943. Questions about available programs or admission procedures may be telephoned to (831) 656-3093 or DSN 756-3093 or e-mail: admissions@nps.edu.

The individual's employing agency is expected to meet the tuition expense for regular on-campus enrollment.

Civilian Scholarship-for-Service Programs

The Naval Postgraduate School offers several Scholarship-for-Service programs in which civilians, who are U.S. citizens, are supported with a full salary, generous government benefits, and full tuition waiver while working toward a master's or doctoral degree. Upon degree completion, these students are required to fulfill an obligated service commitment with the Defense Department or in certain programs of other federal agencies. These are highly competitive programs that require an outstanding academic record. GRE and/or GMAT scores are required for consideration for admission to any doctoral program. Current government employees are eligible for some of these programs.

To find program specific information go to Scholarship for Service at the NPS website. Questions about available programs or admission procedures may be telephoned to (831) 656-3093 or DSN 756-3093 or e-mailed to admissions@nps.edu.

Please note: The online application is a means of determining academic eligibility to attend programs offered at NPS and is not a scholarship application.

You must submit a separate scholarship application in addition to the NPS online application to be considered for a scholarship. Links to the Scholarship program applications currently accepted by NPS are found at www.nps.edu/Academics/Admissions/ScholarPrograms/.

Programs available to civilian students can be classified as follows:

Regular Curricula: The School's numerous curricula are designed to meet service-specific education requirements for military officers. These curricular requirements typically exceed the requirements to earn the degree alone. For example, military students may be required to take more courses than civilian students. Civilian students may enter any curriculum at the point at which they are qualified and complete the curriculum along with regular officer students.

Degree Programs: Civilian students may enter programs designed to award a graduate degree, while meeting the educational goals of the individual or the sponsoring agency. To minimize the residency requirement, an off-campus preparatory program may be developed in consultation with a school advisor. If the available time in residence is insufficient to complete degree requirements, the thesis-project portion of the program may be completed off-campus.

Non-Degree Programs: Civilian employees may desire to pursue a program for professional advancement without a degree objective. NPS certificate programs are one such option available to civilians. These typically comprise four courses taken over one year. Certificate Program Managers

are the initial point of contact for admission. Alternatively, for groups of employees from an agency, special courses can be offered to meet particular requirements, provided the demand is in an area of expertise of the school.

Civilian Employees of DoD Contractors

NPS accepts a limited number of employees of corporations that are contractors for the Department of Defense (DoD) in programs related to systems engineering and defense product development. Specifically, the following master's degree programs are open to employees of DoD contractors:

Graduate School of Engineering and Applied Sciences
311 - Systems Engineering (DL)
316 - Space Systems Operations (DL)
366 - Space Systems Operations
372 - Meteorology
373 - Meteorology and Oceanography (METOC)
374 - Operational Oceanography
380 - Applied Mathematics
440 - Oceanography (Master's-only)
525 - Undersea Warfare
533 - Combat Systems Sciences & Engineering
535 - Underwater Acoustic Systems (DL)
570 - Naval/Mechanical Engineering
580 - Systems Engineering
590 - Electronic Systems Engineering
591 - Space Systems Engineering
592 - Electronic Systems Engineering (DL)
721 - Systems Engineering Management-PD21 (DL)

Graduate School of Operations and Information Sciences
326 - Cyber Systems and Operations
356 - Information Systems & Operations
360 - Operations Analysis
361 - Joint Operational Logistics
362 - Human Systems Integration
363 - Systems Analysis (DL)
365 - Joint Cmd, Cntrl, Comm, Comp/Intel (C4I) Sys
368 - Computer Science
369 - Software Engineering (Resident & DL)
370 - Information Systems & Technology
376 - Computer Science (DL)
399 - Modeling, Virtual Environments & Simulation
475 - Remote Sensing
595 - Information Warfare

Joint GSEAS/GSOIS
308 - Systems Engineering & Analysis

Graduate School of Business and Public Policy
805 - Executive Master of Business Administration (DL)
814 - Transportation Management

815 - Acquisitions & Contract Management
816 - Systems Acquisition Management
819 - Supply Chain Management
827 - Materiel Logistics Support Management
835 - Contract Management (DL)
836 - Program Management (DL
837 - Financial Management

For enrollment information on these programs, please visit our Website at:
www.nps.edu/Academics/Admissions/Programs/.

Contractor Application Process

Application packages should include:
1. Submittal of a completed online application. The online application can be accessed at http://www.nps.edu/Academics/Admissions/ApplyOnline/ApplyNow.html.
2. Certified transcripts from ALL undergraduate and graduate institutions attended.
3. Letter from employer stating its willingness to pay tuition for the program and supply salary and benefits during your time at NPS, if a resident program.

Applications should be submitted online, and all official required documents should be mailed to the Naval Postgraduate School, Director of Admissions, 1 University Circle, He-022, Monterey, CA 93943. If you have questions about available programs or admission procedures please call (831) 656-3093 or e-mail: admissions@nps.edu.

Doctoral Program Admissions

The Navy Doctoral Program

This program typically selects a limited number of Navy officers each year for doctoral studies. Generic details are provided in a Navy Personnel Command (NAVADMIN) message that addresses curriculum subspecialty quotas, service obligation, and Naval Personnel Command application procedures for this program. NPS applicants must additionally submit an online application at http://www.nps.edu/Academics/Admissions/ApplyOnline/ApplyNow.html. Upon submission of your application online, you will receive a confirmation page outlining the fuller requirements necessary for a *complete* Ph.D. application to NPS. Applications for doctoral study at NPS under this program are first reviewed by the Admissions Office to ensure all necessary information has been received. Only then is the application package forwarded to the appropriate Departmental Ph.D. committee for consideration. Note: Incomplete applications will not be forwarded -- it is the responsibility of the applicant to ensure the Admissions Office has received all necessary information as outlined in the

confirmation page of the online application form. Doctoral admission requirements are set by the academic units -- the Admissions Office does not have the authority to waive these requirements. Selected officers are notified by their detailers after the Navy Personnel Command conducts an annual Doctoral Program Selection Board.

The Permanent Military Professor (PMP) Program

This program is designed to prepare Navy officers to become military instructors at the U.S. Naval Academy (USNA), the Naval War College (NWC), and the Naval Postgraduate School (NPS). These officers serve a critical role in the education of the Navy's Officer Corps by combining fleet experience with advanced academic preparation to convey relevant knowledge to USNA midshipmen and officers attending NWC or NPS.

Applicants for the PMP program must have attained the rank of 0-5 (select) and 0-6s may apply only if in possession of a completed doctorate in the discipline they propose to teach. The Navy Personnel Command announces the program and publishes generic application procedures through an annual NAVADMIN message.

NPS applicants for both programs must submit an online application at http://www.nps.edu/Academics/Admissions/ApplyOnline/ApplyNow.html. Applications for doctoral study at NPS under this program are first reviewed by the Admissions Office to ensure all necessary information has been received. Only then is the application package forwarded to the appropriate Departmental Ph.D. committee for consideration. Note: Incomplete applications will not be forwarded -- it is the responsibility of the applicant to ensure the Admissions Office has received all necessary information as outlined in the confirmation page of the online application form. Doctoral admission requirements are set by the academic departments -- the Admissions Office does not have the authority to waive these requirements. The Navy Personnel Command conducts the selection board and notifies selected officers. Once selected, the officers are obligated to serve as a PMP until their statutory retirement date.

Ph.D. applications for Naval Officers (USN/USMC) that do not fall under the Doctoral Studies or PMP guidelines will not be accepted.

Individual Doctoral Programs - All Services, Civilians, and Internationals

NPS doctoral programs are available to officers of all U.S. services, civilian employees of the government, and to individuals sponsored by selected allied nations. Applications may be submitted at any time. An individual applying for admission to a Ph.D. program must hold a bachelor's degree qualifying the student for graduate status in the department of his/her major study, or shall have completed an equivalent course of study.

Naval Officers (USN and USMC) can only apply to Ph.D. programs under the annual USN PMP or Doctoral Studies Program or under the USMC Special Education Program (SEP). At this time, SEP has no quotas for Ph.D. programs. Applications from active duty Marine Corps officers will not be accepted for Ph.D. programs.

All U.S. applications shall be submitted to the Director of Admissions, who will be responsible for processing them. International applications shall be submitted to the International Graduate Programs Office. All completed applications are forwarded to the Chair of the academic unit of the proposed major subject area for determination of acceptability by the Departmental Ph.D. Program Committee. The Chair will recommend appropriate action to the Director of Admissions, who will notify applicants.

NPS PhD applicants must submit an online application at www.nps.edu/Academics/Admissions/ApplyOnline/. Once submitted, an application will only be considered complete if the following materials are submitted:

1. Official copies of all undergraduate and graduate transcripts. (Transcripts from NPS are not necessary.)
2. Results of a Graduate Record Examination (GRE) General Test taken within the past five-years.
3. A brief outline (200 words or fewer) of specific areas of interest within the proposed major field of study.
4. Two letters of recommendation regarding academic potential (three for Information Sciences, Curriculum 474).
5. Applicants to the Ph.D. in Security Studies, Curriculum 694, must provide a writing sample.
6. International applicants not currently enrolled at NPS whose native language is other than English, or whose primary language of instruction was other than English, must submit current results of the Test of English as a Foreign Language (TOEFL). Applicants need to score at least 100 on the Internet-Based Test (IBT). Waivers will be considered on a case by case basis for scores between 90 and 100 based on the overall application package.
7. Attestation by the student's sponsoring agency or nation that they are committed to tuition and salary support during the student's residence at NPS will be required before enrollment.

Applicants should review the NPS catalog for specific application and admission timelines pertaining to their intended Ph.D. program. In particular, applicants for the

Ph.D. in Security Studies should note that although the program accepts applications for its program year-round, admissions decisions are made twice yearly; in March and the last week in September. Furthermore, applicants for the Ph.D. in Security Studies must now possess a Master's degree in Security Studies or a closely allied field.

The mailing address and contact information for the Director of Admissions is:

Naval Postgraduate School
Admissions Office
1 University Circle, He-022
Monterey, CA 93943

Telephone: (831) 656-3093 / DSN 756-3093
E-mail: admissions@nps.edu

The mailing address and contact information for the International Government Programs Office is:

Naval Postgraduate School
International Programs Office
1 University Circle, Rm B-047
Monterey, CA 93943-5025

Telephone: (831) 656-2186
www.nps.edu/Adminsrv/IGPO/index.html

Threshold for Admission

Each curriculum at the Naval Postgraduate School has a specified Academic Profile Code (APC) threshold for admission. See the Curriculum Listing in this catalog for specific APC requirements for each curriculum. Officers with deficient APCs may still qualify for entry into these curricula by completing suitable courses from any regionally accredited institution. In certain instances, NPS offers a technical refresher quarter for applicants whose APC does not qualify them for direct entry into a technical curriculum. Transcripts (not grade reports) of work done at civilian schools must be forwarded to the Director of Admissions, Naval Postgraduate School, 1 University Circle, He-022, Monterey, CA 93943, to effect an APC change. The grades in all courses completed will be used to revise an officer's APC.

Academic Profile Codes

The NPS Admissions office evaluates applicants based on three criteria. The result is the assignment of an Academic Profile Code (APC). This is a three-digit code, which summarizes pertinent portions of a student's prior college performance. The three independent digits reflect an individual's cumulative grade-point average (Quality Point Rating), exposure to and performance in calculus-related mathematics courses and exposure to and performance in selected science and engineering areas.

First Digit

The first digit indicates overall academic performance based on a recalculated* GPA from all previous college transcripts. The first digit is derived from the following table:

Code	QPR Range
0	3.60-4.00
1	3.20-3.59
2	2.60-3.19
3	2.20-2.59
4	1.90-2.19
5	0.00 -1.89

*Failures and repeated courses are included in the GPA calculation.

Second Digit

The second digit represents mathematical background according to the following criteria:

Code	Meaning
0	Math Major/Minor, Quantitative Economics Degree with B or better average; math taken less than or equal to 7 years ago.
1	Lower Level, Upper Level, Linear Algebra with a GPA of at least a 3.5; math taken less than or equal to 5 years ago.
2	Lower Level, Upper Level with average between C+ and B+; math taken less than or equal to 5 years ago. No Linear Algebra.
3	Lower Level Calculus Sequence with a C or better; or if math taken greater than 5 years ago.
4	Calculus for Business/Social Sciences with a C or better. 1 Lower Level Calculus Course with at least a C-. 2 pre-Calculus Courses with a B+ or better.
5	At least one pre-Calculus with C- or better grade.
6	No pertinent college-level math with a grade of C- or better.

*All math courses from calculus through post-calculus are considered when evaluating the transcripts for the second digit. A minimum calculus sequence is Calculus I and II.

Third Digit

The third digit represents previous course coverage in science and technical fields according to the following criteria:

Code	Eng/Tech GPA	Meaning
0	3.00 - 4.00	ABET EAC accredited, BS Eng Degree (regardless of time passed)
1	> = 2.30	Non-ABET EAC accredited, Eng Degree (regardless of time passed)
2	> = 2.30	Any BS Tech degree (regardless of time passed)
3	> = 3.00	Completed calculus-based physics sequence with a B average or above
4	> = 2.00	One calculus-based physics course with at least a C
5	< = 1.99	No pertinent technical courses.

Eng Degrees includes: Aero/Astro, Comp/Elect, Mechanical, Materials, Marine, Naval, Ocean, Systems, Industrial, Chemical, and Bioengineering and Naval Architecture. **This list is not exhaustive.**

Technical degree to include: Applied Physics, Engineering Physics, Physics

Eng/Tech GPA is based upon a 4.0 scale.

General Engineering and EE/ME Technology degrees are not counted as engineering degrees nor technical degrees for purposes of calculating an APC.

When calculating the APC, if the record cannot meet all the requirements to obtain Code 0 (i.e. GPA is 2.75 but all other requirements are met) the Code drops to a 1 automatically but no further.

A first digit code of 0, 1, 2 or 3 (as appropriate) will be assigned only if transcripts provided exhibit at least 75 semester-hours or 112 quarter-hours of actual graded classroom instruction. Grades of Pass/Fail, Credit/No Credit will not count toward the 75/112 hour requirement.

Catalogs

The point of contact for the Naval Postgraduate School catalog is:

Naval Postgraduate School
Office of the Registrar
1 University Circle, He-022
Monterey, CA 93943

e-mail: registrar@nps.edu

The online edition of the University's catalog is updated quarterly and is located at:
www.nps.edu/Academics/Admissions/Registrar/Academic Catalog/index.html

The point of contact for requests for printed catalogs and admissions for international students is:

Naval Postgraduate School
Director of International Programs
1 University Circle, Rm B-047
Monterey, CA 93943-5025

Telephone: (831) 656-2186 / DSN 756-2186 / FAX (831) 656-3064
www.nps.edu/Adminsrv/IGPO/index.html

CURRICULUM LISTING

Curric Title	Curric Number	Normal Length (Months)	Convenes	APC	P-Code	Dept	Degree	Program Officer
The Graduate School of Operational & Information Sciences								
Computing Technology (DL)	357	48	Winter/ Summer	325	None	CS	Master of Computing Technology	Loren Peitso
Operations Analysis (Energy)	358	24	Fall	325	3213P	OR	M.S. Operations Research	Walter DeGrange
Human Systems Integration (DL)	359	24	Fall	345	None	OR	Master of Human Systems Integration	Lawrence Shattuck
Operations Analysis	360	24	Fall/ Spring	325	3211P	OR	M.S. Operations Research	Jeffrey H. Hyink
		24	Fall/ Spring	325	3210I/ 3211P	OR	M.S. Applied Science (Operations Research)	Jeffrey H. Hyink
		36	Fall/ Spring	325	3211D	OR	Ph.D. Operations Research	Jeffrey H. Hyink
Joint Operational Logistics	361	24	Fall/ Spring	325	3212P	OR	M.S. Operations Research	Walter DeGrange
					3212D	OR	Ph.D. Operations Research	Walter DeGrange
Human Systems Integration	362	24	Fall	335	4600P	OR	M.S. Human Systems Integration	Walter DeGrange
Master of Systems Analysis (DL)	363	24	Fall/ Spring	335	3210P	OR	Master of Systems Analysis	Jeffrey H. Hyink
Joint Command, Control, Communications, Computers, and Intelligence (C4I) Systems	365	21	Fall	334		IS	M.S. Systems Technology (C3)	Jim Robinette
Computer Science	368	18	Fall/ Spring	325	6203P	CS	M.S. Computer Science	Eric McMullen
		36			6203D	CS	Ph.D. Computer Science	Eric McMullen
Software Engineering	369	12 to 18	Any Quarter	325	None	CS	M.S. Software Engineering	Eric McMullen
		36			6203D	CS	Ph.D. Software Engineering	Eric McMullen
Software Engineering (DL)	369	18 to 24	Any Quarter	325	6203P	CS	M.S. Software Engineering	Eric McMullen
		36			6203D	CS	Ph.D. Software Engineering	Eric McMullen
Information Systems and Technology	370	24	Fall/ Spring	325	6201P	IS	M.S. Information Technology Management	Jim Robinette
Computer Science (DL)	376	24	Fall/ Spring	325	None	CS	M.S. Computer Science	Eric McMullen

Curric Title	Curric Number	Normal Length (Months)	Convenes	APC	P-Code	Dept	Degree	Program Officer
Identity Management and Cyber Security (DL)	377	18	Fall	344	None	CS	M.A. Identity Management and Cyber Security	Eric McMullen
Identity Management and Cyber Security (Hybrid)	378	12	Fall	344	None	CS	M.A. Identity Management and Cyber Security	Eric McMullen
Cost Estimating and Analysis (DL)	379	24	Spring	335	None	OR	Master of Cost Estimating and Analysis	Kevin Maher
Network Operations and Technology	386	18	Fall	344	6209P	IS	M.S. in Network Operations	Jim Robinette
Modeling, Virtual Environments, and Simulation	399	24	Fall	325	6202P	CS	M.S. Modeling, Virtual Environments, and Simulation	Eric McMullen
					6202D	CS	Ph.D. Modeling, Virtual Environments and Simulation	Eric McMullen
Information Sciences	474	36	Any Quarter		6201D	IS	Ph.D. Information Sciences	Dan C. Boger
Remote Sensing Intelligence	475	12	Fall	234	None	IS	M.S. Remote Sensing Intelligence	Jim Robinette
Information Warfare	595	24	Fall	324	None	IS	M.S. Information Warfare Systems Engineering	Jim Robinette
Joint Information Operations	698	18	Winter/ Summer	265	None	DA	M.S. Information Operations	Jennifer J. Duncan
Special Operations/ Irregular Warfare	699	18	Winter/ Summer	265	2500P	DA	M.S. Defense Analysis	Jennifer J. Duncan

The Graduate School of Engineering & Applied Sciences

Curric Title	Curric Number	Normal Length (Months)	Convenes	APC	P-Code	Dept	Degree	Program Officer
Systems Engineering (DL)	311	24	Any Quarter	323	5000P	SE	M.S. Systems Engineering	Joseph Sweeny
			Fall/ Spring	323	5000P	SE	M.S. Engineering Systems	Joseph Sweeny
			Fall/ Spring	323	5000P	SE	M.S. Systems Engineering Management	Joseph Sweeny
Space Systems Operations (DL)	316	24	Fall	324	6206G	SSAG	M.S. Space Systems Operations	Jason W. Pratt
Space Systems Operations (International)	364	18	Fall	324	None	SP	M.S. Space Systems Operations	Jason W. Pratt
Space Systems Operations (Res)	366	18	Fall	324	6206P	SP	M.S. Space Systems Operations	Jason W. Pratt
		24	Fall		6206P	SP	M.S. Astronautical Engineering	Jason W. Pratt

Curric Title	Curric Number	Normal Length (Months)	Convenes	APC	P-Code	Dept	Degree	Program Officer
Meteorology	372	18	Fall/ Spring	323	None	MR	M.S. Meteorology	William Sommer
		36	Fall/ Spring		6403D	MR	Ph.D. Meteorology	William Sommer
METOC	373	27	Fall/ Spring	323	6401P	MR/OC	M.S. Joint Meteorology & Physical Oceanography	William Sommer
Operational Oceanography	374	24	Winter/ Summer	323	6402P	OC	M.S. Physical Oceanography	William Sommer
Applied Mathematics	380	24	Summer	324	4100P	MA	M.S. Applied Mathematics	Thor Martinsen
		36	Summer		4100D	MA	Ph.D. Applied Mathematics	Thor Martinsen
Oceanography	440	18 to 24	Winter/ Summer	323	None	OC	M.S. Physical Oceanography	William Sommer
		36			6402D	OC	Ph.D. Physical Oceanography	William Sommer
Undersea Warfare	525	12 to 24	Fall/ Spring	323	6301P	EAAC	M.S. Engineering Acoustics	William Sommer
			Fall/ Spring	323	6301P	ME	M.S. Mechanical Engineering	William Sommer
			Fall/ Spring	323	6301P	MA	M.S. Applied Mathematics	William Sommer
			Fall/ Spring	323	6301P	ME	M.S. Engineering Science	William Sommer
			Fall/ Spring	323	6301P	EC	M.S. Electrical Engineering	William Sommer
			Fall/ Spring	323	6301P	OC	M.S. Physical Oceanography	William Sommer
			Fall/ Spring	323	6301P	USWAG	M.S. Applied Science (Physical Oceanography)	William Sommer
			Fall/ Spring	323	6301P	USWAG	M.S. Applied Science (Acoustics)	William Sommer
			Fall/ Spring	323	6301P	USWAG	M.S. Applied Science (Operations Research)	William Sommer
			Fall/ Spring	323	6301P	USWAG	M.S. Applied Science (Signal Processing)	William Sommer
Undersea Warfare (International)	526	12 to 36	Fall/ Spring	323	None	OC	M.S. Physical Oceanography	William Sommer
			Fall/ Spring		None	ECE	M.S. Electrical Engineering	William Sommer
			Fall/ Spring		None	EAAC	M.S. Engineering Acoustics	William Sommer
			Fall/ Spring		None	ECE	M.S. Engineering Science (Electrical Engineering)	William Sommer

Curric Title	Curric Number	Normal Length (Months)	Convenes	APC	P-Code	Dept	Degree	Program Officer
Combat Systems Science & Engineering	533	12 to 24 (MS)	Winter/ Summer	323	5000P/ 5701-5705 P/I	PH	M.S. Applied Physics	Robert Kerchner
					5000P/ 5701-5705 P/I	PH	M.S. Physics	Robert Kerchner
					5000P/ 5701-5705 P/I	PH	M.S. Combat Systems Technology	Robert Kerchner
					5000P/ 5701-5705 P/I	EAAC	M.S. Engineering Acoustics	Robert Kerchner
					5000P/ 5701-5705 P/I	MAE	M.S. Mechanical Engineering	Robert Kerchner
		36 (Ph.D.)			5700D	PH	Ph.D. Physics	Robert Kerchner
		36 (Ph.D.)			5700D	PH	Ph.D. Applied Physics	Robert Kerchner
		36 (Ph.D.)			5700D	PH/ECE	Ph.D. Engineering Acoustics	Robert Kerchner
Underwater Acoustic Systems (DL)	535	24-36	Summer	323	None	EAAC	M.S. Engineering Acoustics or Masters of Engineering Acoustics	Robert Kerchner
Naval/Mechanical Engineering (Energy)	563	24	All Quarters	323	5603P	MAE	M.S. Mechanical Engineering	Michael Porter
Naval/Mechanical Engineering	570	12 to 24 (MS)	Winter/ Summer	323	5000P/ 5601P/ 5602P	ME	M.S. Mechanical Engineering	Michael Porter
					5000P/ 5601P/ 5602P	ME	M.S. Engineering Science	Michael Porter
					5601N	ME	Mechanical Engineer	Michael Porter
		36 (Ph.D.)	Fall		5601D	ME	Ph.D. Mechanical Engineering	Michael Porter
Reactors/ Mechanical Engineering (DL)	571	12 to 15	Fall/ Spring	121	None	ME	M.S. Engineering Science (ME)	Michael Porter
Mechanical Eng for Nuclear Trained Officers (DL)	572	24	Any Quarter	323	None	ME	M.S. Engineering Science (Mechanical Engineering)	Michael Porter
Systems Engineering	580	21	Fall/ Spring	323	5800P-5803P	SE	M.S. Systems Engineering	Michael Porter
			Fall/ Spring		5800P-5803P	SE	M.S. Engineering Systems	Michael Porter
Systems Engineering, Ph.D.	581	36-48	Any Quarter		None	SE	Ph.D. Systems Engineering	Paul Montgomery

Curric Title	Curric Number	Normal Length (Months)	Convenes	APC	P-Code	Dept	Degree	Program Officer
Electronic Systems Engineering	590	24	Any Quarter	323	5300P/ 5302P/ 5304P- 5306P/ 5309P- 5311P	EC	M.S. Electrical Engineering (MSEE)	Thor Martinsen
					5300P/ 5302P/ 5304P- 5306P/ 5309P- 5311P	EC	M.S. Engineering Science (EE)	Thor Martinsen
					5300P/ 5302P/ 5304P- 5306P/ 5309P- 5311P/	EC	M.S. Computer Engineering	Thor Martinsen
					5300N	EC	Electrical Engineer	Thor Martinsen
					5300D	EC	Ph.D. Electrical Engineering	Thor Martinsen
Space Systems Engineering	591	27	Fall	323	5500P	ME	M.S. Astronautical Engineering	Jason W. Pratt
					5500P	ME	M.S. Mechanical Engineering	Jason W. Pratt
					5500P	ME	M.S. Engineering Science (Astronautical Engineering)	Jason W. Pratt
					5500P	EC	M.S. Electrical Engineering	Jason W. Pratt
					5500P	CS	M.S. Computer Science	Jason W. Pratt
					5500P	PH	M.S. Physics	Jason W. Pratt
					5500P	PH	M.S. Applied Physics	Jason W. Pratt
					5500P	ME	Astronautical Engineer	Jason W. Pratt
					5500D	ME	Ph.D. Astronautical Engineering	Jason W. Pratt
					5500D	EC	Ph.D. Electrical Engineering	Jason W. Pratt
					5500D	PH	Ph.D. Physics	Jason W. Pratt
Electronic Systems Engineering (DL)	592	48	Any Quarter	323	None	EC	M.S.E.E. M.S.E.S. (E.E.) M.Eng. (E.E.)	unassigned
					None		M.S. Engineering Science (E.E.)	unassigned

Curric Title	Curric Number	Normal Length (Months)	Convenes	APC	P-Code	Dept	Degree	Program Officer
					None		Master of Engineering	unassigned
Electrical Systems Engineering (Energy)	593	24	Winter	323	5311	EC	M.S. Electrical Engineering	Thor Martinsen
Naval Test Pilot/Mechanical & Aerospace Engineering Program	613	18	Summer/ Winter	323	None	MAE	M.S.E.S. Aerospace Engineering	Jason W. Pratt
Systems Engineering Management - PD21 (DL)	721	24	Fall	N/A	5000P	SE	M.S. Systems Engineering Management	Joseph Sweeny
					5000P		M.S. Product Development	Joseph Sweeny
					5000P		M.S. Systems Engineering	Joseph Sweeney
					5000P		M.S. Systems Engineering	Joseph Sweeny

The Graduate School of Business & Public Policy

Curric Title	Curric Number	Normal Length (Months)	Convenes	APC	P-Code	Dept	Degree	Program Officer
Executive Master of Business Admin. (DL)	805	24	Fall/ Spring	245	3100P	GB	E.M.B.A.	Jefferson E. McCollum
Civilian Executive Master of Business Admin. (DL)	807	24	Winter/ Summer	245	None	GB	E.M.B.A.	Jefferson E. McCollum
Defense Business Management	809	18 if full time; 30-48 if part time	Winter/ Summer	345	None	GB	M.B.A.	Jefferson E. McCollum
Transportation Management	814	18	Winter/ Summer	345	3122P	GB	M.B.A.	Jefferson E. McCollum
Acquisition & Contract Management	815	18	Winter/ Summer	345	1306P	GB	M.B.A.	Jefferson E. McCollum
Systems Acquisition Management	816	18/21	Winter/ Summer	345	None	GB	M.B.A.	Jefferson E. McCollum
Defense Systems Analysis	817	18	Summer	345	None	GB	M.S. Management	Jefferson E. McCollum
Defense Systems Management (International)	818	18	Winter/ Summer	345	None	GB	M.B.A. (International students)	Jefferson E. McCollum
Supply Chain Management	819	18	Winter/ Summer	345	1302P	GB	M.B.A.	Jefferson E. McCollum
Resource Planning and Management for International Defense	820	18	Winter	345	None	GB	M.B.A. (International students)	Jefferson E. McCollum
Materiel Logistics Support Management	827	18	Winter/ Summer	345	3121P	GB	M.B.A.	Jefferson E. McCollum
Management (Financial Management Emphasis)	834	18 (6 DL + 12 Resident)	Winter	245	3000P	GB	M.A.	Jefferson E. McCollum
Contract Management (DL)	835	24	Any Quarter	345	None	GB	M.S. Contract Management	Jefferson E. McCollum
Program Management (DL)	836	24	Any Quarter	335	None	GB	M.S. Program Management	Jefferson E. McCollum

Curric Title	Curric Number	Normal Length (Months)	Convenes	APC	P-Code	Dept	Degree	Program Officer
Financial Management	837	18	Winter/ Summer	345	3110P	GB	M.B.A.	Jefferson E. McCollum
Financial Management (Energy)	838	18	Winter/ Summer	345	3113P	GB	M.B.A.	Jefferson E. McCollum
Manpower Systems Analysis	847	21	Summer	345	3130P	GB	M.S. Management	Jefferson E. McCollum
Information System Management	870	18	Summer	345	None	GB	M.B.A.	Jefferson E. McCollum

The School of International Graduate Studies

Curric Title	Curric Number	Normal Length (Months)	Convenes	APC	P-Code	Dept	Degree	Program Officer
Middle East, South Asia, and Sub-Saharan Africa	681	18	Any Quarter	265	2101P	NS	M.A. Security Studies (Middle East, South Asia, and Sub-Saharan Africa)	Jorge F. Garcia
Far East, Southeast Asia and the Pacific	682	18	Any Quarter	265	2102P	NS	M.A. Security Studies (Far East, Southeast Asia, and the Pacific)	Jorge F. Garcia
Western Hemisphere	683	18	Any Quarter	265	2103P	NS	M.A. Security Studies (Western Hemisphere)	Jorge F. Garcia
Europe and Eurasia	684	18	Any Quarter	265	2104P	NS	M.A. Security Studies (Europe and Eurasia)	Jorge F. Garcia
Civil-Military Relations	685	15	Any Quarter	265	None	NS	M.A. Security Studies (Civil-Military Relations)	Jorge F. Garcia
Stabilization and Reconstruction	686	15	Any Quarter	265	None	NS	M.A. Security Studies (Stabilization and Reconstruction)	Jorge F. Garcia
Strategic Studies	688	15	Any Quarter	265	2301P	NS	M.A. Security Studies (Strategic Studies)	Jorge F. Garcia
Homeland Security and Defense (Military)	691	15 or 18	Any Quarter	265	2600P	NS	M.A. Security Studies (Homeland Security and Defense)	Jorge F. Garcia
Homeland Defense and Security (Civilian)	692	18	Fall/ Spring	TBD	2600P	NS	M.A. Security Studies (Homeland Security and Defense)	Theodore G. Lewis
Combating Terrorism: Policy and Strategy	693	15	Any Quarter	265	None	NS	M.A. Security Studies (Counter-Terrorism Policy and Strategy)	Jorge F. Garcia
Security Studies	694	36	Any Quarter		2000D	NS	Ph.D. Security Studies	Jorge F. Garcia

Curric Title	Curric Number	Normal Length (Months)	Convenes	APC	P-Code	Dept	Degree	Program Officer
Cyber Systems and Operations Program								
Cyber Systems and Operations	326	18	Fall/ Spring	344	6208	CAG	M.S. Cyber Systems and Operations	Eric McMullen
Cyber Systems and Operations (DL)	327	27	Fall	344	None	CAG	M.S. Cyber Systems and Operations	Eric McMullen
Applied Cyber Operations	336	12	Fall/ Spring	344	None	CAG	M.S. Applied Cyber Operations	Eric McMullen
Systems Engineering Analysis Program								
Systems Engineering Analysis	308	24	Winter/ Summer	334	6500P	SE/OR	M.S. Systems Engineering-Analysis (MSSEA)	Keith Littrell
Systems Engineering Analysis (Mixed Mode)	309	12 DL 12 Res = 24	Summer	322	6500P	SE/OR	M.S. Systems Engineering Analysis (SEA MM)	Keith Littrell
Certificate Curricula (Taught Web-Based Except 211, 212, 213, 222, 258, 260, 290, 291)								
Stability, Security and Development in Complex Operations (Res & DL)	210	3	Any Quarter	365	None	GPPAG	Certificate	Robert McNab
Advanced Acquisition Program (DL)	211	12	Any Quarter	N/A	None	GB	DAWIA Level III Certification	John Dillard
Acquisition Management Program Certificate (DL)	212	3	Any Quarter	N/A	None	GB	Certificate	Walter Owen
Army Cost Management Certificate (Res)	213	1	Any Quarter	245	3110L	GB	Certificate	Jefferson McCollum
Civil Military Operations and the Rule of Law Certificate (Res & DL)	215	3	Fall/ Spring	N/A	None	GPPAG	Certificate	Robert McNab
Naval Nuclear Power School Certificate	222	6	Any Quarter	N/A	None	MAE	Certificate	Not assigned
Cyber Wargaming	225 (DL) 226 (Res)	9	Fall/ Spring	344	6208L	CAG	Certificate	Eric McMullen
Cyber Operations Infrastructure	227 (DL) 228 (Res)	9	Winter/ Summer	344	6208L	CAG	Certificate	Not assigned
Defense Energy Certificate	234	12	Any Quarter	365	3000L	EAG	Certificate	Walter DeGrange
Healthcare Modeling and Simulation Certificate (DL)	240	12	Fall	325	None	CS	Certificate	Eric McMullen
International Defense Planning Certificate	245	3	Summer	365	2000L	NS	Certificate	Jorge F. Garcia

Curric Title	Curric Number	Normal Length (Months)	Convenes	APC	P-Code	Dept	Degree	Program Officer
RS Studies (Middle East, South Asia, and Africa)	246	3-9 months	Any Quarter	265	2101L	NS	Certificate	Jorge F. Garcia
RS Studies (East and Southeast Asia)	247	3-9 months	Any Quarter	265	2102L	NS	Certificate	Jorge F. Garcia
RS Studies (Western Hemisphere)	248	3-9 months	Any Quarter	265	2103L	NS	Certificate	Jorge F. Garcia
RS Studies (Europe and Eurasia)	249	3-9 months	Any Quarter	265	2104L	NS	Certificate	Jorge F. Garcia
Cyber Security Fundamentals	256 (DL), 257 (RES)	6	Any Quarter	325	6203L	CS	Certificate	Eric McMullen
Cyber Security Defense	258 (DL), 259 (RES)	3-6 months	Any Quarter	325	6203L	CS	Certificate	Eric McMullen
Cyber Security Adversarial Techniques	260 (DL), 261 (RES)	6	Any Quarter	325	6203L	CS	Certificate	Eric McMullen
Human Systems Integration (Res & DL)	262	12	Fall	345	4600L	OR	Certificate	Lawrence G. Shattuck
Modeling and Simulation Management Certificate (Res & DL)	265	12	Fall/ Spring	323	6202L	SE	Certificate	Mark Rhoades
Information Systems Security Engineering Certificate (Res & DL)	270	9	Any Quarter	325	6203L	CS	Certificate	Eric McMullen
Network Operations and Technology - Operations Certificate (DL)	271	12	Any Quarter	N/A	6200L	IS	Certificate	Steven J. Iatrou
Network Operations and Technology - Technology Certificate (DL)	272	12	Any Quarter	N/A	6200L, 6201L	IS	Certificate	Steven J. Iatrou
Space Systems Certificate Program (DL)	273	12	Fall/ Spring	N/A	6206L	SP	Certificate	Jason W. Pratt
ASW Certificate Program (Res & DL)	274	15	Spring	234	6301L	USWAG	Certificate	William Sommer
Knowledge Superiority Academic Certificate in Information Systems and Operations (DL)	277	12	Any Quarter	325	6201L	IS	Certificate	Mark E. Nissen
Federal/DoD Identity Management Certificate (Res)	278	6	Any Quarter	325	6203L	CS	Certificate	Eric McMullen
Engineering Modeling and Simulation Certificate (Res & DL)	279	12	Fall	334	6202L	MA	Certificate	unassigned

Curric Title	Curric Number	Normal Length (Months)	Convenes	APC	P-Code	Dept	Degree	Program Officer
Mathematics of Secure Communications Certificate (Res)	280	12	Fall	N/A	4100L	MA	Certificate	Thor Martinsen
Systems Analysis Certificate (DL)	281	12	Spring/ Fall	335	3210L	OR	Certificate	Jeffrey H. Hyink
Systems Engineering Certificate (Res & DL)	282	12	Fall/ Spring	N/A	5800L	SE	Certificate	Joseph Sweeney
Scientific Computation Certificate (Res)	283	9	Any Quarter	N/A	4100L	MA	Certificate	Thor Martinsen
Guidance Navigation & Control Systems Certificate (Res & DL)	284	12	Winter/ Summer	323	5300L	EC	Certificate	Thor Martinsen
Fault Tolerant Computing Certificate (Res & DL)	285	12	Fall/ Spring	323	5300L	EC	Certificate	Thor Martinsen
Reconfigurable Computing Certificate (Res & DL)	286	9	Spring	323	5300L	EC	Certificate	Thor Martinsen
Digital Communications Certificate (Res & DL)	287	9	Fall/ Spring	323	5300L	EC	Certificate	Thor Martinsen
Cyber Warfare Certificate (Res & DL)	288	9	Winter	323	5300L	EC	Certificate	Thor Martinsen
Cost Estimating and Analysis Certificate (DL)	289	12	Summer	335	5300L	OR	Certificate	Kevin Maher
Signal Processing Certificate (Res & DL)	290	12	Any Quarter	323	5300L	EC	Certificate	unassigned
Electric Ship Power Certificate (Res & DL)	291	12	Any Quarter	323	5300L	EC	Certificate	unassigned
EW Engineer Certificate (Res & DL)	292	12	Any Quarter	323	5300L	EC	Certificate	David Jenn
Journeyman EW Engineer Certificate (Res & DL)	293	12	Any Quarter	323	5300L	EC	Certificate	Thor Martinsen
Senior EW Engineer Certificate (Res & DL)	294	12	Any Quarter	323	5300L	EC	Certificate	Thor Martinsen
Network Engineering Certificate (Res & DL)	295	12	Fall/ Spring	323	5300L	EC	Certificate	Thor Martinsen
Cyber Systems Certificate (Res & DL)	296	12	Fall	323	5300L	EC	Certificate	Thor Martinsen

Curric Title	Curric Number	Normal Length (Months)	Convenes	APC	P-Code	Dept	Degree	Program Officer
Wireless Network Security Certificate (Res & DL)	297	12	Fall	323	5300L	EC	Certificate	Thor Martinsen

GRADUATE SCHOOL OF BUSINESS AND PUBLIC POLICY (GSBPP)

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Website

www.nps.edu/Academics/Schools/GSBPP/

The Nation's Premier School for Defense Management Graduate Education and Research

Dean

William R. Gates, Ph.D.
Code GB, Ingersoll Hall, Room 305

(831) 656-2754, DSN 756-2754,
bgates@nps.edu

Associate Deans

Associate Dean of Instruction

Keith Snider, Ph.D.
Code GB, Ingersoll Hall, Room 331C

(831) 656-3621, DSN 756-3621
KSnider@nps.edu

Associate Dean for Research & Development

Uday Apte, Ph.D.
Code GB, Ingersoll Hall, Room 317

(831) 656-3598, DSN 756-3598
umapte@nps.edu

Military Associate Dean

Simonia Blassingame, CDR, USN
Code GB, Ingersoll Hall, Room 238

(831) 656-2697, DSN 756-2697
sblassi@nps.edu

The Graduate School of Business and Public Policy includes:
Acquisition Management Academic Area
Financial Management Academic Area
Manpower and Economics Academic Area
Operations and Logistics Management Academic Area
Organizations and Management Academic Area
Enterprise and Information Academic Area

Vision

To be recognized as the nation's premier school for defense-focused business management and public policy education and research. To be the institution that national leaders look to for education, research, information, and innovation in the management of the business of defense. To be recognized by our students, alumni, and other stakeholders for our excellence in defense-focused education and research.

Mission

To serve our Nation by educating US and allied military officers as well as defense civilians in defense-focused business and public policy, by conducting research in defense management and public policy, and by providing intellectual resources for leaders and organizations concerned with defense business management practices and policies.

Means

We pursue our vision and perform our mission through graduate education, research, and professional service.

- In Education: Through resident and distance learning degree and non-degree programs, we develop students' abilities to analyze, think critically, and take intelligent actions so they can more effectively carry out their future professional responsibilities to manage organizations, resources, people, and programs in complex, sometimes life-threatening environments.

- In Research: Conduct research, using the scholarships of discovery, application, integration, or teaching, that supports defense enterprise decision-making, problem solving, and policy setting; improves business management processes and practices; contributes knowledge to academic disciplines via dissemination in high-quality refereed research journals or suitable practitioner-oriented journals; and advances the development of graduate education.

- In Professional Service: Provide professional expertise that advances knowledge and business management within GSBPP, NPS, the Department of Navy, the Department of Defense, and other government agencies, as well as in our professional and academic organizations.

Areas of Excellence

The Defense-Focused MBA Program: "Business Management Knowledge for DoD"

GSBPP at NPS offers the only MBA program specifically designed to provide a defense-focused, graduate business education. The objectives of the MBA program are both to provide professional knowledge and skills to prepare officers for management positions within DoD and to

develop broad critical thinking and analytical abilities of benefit throughout an officer's career. Designed to satisfy both current and future management competencies of active duty military officers and government civilians, the MBA program consists of:

· A Business Management Core, with a distinct defense focus
· A Mission-Related Core, comprised of unique defense management courses
· Alternative Curricular Concentrations, each providing advanced study in military sub-specialty areas
· An Applications Project or Thesis, designed for students to address significant defense problems and issues.
· Professional Certification Programs, in both military and management areas

The GSBPP MBA is one of only two MBA programs in the world to hold dual accreditation from both AACSB, the premier accrediting agency for schools of business, and NASPAA, the premier accrediting agency for schools of public administration. The hallmark of the MBA program is the melding of private-sector and public-sector management education relevant to the defense community.

Distance learning Programs:
"Reaching out to Serve Defense Community Needs"

GSBPP is a leader in developing and providing off-campus education for the Defense community. GSBPP has developed faculty, facilities and capabilities to deliver graduate programs using VTE, off-site, and Web-enhanced modes of instruction. Currently, GSBPP offers three unique distance learning degrees to serve Defense community needs.

Executive MBA: Developed initially to serve the needs of the Aviation community, the EMBA provides graduate business education to experienced naval officers expected to become future leaders in their military community. The program consists of broad management education coupled with a Financial and Acquisition specialization.

Master of Science in Program Management: Developed to respond to the need for professional education for the Defense Acquisition workforce, the MSPM meets Defense Acquisition Workforce Improvement Act (DAWIA) training requirements within the context of a graduate-level degree program.

Master of Science in Contract Management: Developed to respond to the need for professional education for the Defense Acquisition workforce, the MSCM meets Defense Acquisition Workforce Improvement Act (DAWIA) training requirements within the context of a graduate-level degree program.

Management Development Programs
"Continuing Education for Professional Success"

GSBPP provides Continuing Education in the form of Executive and Management Development programs. Programs are provided in residence, via VTE; and internationally, by GSBPP faculty with both academic and professional experience in discipline areas. GSBPP offers unique programs to serve Defense community needs.

Practical Comptrollership Course (PCC): A mid-career course sponsored by the Assistant Secretary of the Navy (Financial Management & Comptroller) that provides graduate-level financial management education to DoN civilians and military officers. Primarily offered in Monterey and is also taught at major Navy concentration areas such as San Diego and Norfolk.

Advanced Acquisition Program (AAP): The AAP provides education and DAWIA certification to DoD's acquisition workforce, including Army, Navy and Air Force acquisition commands.

Acquisition Management Distance Learning Program (AMDLP): GSBPP provides this educational outreach program to the Defense acquisition community, offering acquisition management courses to Defense agencies across the country. These courses satisfy certain DAU mandatory training requirements and DAWIA requirements for business subjects, and may also be taken for continuing education.

International Defense Acquisition Resource Management (IDARM): This international program focuses on the development of strategies for establishing or improving a country's defense acquisition resource management in a manner that contribute to both national security and economic well-being. The IDARM program involves needs assessment, curriculum development, and course delivery, providing tailored executive education in Strategic Planning, Contracting, Logistics, Financial Management, and Program Management. This program is managed in the School of International Graduate Studies.

Executive Education: NPS' Center for Executive Education (CEE) provides courses for executive-level military officers and defense civilians, including the Executive Business Course, the Navy Corporate Business Course, Strategic Planning Seminar and Leading Transformational Change. GSBPP supports CEE on business education requirements.

Defense Specialty Curricula:
"Education Responsive to Sponsor Requirements"

GSBPP provides graduate management education in six curricular areas of direct relevance to military educational needs. All curricula have a senior leader from one of the services who sponsors the program. Sponsors are actively involved in the design and review of programs. These reviews, in conjunction with NPS and GSBPP

assessments, result in high quality, unique, and military-relevant programs. Collectively, the curricula encompass all aspects of Resource Management, including the management of Human Resources, Physical Resources, Financial Resources, and Information Resources.

Logistics Management: Designed for military officers who will be responsible for managing the various segments of a military system's life cycle from initial planning for support to fielding the system, through sustaining operations to phase-out. Emphasizes all of the aspects of providing integrated logistics support of military systems.

Acquisition Management: Develops the knowledge, skills and competencies necessary for graduates to assume leadership roles in the acquisition workforce and efficiently manage the resources allocated to the acquisition process.

Manpower Management: Serves the Navy Human Resource Community of Interest by developing leaders in the design, analysis, and management of Manpower, Personnel, Training and Education Systems to maximize fleet readiness.

Financial Management: Designed to prepare military officers for effectively managing financial resources to achieve the goals and objectives of the defense forces. Graduates are prepared for assignment to positions in budgeting, accounting, business and financial management, cost management, cost analysis, internal control and auditing, and financial analysis.

Defense Management and Analysis: Designed to prepare military officers broadly for positions of leadership and management responsibility in defense organizations, and to develop the knowledge and abilities necessary for the analysis of policies and problems in defense organizations.

Information Systems Management: Designed to provide both technical skills and business acumen. This curriculum provides the knowledge to: acquire and manage information systems and infrastructure; address IS engineering and management problems; assimilate new technologies and transform organizations, processes, and strategies to compete in the marketplace or on the battlefield in the constantly changing digital world.

Faculty:
"A Unique Blend to Perform GSBPP's Academic Mission"

The GSBPP faculty is unique in its composition, combining individuals with varying academic, professional, practitioner, and service backgrounds to provide relevant graduate instruction and research programs.

Academics and Professionals: GSBPP has 66 full-time faculty who are drawn from a wide variety of academic disciplines. A majority of the faculty holds doctoral degrees from the nation's more distinguished universities. In addition to the academics, practitioners are an integral

part of the faculty. In keeping with our mission, we employ highly qualified practitioners on a full-time basis to enhance the relevance and quality of our programs. All full-time practitioners have at least a master's degree and have been recognized as accomplished professionals in their fields.

Civilian and Military: A combination of top notch civilian faculty combined with active and retired military officers provides BPP with expertise both within and beyond the DoD. The civilian faculty provides the theoretical and academic expertise enhanced by numerous contacts throughout the Navy and Defense community, while the military faculty provides recent DoD experience, and professional and operational expertise.

Business and Government: The GSBPP faculty blends backgrounds from both the private and public sectors. More than half of the faculty come with academic and/or professional experience from the business world. More than half come with academic and/or professional experience in the public sector.

Instruction and Research: GSBPP faculty are expected to excel in teaching as well as conduct significant research that is relevant to the Department of Defense. Faculty members maintain high degree of connectivity with sponsors of instructional and research programs. Almost all faculty work year round, teaching two quarters and conducting research and/or engaging in administrative work for the other two quarters.

Business and Public Management Research: "Scholarship Analysis Relevant to Defense Problems"

Research Mission: Research is an important component of GSBPP's mission. The primary goal of GSBPP's research programs are to provide the Navy and DoD with the capability of managing defense organizations, systems, and processes both efficiently and effectively. GSBPP recognizes the importance of both basic and applied research to the Navy and DoD; and seeks to create a balance of both types of research in its research program. GSBPP's research programs can be grouped into six functional areas:

Acquisition and Contracting

Logistics and Transportation

Financial Management

Manpower Systems and Human Resources

Organization and Management

Economic and Policy Analysis

Research Relevance: In-depth knowledge of military problems allows the faculty to provide assistance to DoD decision makers. Expertise in private sector business practices enables the faculty to assist DoD organizations in

GRADUATE SCHOOL OF BUSINESS AND PUBLIC POLICY (GSBPP)

adopting best business practices. Research in military-relevant issues additionally allows the faculty to develop unique and relevant instructional material for education of military officers.

DoD sponsorship of GSBBP research comes from several commands and areas, such as: ONR, OSD, SPAWAR, NAVSUP, AIRPAC, DAU, NETSAFA, NPRST, PERSEREC, USMC, N82, Manpower, Acquisition, and Logistics.

Research Excellence: GSBPP faculty include nationally and internationally recognized experts in simulation modeling, supply chain management, work motivation, knowledge management, military manpower, public sector management, change management, public budgeting, managerial communications, conflict management, acquisition, defense economics, information technology and other defense-relevant fields.

Research Centers and Programs

Acquisition Research Program: Established in 2002, Naval Postgraduate School's Acquisition Research Program provides leadership in innovation, creative problem solving and an on-going dialogue, contributing to the evolution of Department of Defense acquisition strategies. Objectives of the NPS Acquisition Research Program include: Establishing NPS acquisition research as an integral part of policy-making for Departments of Defense and Navy officials. Creating a stream of relevant information concerning the performance of DoD acquisition policies with viable recommendations for continuous process improvement, Preparing the workforce to participate in the continued evolution of the defense acquisition process, Collaborating with other universities, think tanks, industry and Government in acquisition research.

Center for Defense Management Reform: The Center serves three purposes: First, as a forward-looking source of research to support current and future Defense leaders who embark upon management reform agendas; second, as a resource where knowledge of the history, theories, themes, successes and failures of past Defense reforms can help to inform and guide the design and execution of future reform; and third as a point of intellectual coordination for academic, professional and governmental entities engaged in the topic of defense management reform.

Human Resources Center of Excellence: Established in October 2007 by the Chief of Naval Personnel, the Human Resources Center of Excellence (HRCOE) serves as a focal point for the lifelong career learning for the Human Resources (HR) community. In support of this goal, the Center is responsible for the development and execution of programs that promote professional development for all active duty and reserve HR officers to include formal education opportunities for new and experienced HR officers, a robust mentoring program, and a resources and learning tools repository. Center activities

and efforts to enrich the professional development and abilities of the HR Community will be aligned with the Manpower, Personnel, Training and Education mission to anticipate warfighting needs, identify associated personnel capabilities, and recruit, develop, manage and apply those capabilities in an agile and cost effective manner.

Programs Offered

The Graduate School of Business and Public Policy (GSBPP) has responsibility for seven graduate academic programs and awards seven graduate degrees. The largest program is the resident defense-focused Master of Business Administration (MBA) program. GSBPP also offers a non-resident Executive MBA program. In addition, GSBPP offers three specialized Master of Science degree programs focused on particular defense management fields, and non-degree professional development programs. These programs are:

Master of Business Administration Degree Program
· Defense-Focused MBA

Executive Management Degree Programs
· Executive MBA

Master of Science Degree Programs
· MS in Management
· MS in Program Management
· MS in Contract Management

Professional Development Programs
· Advanced Acquisition Program
· Practical Comptrollership Course
· Acquisition Management Distance Learning Program

Master of Business Administration Degree (MBA)

This is a Defense-Focused MBA which encompasses five curricular areas: Acquisition Management, Financial Management, Logistics Management, Information Management and Defense Management. Graduates of curricula in the MBA program are awarded the degree Master of Business Administration. This degree is accredited by the Association to Advance Collegiate Schools of Business - International (AACSB) and by the National Association of Schools of Public Affairs and Administration (NASPAA). The MBA is a full-time resident program, open to all services, with curriculum lengths typically 18 months. The curricula within the Defense-Focused MBA program include: Acquisition and Contract Management (815), Systems Acquisition Management (816), Financial Management (837), Financial Management (Energy) (838), Transportation Management (814), Supply Chain Management (819), Material Logistics Support (827), Information Systems Management (870), Defense Systems Management (818),

Defense Business Management (809), and Resource Planning and Management (820).

Executive Master of Business Administration (EMBA)

The Executive Master of Business Administration (EMBA) is a defense-focused general management program with emphasis in financial management and acquisition for more senior DoD officers and civilians. The program design and coursework capitalize on the current managerial and leadership experience of program participants. The EMBA is a 24 month, part-time, distance learning degree program.

Master of Science Degrees (MS)

The Graduate School of Business and Public Policy awards three Master of Science degrees, including the Master of Science in Management (817, 847), the Master of Science in Contract Management (835), and the Master of Science in Program Management (836). Each of the Master of Science degrees is accredited by the Association to Advance Collegiate Schools of Business - International (AACSB).

Master of Arts Degree (MA)

This is a Management degree with a focus on Financial Management. The degree is tailored to minimize the time spent as a resident student at NPS. The first two quarters are taken via distance learning followed by four quarters in residence at NPS.

Professional Development Programs

The Graduate School of Business and Public Policy also administers several non-degree programs consisting of graduate education or professional courses taught in residence or via distance learning modes. These programs support professional development for managers in DoD. Current programs emphasize acquisition and financial management, and include: Advanced Acquisition Program, Practical Comptrollership Course, Acquisition Management distance learning program.

GSBPP Degree Programs and Curricula Summary

Curricular Area	Curriculum Title	Curric #	Degree	Mode	P-Code	Entry	Qtrs
Defense-Focused MBA Program							
Logistics	Transportation Mgmt	814	MBA	Res	3122	Jan/Jul	6
	Supply Chain Mgmt	819	MBA	Res	1302	Jan/Jul	6
	Material Logistics Support	827	MBA	Res	3121	Jan/Jul	6
Acquisition	Acquisition & Contract Mgmt	815	MBA	Res	1306	Jan/Jul	6
	Systems Acquisition Mgmt	816	MBA	Res	n/a	Jan/Jul	6
Financial Mgmt	Financial Management	837	MBA	Res	3110	Jan/Jul	6
Financial Mgmt (Energy)	Financial Management (Energy)	838	MBA	Res	3113	Jan/Jul	
Information Mgmt	Information Systems Mgmt**	870	MBA	Res	1309	Jan/Jul	7
Defense Mgmt	Resource Planning & Mgmt*	820	MBA	Res	Intl	Jan	6
	Defense Systems Mgmt	818	MBA	Res	Intl	Jan/Jul	6
	Defense Business Mgmt	809	MBA	Res	none	Jan/Jul	6 if full time; 30-48 if part time
Master of Science in Management Program							
Manpower	Manpower Systems Analysis	847	MSM	Res	3130	Jul	7
Defense	Defense Systems Analysis	817	MSM	Res	n/a	Jul	6
Master of Arts in Management							
Masters of Arts in Management		834	MAM	DL/Res	3130	Jan	6
Executive Degree Programs							
Financial & Acquisition	Executive MBA (for military)	805	EMBA	VTE	3100	Oct/Apr	8
Financial & Acquisition	Executive MBA (for civilians)	807	EMBA	VTE	n/a	Jan/Jul	8
General	Master of Exec. Mgmt	808	MEM	Res	n/a	Jan/Jul	4
Master of Science Degree Programs							
Acquisition	Contract Management	835	MSCM	VTE	n/a	Any	8
	Program Management	836	MSPM	VTE	n/a	Any	8
	Systems Eng. Mgmt ***	721	MSSEM	VTE	n/a	Sept	8

*Joint program with NSA Dept.

**Joint program with IS Dept.

***Joint program with SE Dept. PD21 Program

GSBPP Administration

Area Chairs

Financial Management

Kenneth J. Euske, Ph.D.
Code GB, Ingersoll Hall, Room 309

(831) 656-2960, DSN 756-2860
kjeuske@nps.edu

Manpower and Economics

Elda Pema, Ph.D.
Code GB/Mp, Ingersoll Hall, Room 240

(831) 656-3631, DSN 756-3631
epema@nps.edu

Organizations and Management

Deborah E. Gibbons, Ph.D.
Code GB/Br, Ingersoll Hall, Room 333

(831) 656-1842, DSN 756-1842
degibbon@nps.edu

Operations and Logistics

Geraldo Ferrer, Ph.D.
Code GB, Ingersoll Hall, Room 318
(831) 656-3290, DSN 756-3290
gferrer@nps.edu

Acquisition Management

John T. Dillard, COL, USA (Ret.), M.S.
Code GB, Ingersoll Hall, Room 336

(831) 656-2650, DSN 756-2650
jtdillar@nps.edu

Program Officer

Jefferson E. McCollum, CDR, SC, USN
Code GB, Ingersoll Hall, Room 201

(831) 656-3953, DSN 756-3953
jemccoll@nps.edu

Academic Associates

Acquisition and Contract Management Curriculum (815)

Rene G. Rendon, D.B.A.
Code GB, Ingersoll Hall, Room 331D

(831) 656-3464, DSN 756-3464
rgrendon@nps.edu

System Acquisition Management Curriculum (816)

John T. Dillard, COL, USA (Ret.), M.S.
Code GB, Ingersoll Hall, Room 336

(831) 656-2650, DSN 756-2650
jtdillar@nps.edu

Master of Arts in Management (834)

Financial Management Curriculum (837)

Financial Management (Energy) (838)

Robert Wythe Davis, M.B.A.
Ingersoll Hall, Room 314

(831) 656-2672, DSN 756-2672
rwdavis@nps.edu

Defense Systems Analysis Curriculum (817)

Donald E. Summers, M.S.
Code GB/Ds, Ingersoll Hall, Room 337

(831) 656-3632, DSN 756-3632
desummer@nps.edu

Manpower Systems Analysis Curriculum (847)

Yu-Chu Shen, Ph.D.
Code GB, Ingersoll Hall, Room 204

(831) 656-2951, DSN 756-2951
yshen@nps.edu

Transportation Management Curriculum (814)
Supply Chain Management Curriculum (819)
Material Logistics Support Curriculum (827)

Bryan Hudgens, M.S.
Code GB, Ingersoll Hall, Room 219

(831) 656-2039, DSN 756-2039
bhudgen@nps.edu

Resource Planning and Management for International Defense Curriculum (820)
Defense Systems Management - International Curriculum (818)

Simonia Blassingame, CDR, USN
Code GB, Ingersoll Hall, Room 238

(831) 656-2697, DSN 756-2697

slblassi@nps.edu

Defense Business Management Curriculum (809)

James Suchan, Ph.D.
Code GB/Su, Ingersoll Hall, Room 313

(831) 656-2905, DSN 756-2905

jsuchan@nps.edu

Information Systems Management Curriculum (870)

Glenn R. Cook, M.S.
Code IS, Glasgow West, Room GW-3012

(831) 656-2778, DSN 756-2778
grcook@nps.edu

Executive Master of Business Administration (805)

William D. Hatch II, CDR, USN (Ret.)
Code GB/Hh, Ingersoll Hall, Room 339

(831) 656-2463, DSN 756-2463
whatch@nps.edu

Master of Science in Contract Management (835)

Elliott Cory Yoder, CDR, USN (Ret.), M.S.
Code GB, Ingersoll Hall, Room 205

(831) 656-3619, DSN 756-3619
ecyoder@nps.edu

Master of Science in Program Management (836)

Brad Naegle, LTC, USA (Ret.), M.S.
Code GB, Ingersoll Hall, Room 206

(831) 656-3620, DSN 756-3620
bnaegle@nps.edu

Program Managers

Master of Science in Contract Management (835)
Master of Science in Program Management (836)
Acquisition Management Distance Learning Program (212)

Walter E. Owen, D.P.A. (Joint GSBPP/GSEAS)
Code SE/Wo (located in St. Louis, MO)

(831) 402-6086 or (636) 925-2982
wowen@nps.edu

Executive Master of Business Administration (805)

William D. Hatch II, CDR, USN (Ret.)
Code GB/Hh, Ingersoll Hall, Room 339

(831) 656-2463, DSN 756-2463
whatch@nps.edu

Advanced Acquisition Program (211)

John T. Dillard, COL, USA (Ret.), M.S.
Code GB, Ingersoll Hall, Room 336

(831) 656-2650, DSN 756-2650
jtdillar@nps.edu

Practical Comptrollership Program

Lisa F. Potvin, CAPT, USN, M.B.A.
Code GB, Ingersoll Hall, Room 219

(831) 656-3628, DSN 756-3628
lfpotvin@nps.edu or pcc@nps.edu

GSBPP Faculty

Acquisition Management Academic Area

Area Chair

John T. Dillard
Code GB, Ingersoll Hall, Room 336

(831) 656-2650, DSN 756-2650
jtdillar@nps.edu

Michael W. Boudreau, COL, USA (Ret.) Senior Lecturer in Acquisition and Logistics (1995); M.B.A., Santa Clara University, 1966.

John T. Dillard, COL , USA (Ret.) Senior Lecturer (2000); M.S., University of Southern California, 1985.

William R. Fast, COL , USA (Ret.) Senior Lecturer (2010); M.S., University of Southern California, 1979.

Timothy G. Hawkins, Lt Col (Sel), USAF, Assistant Professor (2008); Ph.D., University of North Texas, 2007.

Max V. Kidalov, Assistant Professor of Procurement Law & Policy (2009); L.L.M. Government Contracts Law, George Washington University, 2010; J.D., University of South Carolina, 1999; B.S., University of South Carolina, 1996.

Janie L. Maddox, Maj, USAF (Ret.) Lecturer (2009); M.B.A., Golden Gate University, 1982.

David F. Matthews, COL, USA (Ret.), Senior Lecturer in Acquisition Management (1994); M.A., Middle Tennessee State University, 1974.

Brad Naegle, LTC, USA (Ret.), Senior Lecturer (1997); M.S., Naval Postgraduate School, 1994.

CDR Jim Neuman, USN, Lecturer, MBA, Naval Postgraduate School, 2003.

Walter E. Owen, Senior Lecturer in Acquisition and Project Management (1992); M.S., Naval Postgraduate School, 1992; DPA, Golden Gate University, 2002.

Diana F. Petross, Lecturer in Acquisition Management (2007); M.S. University of Oklahoma, 1991.

Rene G. Rendon, Associate Professor of Acquisition Management (2004); D.B.A., Argosy University, 2003.

Keith F. Snider, Associate Professor of Public Administration and Management (1993); Ph.D., Virginia Polytechnic Institute and State University, 1997.

E. Cory Yoder, Lecturer of Acquisition and Contracting (2004); M.S., Naval Postgraduate School, 1993.

Professor Emeritus:

David V. Lamm, Associate Professor of Acquisition and Contract Management (1978); D.B.A., George Washington University, 1976.

Financial Management Academic Area

Area Chair

Kenneth J. Euske, Ph.D.
Code GB, Ingersoll Hall, Room 309

(831) 656-2860, DSN 756-2860
kjeuske@nps.edu

Douglas A. Brook, Professor of Public Policy (2002); Ph.D., George Mason University, 2001.

Philip J. Candreva, CDR, USN (Ret.), Senior Lecturer in Financial Management (2002); M.S., Naval Postgraduate School, 1996.

Wythe Davis, Lecturer in Financial Management (2010); M.B.A., University of Dayton, 1985.

Kenneth J. Euske, Professor of Accounting (1978); Ph.D., Arizona State University, 1978.

Stephen C. Hansen, Associate Professor of Accounting (2011); Ph.D., Carnegie Mellon University, 1988.

Amilcar A. Menichini, Assistant Professor of Finance (2011); Ph.D., University of Arizona, 2011

Douglas Moses, Associate Professor of Accounting (1985); Ph.D., University of California at Los Angeles, 1983.

Noah Myung, Assistant Professor of Finance and Economics (2009); Ph.D., California Institute of Technology, 2009.

Lisa F. Potvin, CAPT, USN, Lecturer of Financial Management (2006); MBA, University of Denver, 1997.

Juanita M. Rendon, CPA, Lecturer of Accounting (2006); MBA, University of North Dakota, 1986.

Joseph G. San Miguel, Professor of Accounting (1982); Ph.D., University of Texas, 1972.

Donald E. Summers, Senior Lecturer in Accounting (2000); M.S., Naval Postgraduate School, 1985.

Chong Wang, Assistant Professor of Accounting (2007); Ph.D., Iowa State University, 1998.

GRADUATE SCHOOL OF BUSINESS AND PUBLIC POLICY (GSBPP)

Professors Emeriti:

James M. Fremgen, Professor of Accounting (1965); D.B.A., Indiana University, 1961.

Shu S. Liao, Professor of Accounting (1977); Ph.D., University of Illinois, 1971.

Jerry L. McCaffery, Professor of Public Budgeting (1984); Ph.D., University of Wisconsin, 1971.

Manpower and Economics Academic Area

Area Chair

Elda Pema, Ph.D.
Code GB/Mp, Ingersoll Hall, Room 240

(831) 656-3631, DSN 756-3631
epema@nps.edu

Jeremy A. Arkes, Associate Professor of Economics (2007); Ph.D., University of Wisconsin-Madison, 1997.

Peter J. Coughlan, Associate Professor of Business (2004); Ph.D., California Institute of Technology, 1999.

Jesse M. Cunha, Assistant Professor of Economics; Ph.D., Stanford University, 2010.

Mark J. Eitelberg, Professor of Public Policy (1982); Ph.D., New York University, 1979.

William R. Gates, Associate Professor of Economics (1988); Ph.D., Yale University, 1984.

William D. Hatch II, CDR, USN (Ret.), Lecturer in Manpower Systems Analysis (2005), M.S., Naval Postgraduate School, 1991.

David R. Henderson, Associate Professor of Economics (1984); Ph.D., University of California at Los Angeles, 1976.

Noah Myung, Assistant Professor of Finance and Economics (2009); Ph.D., California Institute of Technology, 2009.

Elda Pema, Associate Professor of Management (2003); Ph.D., Michigan State University, 2003.

Dina I. Shatnawi, Assistant Professor of Economics (2010); Ph.D., University of Arizona, 2010.

Yu-Chu Shen, Assistant Professor of Economics (2004); Ph.D., Harvard University, 2001.

Benjamin J. Roberts, Senior Lecturer in Management and Human Resource Management (1985); Ph.D., The Pennsylvania State University, 1977.

Operations and Logistics Management Academic Area

Area Chair

Deborah E. Gibbons, Ph.D.
Code GB/Br, Ingersoll Hall, Room 333

(831) 656-1842, DSN 756-1842
degibbon@nps.edu

Aruna U. Apte, Assistant Professor of Management Science (2004), Ph.D., Southern Methodist University, 1997

Uday M. Apte, Professor of Operations Management (2004); Ph.D., University of Pennsylvania, 1982.

Michael Dixon, Assistant Professor of Operations Management (2011); Ph.D., Cornell University

Kenneth Doerr, Associate Professor of Operations Management (2001); Ph.D., University of Washington, 1994.

Geraldo L. Ferrer, Associate Professor of Logistics (2004); Ph.D., INSEAD, 1997.

Susan K. Heath, Assistant Professor of Operations Management (2006); Ph.D., University of Texas at Austin, 2006.

Bryan J. Hudgens, Lecturer in Operations and Logistics Management (2005); M.S., Air Force Institute of Technology, 1997.

Keebom Kang, Associate Professor of Logistics (1988); Ph.D., Purdue University, 1984.

John Khawam, Assistant Professor of Operations & Logistics (2010); Ph.D., Stanford University, 2009.

Keenan D. Yoho, Assistant Professor of Operations Management (2009); Ph.D., University of Wisconsin-Madison, 2006.

Professors Emeriti:

Donald R. Eaton, RADM, USN (Ret.), Arthur Chair and Senior Lecturer in Logistics (1994); M.S., George Washington University, 1980.

Alan W. McMasters, Professor of Operations Research and Systems Management Emeritus (1965); Ph.D., University of California at Berkeley, 1966.

Organizations and Management Academic Area

Area Chair

James E. Suchan, Ph.D.
Code GB, Ingersoll Hall, Room 313

(831) 656-2905, DSN 756-2905
jsuchan@nps.edu

Kathryn Aten, Assistant Professor of Management (2010); Ph.D., University of Oregon, 2009.

Frank J. Barrett, Professor of Organization and Management (1990); Ph.D., Case Western Reserve University, 1989.

Nicholas Dew, Associate Professor of Management (2003); Ph.D., University of Virginia, 2003.

Marco S. DiRenzo, Assistant Professor of Management (2010) ; Ph.D., Drexel University, 2010.

Deborah E. Gibbons, Associate Professor of Management (2004); Ph.D., Carnegie Mellon University, 1996.

Susan P. Hocevar, Associate Professor of Organization and Management (1990); Ph.D., University of Southern California, 1989.

Cindy L. King, Associate Professor of Management Communication (2004); Ph.D., University of Washington, 2004.

Lisa L. Massi Lindsey, Associate Professor of Management Communication (2010); Ph.D., Michigan State University, 2003.

Edward H. Powley, Assistant Professor of Management (2006); Ph.D., Case Western Reserve University, 2005.

Cary A. Simon, Lecturer of Management (1997); D.B.A., U.S. International University, 1997.

James E. Suchan, Professor of Management Communication (1986); Ph.D., University of Illinois, 1980.

Gail Fann Thomas, Associate Professor of Management Communication (1989); Ed.D., Arizona State University, 1986.

Professor Emeritus:

Kenneth W. Thomas, Professor of Management (1987); Ph.D., Purdue University, 1971.

Enterprise and Information Academic Area

Douglas Brinkley, Senior Lecturer in Information Systems and Director of Computer Support Services (1998); Ed.D, Nova Southeastern University, 2003.

Patricia J. Cook, Visiting Assistant Professor of Ethics and Public Policy (2010), Ph.D., Emory University, 1992.

Becky D. Jones, Lecturer (2002); M.B.A., Golden Gate University, 1998.

George R. Lucas Jr., Professor of Ethics and Public Policy (2011), Ph.D. Northwestern University, 1978.

GSBPP Programs and Curricula

Defense-Focused MBA Program

Brief Overview

The Master of Business Administration (MBA) is a defense-focused MBA program designed to provide officers and DoD civilians an advanced education in interdisciplinary approaches to problem solving and policy analysis by applying quantitative, financial, economic, information technology, and other state-of-the-art management techniques and concepts to military management and policy issues. Graduates of the MBA program will know the latest management theories and practices, including leadership, communication, organization design, and planning, and how to apply them within large public and private sector organizations, as well as military sub-units and activities.

The MBA degree program has been designed to meet four objectives:
· To provide a defense-focused graduate management education program of specific relevance to U.S. military officers and DoD civilians.
· To satisfy educational requirements for military subspecialties or occupational and functional areas.
· To meet the Association to Advance Collegiate Schools of Business International (AACSB) and the National Association of Schools of Public Affairs and Administration (NASPAA) accreditation requirements.
· To allow officers to complete JPME requirements, if desired.

To satisfy these objectives, the MBA program consists of four parts:
· Business Core (35 credit hours)
· Mission-Related Core (17 credit hours)
· Curricular Concentration (24+ credit hours)
· Master's Application Project or Thesis

Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. International students should refer to the Admissions section for current TOEFL and entrance requirements.

Entry Dates

January and/or July, depending on curriculum.

Degree

Requirements for the degree of Master of Business Administration are met by:
1. Completion of all required courses in the business core.
2. Completion of all required courses in the mission-related core.
3. Completion of an approved sequence of courses in a concentration area with a minimum of 24 graduate-level credit hours.
4. Completion (excluding by validation) of a minimum of 58 credit hours of graduate-level courses, at least 22 of which are at the 4000 level.
5. Completion of an acceptable application project or thesis.
6. Approval of the candidate's program by the Dean, Graduate School of Business and Public Policy.

Typical Course of Study

Quarter 1

GB3014	(1-0)	Ethics for Public Managers
GB3010	(4-0)	Managing for Organizational Effectiveness
GB3020	(3-0)	Fundamentals of Information Technology
GB3050	(4-0)	Financial Reporting and Analysis
GB3070	(4-0)	Economics of the Global Defense Environment
GB1000	(0-3)	Quantitative Skills for Graduate Management Studies

Quarter 2

GB3040	(4-0)	Managerial Statistics
GB3051	(3-0)	Cost Management
GB4052	(3-0)	Managerial Finance
GB4071	(4-0)	Economic Analysis & Defense Resource Allocation
GB3031	(2-0)	Principles of Acquisition Management *

Quarter 3

GB3012	(3-0)	Communication for Managers
GB3042	(4-0)	Operations Management
GB4043	(3-0)	Business Modeling Analysis
GB4053	(4-0)	Defense Budget and Financial Management Policy
GB/MN	(X-0)	Subspecialty Curriculum Course

Quarter 4

GB4014	(4-0)	Strategic Management
GBXXXX	(2-0)	MBA Core Elective **
GB/MN	(X-0)	Subspecialty Curriculum Course
GB/MN	(X-0)	Subspecialty Curriculum Course

Quarter 5

NW3230	(4-2)	Strategy & Policy***
GB/MN	(X-0)	Subspecialty Curriculum Course
GB/MN	(X-0)	Subspecialty Curriculum Course
GB4090	(0-6)	Application Project ****

Quarter 6

GB/MN	(X-0)	Subspecialty Curriculum Course
GB/MN	(X-0)	Subspecialty Curriculum Course
GB4090	(0-6)	Application Project ****
GB/MN	(X-0)	Elective

*May be replaced by appropriate concentration course (MN3301, MN3331) within a curriculum.

** Selected from four available courses offered in the fourth quarter.

*** Not required for International students. International students take American Life and Institutions (IT1500) and Communication Skills for International Officers (IT1600) in quarters 1 and 2.

**** Students may elect to complete a thesis.

Curricular Areas and Curricula

Students in the MBA program complete a specialization curriculum in one of the following areas of particular importance to DoD:

Logistics Management

814	Transportation Management
819	Supply Chain Management
827	Material Logistics Support

Acquisition Management

815	Acquisition and Contract Management
815	Strategic Purchasing
816	Systems Acquisition Management

Financial Management

837	Financial Management

Information Management

870	Information Systems Management

Defense Management

809	Defense Business Management
818	Defense Systems Management - International
820	Resource Planning and Management for International Defense

Logistics Management Curricula

The Logistics Management curricula provide education in all aspects of the logistics function. The curricula are comprised of management core and logistics concentration subjects. The management core of the Logistics Management curricula provides study in mathematics, accounting, economics, communications, marketing management, risk analysis, DoD mission, structure and resource determination, strategy making, and the global defense marketplace. The logistics curricula subjects are significant components of the military supply chain and each provides unique and relevant education that meets the critical needs of the armed services. The specialized logistics courses concentrate on studies in operations and project management, business modeling for decision making, inventory management, integrated logistics support, procurement and contract administration, systems acquisition, and logistics strategic planning. The logistics curricula are rounded out by including education in national, international, and defense transportation systems. The educational skills in these curricula prepare those responsible for managing the various elements of total life cycle support from requirements determination through sustainment.

Program Officer

Jefferson E. McCollum, CDR, SC, USN
Code GB, Ingersoll Hall, Room 201

(831) 656-3953, DSN 756-3953
jemccoll@nps.edu

Academic Associate

Geraldo L. Ferrer, Ph.D.
Code GB, Ingersoll Hall, Room 318

(831) 656-3920, DSN 756-3920
gferrer@nps.edu mailto:gferrer@nps.edu

Transportation Management - Curriculum 814
Supply Chain Management - Curriculum 819
Material Logistics Support - Curriculum 827

Brief Overview

The Logistics Management curricula are interdisciplinary, integrating mathematics, accounting, economics, management theory, operations analysis, and the specialty concentration into an understanding of the process by which the defense mission is accomplished. The curricula are designed to provide the officer with fundamental interdisciplinary techniques of quantitative problem-solving methods, operations management, behavioral and management science, economic analysis, and financial management. Furthermore, they are intended to provide the officer with a Navy Defense Systems-oriented graduate management education and to provide the officer with the specific functional skills required to effectively manage in these subspecialty areas. The objective of these curricula is to prepare officers for naval logistics system positions. The Logistics Management curricula emphasize all of the aspects for providing integrated logistics support of military systems. Skills resulting from the curricula will

prepare those responsible for managing the various segments of a military system's life cycle from initial planning for support to fielding the system, through sustaining operations to phase out. These curricula additionally emphasize the management of military owned inventories at the three levels of wholesale, intermediate and retail customer support, and worldwide transportation and distribution systems.

Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. International students should refer to the Admissions section for current TOEFL and entrance requirements.

Entry Date

January/July

Program Length

Six Quarters

Degree

Requirements for the Master of Business Administration (MBA) degree are met en route to satisfying the Educational Skills Requirements.

Subspecialty

Completion of these curricula provides a naval officer with a specialization in Supply Chain Management (1302P), Materiel Logistics Support Management (subspecialty code 3121P), or Transportation Management (subspecialty code of 3122P). U.S. Marine officers receive MOS 9662.

Typical Subspecialty Jobs (various positions at each Command)

Naval Air Stations, Naval Bases and other installations

Naval Supply systems Command, Naval Air Systems Command, Naval Sea Systems Command, Space and Naval Warfare Systems Command (Headquarters and components)

Fleet and Industrial Supply Centers

DLA Defense Supply Centers: Dayton, OH, Philadelphia, PA, and Richmond, VA

DLA Distribution Depots

Fleet Commands

Aircraft Intermediate Maintenance Departments (ashore and afloat)

Air Terminals and Detachments

NAVCHAPGRU

MSCHQ offices and MSC field activities

Military Surface Deployment and Distribution Command

Naval Submarine Support Facility, New London, CT

Unified Combatant Commands and Defense Agencies

Bureau of Medicine, Washington, DC

Marine Corps Logistics Base, Albany, GA

Marine Corps Systems Command, Quantico, VA

MAJCOM or HQ USAF level: A7 (Mission Support) staff action officer

MAJCOM or HQ USAF level: A4 (Logistics) staff action officer

Maintenance or Logistics Readiness Squadron commander, operations officer, or flight commander

Joint Staff or Joint Command (TRANSCOM, CENTCOM, etc.): J4 staff action officer

Curriculum Sponsors

Naval Supply Systems Command Headquarters (819)
Naval Air Systems Command Headquarters (827)
Navy Military Sealift Command Headquarters (814)

Typical Course of Study: Curricula 814, 819, 827

Quarter 1

GB3014	(1-0)	Ethics for Public Managers
GB3010	(4-0)	Managing for Organizational Effectiveness
GB3020	(3-0)	Fundamentals of Information Technology
GB3050	(4-0)	Financial Reporting and Analysis
GB3070	(4-0)	Economics of the Global Defense Environment
GB1000	(0-3)	Quantitative Skills for Graduate Management Studies

Quarter 2

GB3040	(4-0)	Managerial Statistics
GB3051	(3-0)	Cost Management
GB4052	(3-0)	Managerial Finance
GB4071	(4-0)	Economic Analysis & Defense Resource Allocation
MN3301	(4-0)	Systems Acquisitions*

Quarter 3

GB3012	(3-0)	Communication for Managers
GB3042	(4-0)	Operations Management
GB4043	(3-0)	Business Modeling Analysis
GB4053	(4-0)	Defense Budget and Financial Management Policy

Quarter 4

GB4014	(4-0)	Strategic Management
GBXXXX	(3-0)	MBA Core Elective **

GB4480	(4-0)	Supply Chain Management
GB4460	(4-0)	Logistics Risk Assessment and Control

Quarter 5

GB4410	(4-0)	Logistics Engineering
GB4430	(4-0)	Defense Transportation System
GB4090	(0-6)	Application Project ****
GB4999	(4-0)	Curricular Elective

Quarter 6

GB4450	(4-0)	Logistics Strategy *
NW3230	(4-2)	Strategy & War***
GB4090	(0-6)	Application Project ****

* USN Supply Corps and USMC must replace by MN3331. International students must replace by GB3031.

** Selected from three or four available courses offered in the 4th quarter.

*** Required for USN and USMC only. International students take American Life and Institutions (IT1500) and Communication Skills for International Officers (IT1600) in quarters 1 and 2. USN students may add JPME classes in Quarters 5 and 6.

**** Students may elect to complete a thesis.

**Educational Skills Requirements (ESR)
Transportation Management -
Curriculum 814 Subspecialty code 3122P**

**Supply Chain Management -
Curriculum 819 Subspecialty code 1302P**

**Materiel Logistics Support Management -
Curriculum 827 Subspecialty code 3121P**

1. **Management Fundamentals - Quantitative Analysis:** The graduate will have the skills to apply mathematical, statistical, accounting, economic, and other state-of-the-art quantitative techniques and concepts to the solving of day-to-day military management problems as well as the capability to use these skills as a participant in the long-range strategic planning efforts of the Navy and DoD.

2. **Management Fundamentals - Organization and Management**: The graduate will have a thorough knowledge of basic management theory and practices, embracing leadership, communication, organizational design, staffing, directing, planning, and controlling of military organizations.

3. **Integrated Logistics Support Management:** The graduate will have a detailed understanding of the processes associated with designing an integrated logistics support system for a new weapon system. The graduate will also have detailed knowledge about

the DoD processes for contracting for and acquiring a new weapon system. The graduate will be able to serve as an assistant program manager for logistics (APML) for a major weapon system.

4. **Budgeting and Financial Controls:** The graduate will have an understanding of the financial management practices of DoD, will be able to conduct cost/benefit analyses, and participate in the budgetary planning by a hardware systems command for the support of both old and new weapon systems.

5. **Production/Operations Management:** The graduate will be able to apply the techniques of production/operations management at Naval Aviation Intermediate Activities and Depots, Navy Fleet Industrial and Support Activities, and other DoD maintenance and maintenance support activities.

6. **Materials and Physical Distribution Management:** The graduate will be able to apply the techniques of materials management and physical distribution management in designing and operating of fleet and troop support systems, both during peacetime and during rapidly developing wartime contingencies. This will include acquiring material and transportation assets to ensure that the distribution of material is both cost-effective and efficient. The graduate will also have an in-depth understanding of domestic, international, and defense transportation systems including the various modes, types of carriers within each mode, and the regulations affecting material movement by each type of carrier.

7. **Joint and Maritime Strategic Planning:** The graduate will have knowledge of the development and execution of military strategy and the effects of technical effects on warfare, an understanding of the means of formulation of U.S. policy, the roles of military forces and joint planning, and current issues in the defense organization. The graduate will also have a detailed understanding of the plans and processes of the DoD for providing support of strategic sealift and mobilization.

8. **Thesis/Project:** The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing by means of a thesis appropriate to this curriculum.

Acquisition Management Curricula

The Acquisition Management Curricula are designed to develop the knowledge, skills and competencies necessary to effectively lead the acquisition workforce and efficiently manage the resources allocated to the acquisition process. The curricula focus on problem solving and decision-making in a variety of acquisition situations demanding

critical thinking and a balanced approach in the application
of theory and practical solutions. Graduates of the
curricula are expected to assume leadership positions in the
acquisition workforce.

Acquisition and Contract Management Curriculum 815

The Acquisition & Contract Management Curricula are designed to develop the knowledge, skills and competencies necessary to effectively lead the acquisition workforce and efficiently manage the resources allocated to the acquisition process. The curricula focus on problem solving and decision making in a variety of acquisition situations demanding critical thinking and a balanced approach in the application of theory and practical solutions. Graduates of the curricula are expected to assume leadership positions in the acquisition workforce.

Program Officer

Jefferson E. McCollum, CDR, SC, USN
Code GB, Ingersoll Hall, Room 201

(831) 656-3953, DSN 756-3953
jemccoll@nps.edu

Academic Associate

Rene G. Rendon, D.B.A., Associate Professor
Code GB, Ingersoll Hall, Room 331D

(831) 656-3464, DSN 756-3464
rgrendon@nps.edu

Brief Overview

The Acquisition and Contract Management curriculum is an interdisciplinary program which integrates management theory, accounting, economics, finance, behavioral science, management theory, operations/systems analysis, and specific courses in acquisition and contracting. The 815 curriculum includes a concentration option in strategic purchasing. Student input includes officers and civilians from all DoD services, other federal agencies and allied nations. The curriculum is designed to provide officers and civilians with the skills to serve effectively in systems buying offices, field contracting offices, contract administration offices, and contracting policy offices.

Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. International students should refer to the Admissions section for current TOEFL and entrance requirements.

Entry Date

January and July.

Program Length

Six Quarters.

Degree

Requirements for the Master of Business Administration (MBA) degree are met en route to satisfying the Educational Skills Requirements.

Acquisition and Contract Management Subspecialty

Completion of this curriculum qualifies naval officers as Acquisition and Contract Management Subspecialists with a subspecialty code of 1306P, Army officers as Functional Area 51C, and Marine Corps officers with a 9656 MOS. The curriculum satisfies mandatory Defense Acquisition University (DAU) contracting courses required by the Defense Acquisition Workforce Improvement Act (DAWIA).

Typical Subspecialty Jobs

Contracting Officer:

Naval Inventory Control Point, Philadelphia, PA;
Air Force Major Weapon System Program Offices
Hardware Systems Commands (NAVAIR, NAVSEA, SPAWAR)
Air Force Major System Centers (Aeronautical System Center, Space and Missiles System Center)
Army Material Command
Major Subordinate Commands (CECOM, AMCOM)
Business/Financial Manager (BFM)
Defense Contract Management Agency (DCMA)
Superintendent, Shipbuilding, Conversion and Repair (SUPSHIP)
Air Force Commodity Council Contracting Officer
Air Force Regional Contracting Center Contracting Officer
Procuring Contracting Officer (Product or Logistic Center)
Administrative Contracting Officer (Defense Contract Management Agency)
Contract Negotiator (Product or Logistic Center)
Flight Commander, Major Command Headquarters
Contracting Squadron Commander (IDE graduates)
Key Staff (HQ USAF, Joint Command) (IDE graduates)

Director of Contracts:

Marine Corps Field Contracting System, Fleet and Industrial Supply Centers, Army and Navy Laboratories, Naval Regional Contracting Centers

Contracts and Business Policy:

Staff of Assistant Secretary of the Navy (Research, Development and Acquisition)
Staff of Assistant Secretary of the Army (Acquisition, Logistics and Technology)
Staff of Assistant Secretary of the Air Force (Acquisition)

Staff of Under Secretary of Defense (Acquisition, Technology and Logistics)

Curriculum Sponsor

Deputy Assistant Secretary of the Navy (Acquisition)

Typical Course of Study: Curriculum 815

Within the 815 curriculum, students may substitute specialty courses in strategic purchasing at the approval of their service and the academic associate.

US Navy students also complete an additional four courses leading to the Naval War College Command and Staff program diploma.

International students take IT1500 American Life and Institutions and IT1600 Communication Skills for International Officers in Quarters one and two.

Quarter 1

GB3014	(1-0)	Ethics for Public Managers
GB3010	(4-0)	Managing for Organizational Effectiveness
GB3020	(3-0)	Fundamentals of Information Technology
GB3050	(4-0)	Financial Reporting and Analysis
GB3070	(4-0)	Economics of the Global Defense Environment
GB1000	(0-3)	Quantitative Skills for Graduate Management Studies

Quarter 2

GB3040	(4-0)	Business Statistics & Data Analysis
GB3051	(3-0)	Cost Management
GB4052	(3-0)	Managerial Finance
GB4071	(4-0)	Economic Analysis & Defense Resource Allocation
MN3331	(5-1)	Systems Acquisition and Program Management

Quarter 3

GB3012	(3-0)	Communications for Managers
GB3042	(4-0)	Operations Management
GB4043	(3-0)	Business Modeling Analysis
GB4053	(4-0)	Defense Budget and Financial Management Policy
MN3303	(4-0)	Principles of Acquisition and Contract Management

Quarter 4

GB4014	(4-0)	Strategic Management
GBXXXX	(3-0)	MBA Core Elective *
MN3315	(4-0)	Acquisition Management and Contract Administration
MN3312	(4-0)	Contract Law

Quarter 5

MN3318	(3-0)	Contingency Contracting
MN4304	(2-0)	Defense Systems Contracting

MN3304	(5-2)	Contract Pricing and Negotiations
GB4090	(0-6)	Application Project or Thesis

Quarter 6

NW3230	(4-2)	Strategy & Policy**
MN4371	(4-0)	Acquisition and Contracting Policy
GB4090	(0-6)	Application Project or Thesis
MN3306	(3-0)	Strategic Purchasing***
	(3-0)	Contracting for Services
MN3384	(4-1)	Principles of Acquisition Production and Quality Management****

* Core Elective will be selected from four available courses offered in Q4

** USN and USMC only; students may complete three additional War College classes for JPME certification

*** USN and USAF only

**** USMC and US Army only

Educational Skills Requirements (ESR) Acquisition Management - Curriculum 815 Subspecialty Code 1306P

1. **Management Fundamentals:** The graduate will understand the theory of and have an ability to apply accounting, economic, mathematical, statistical, managerial, and other state-of-the-art management techniques and concepts to problem solving and decision-making responsibilities as military managers.

2. **Advanced Management Concepts:** The graduate will have the ability to apply advanced management and operations research techniques to defense problems. This includes policy formulation and execution, strategic planning, defense resource allocation, cost benefit and cost effectiveness analysis, federal fiscal policy, computer-based information and decision support systems, and complex managerial situations requiring comprehensive integrated decision making.

3. **Acquisition and Contracting Principles:** The graduate will have an understanding of and will be able to apply the principles and fundamentals of acquisition and contracting within the federal government, including knowledge of the acquisition laws and regulations, particularly the Federal Acquisition Regulation (FAR) and the DoD FAR Supplement (DFARS); the unique legal principles applied in government contract law and the Uniform Commercial Code; and the application of sound business principles and practices to defense contracting problems. Further, the graduate will be able to apply innovative and creative approaches not only to resolve difficult acquisition and contracting issues but to significantly influence the legal and regulatory structure within which acquisition decision making occurs. Finally, the graduate will have the

ability to conceptualize, develop and execute strategic business alliances and relationships necessary to the successful acquisition of goods and services.

4. **Acquisition and Contracting Policy:** The graduate will have an ability to formulate and execute acquisition policies, strategies, plans and procedures; a knowledge of the legislative process and an ability to research and analyze acquisition legislation; and a knowledge of the government organization for acquisition, including Congress, the General Accounting Office, the Office of Federal Procurement Policy, the federal and military contracting offices, the Boards of Contract Appeals, and the court system.

5. **Contracting Process:** The graduate will understand the theory of and have the ability to manage the field contracting, contingency contracting, supplies and services contracting, system acquisition, and contract administration processes. This involves a knowledge of the defense system life cycle processes, including requirements determination, funding, contracting, ownership, and disposal; an ability to evaluate military requirements, specifications, and bids and proposals; an ability to utilize the sealed bid, competitive proposals and simplified acquisition methodologies; a comprehensive knowledge of all contract types and their application in defense acquisition; an ability to conduct cost and price analyses; and an ability to negotiate various contracting actions, including new procurement, contract changes and modifications, claims, equitable adjustment settlements, and noncompliance issues.

6. **Business Theory and Practices:** The graduate will have an understanding of the business philosophy, concepts, practices, and methodologies of the global commercial industrial base, and the ability to apply these to the federal government acquisition environment.

7. **Federal and Defense Budgeting:** The graduate will have an ability to apply economic and accounting principles, including monetary and fiscal theories, to defense acquisition and contracting issues.

8. **Program Management:** The graduate will have an understanding of the basic principles and fundamentals of Program Management, with particular emphasis on the Procuring Contractor Officer's and Administrative Contracting Officer's roles and relationships with the Program Manager.

9. **Acquisition Workforce:** The graduate will satisfy all requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) and mandatory contracting courses required by the Defense Acquisition University (DAU) at Levels I, II, III.

10. **Ethics and Standards of Conduct:** The graduate will have an ability to manage and provide leadership in the ethical considerations of military acquisition, including the provisions of procurement integrity, and to appropriately apply defense acquisition standards of conduct.

11. **Strategy and Policy:** Officers develop a graduate-level ability to think strategically, critically analyze past military campaigns, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's policies and goals and the ways military power may be used to achieve them. This is fulfilled by completing the first of the Naval War College course series leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit.

12. **Analysis, Problem Solving, and Critical Thinking:** The graduate will demonstrate the ability to conduct research and analysis, and proficiency in presenting the results in writing and orally by means of an applied project and a command-oriented briefing appropriate to this curriculum.

Systems Acquisition Management - Curriculum 816

Program Officer

Jefferson E. McCollum, CDR, SC, USN
Code GB, Ingersoll Hall, Room 201

(831) 656-3953, DSN 756-3953
jemccoll@nps.edu

Academic Associate

John Dillard, Ph.D.
Code GB, Ingersoll Hall, Room 336

(831) 656-2650, DSN 756-2650
jtdillar@nps.edu

Brief Overview

The Systems Acquisition Management curriculum is an interdisciplinary program designed to integrate business principles, program leadership and management theory, operations analysis, and systems engineering applications. It is uniquely tailored to federal government acquisition management and intensive exposure to the fundamental principles of the acquisition environment. The courses in this curriculum apply business analysis and problem solving techniques essential to effective major system program management within the structure of DoD acquisition management. It further focuses on the decisions and problems facing the acquisition manager, the various forces at work within industry and government, and the impact of acquisition policies and strategies. Student input includes

officers and civilians from all DoD Services, other federal agencies, and allied nations.

Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. International students should refer to the Admissions section for current TOEFL and entrance requirements.

Entry Dates

January and July

Program Length

Six Quarters

Degree

Requirements for the Master of Business Administration (MBA) degree are met en route to satisfying the Educational Skills Requirements.

Systems Acquisition Management Subspecialty

Completion of this curriculum qualifies an Army officer for Functional Area 51 and a Marine Corps officer for MOS 9657. Department of Defense civilians are typically members of the acquisition work force as specified by the Defense Acquisition Work force Improvement Act (DAWIA). This curriculum satisfies the mandatory Defense Acquisition University (DAU) program management education required by the Defense Acquisition Work force Improvement Act (DAWIA) for Program Management through Level III and provides up to 14 additional DAU equivalencies in other functional areas.

Typical Subspecialty Jobs

Program Manager/Deputy Program Manager/Program Office:

Army/Air Force/Navy/Marine Corps Acquisition
    Category I through III (ACAT I - III) Programs
Program Executive Officer (PEO) staff
Matrix Organization Staff
Army Materiel Command (AMC)
Naval Air Systems Command (NAVAIR)
Naval Sea Systems Command (NAVSEA)
Air Force Systems Command
Army Communications - Electronics Command
    (CECOM)
Marine Corps Systems Command (MARCORSYSCOM)
Force Development Officer
Test and Evaluation Officer
Acquisition Logistics Officer

Curriculum Sponsor

Director, Acquisition Career Management, Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology): ASA/ALT (DACM)

Typical Course of Study: Curriculum 816

The 6-quarter matrix below is for US Army and USAF students.

USN, USMC and international students follow a 7-quarter program. USN students may add JPME courses.

International students also take IT1500 American Life and Institutions and IT1600 Communication Skills for International Officers in quarters one and two.

Quarter 1

GB3014	(1-0)	Ethics for Public Managers
GB3010	(4-0)	Managing for Organizational Effectiveness
GB3020	(3-0)	Fundamentals of Information Technology
GB3050	(4-0)	Financial Reporting and Analysis
GB3070	(4-0)	Economics of the Global Defense Environment
GB1000	(03)	Quantitative Skills for Graduate Management Studies

Quarter 2

GB3040	(4-0)	Business Statistics & Data Analysis
GB3051	(3-0)	Cost Management
GB4052	(3-0)	Managerial Finance
GB4071	(4-0)	Economic Analysis & Defense Resource Allocation
MN3331	(5-1)	Principles of Systems Acquisition and Program Management

Quarter 3

GB3012	(3-0)	Communication for Managers
GB3042	(4-0)	Operations Management
GB4043	(3-0)	Business Modeling Analysis
GB4053	(4-0)	Defense Budget and Financial Management Policy
MN3303	(4-0)	Principles of Acquisition and Contract Management

Quarter 4

GB4014	(4-0)	Strategic Management
GBXXXX	(3-0)	MBA Core Elective *
SE4011	(3-2)	Systems Engineering for Acquisition Managers
MN3384	(4-1)	Principles of Acquisition Production and Quality Management

Quarter 5

MN3309	(4-1)	Acquisition of Embedded Weapon Systems Software
GB4410	(3-0)	Logistics Engineering
MN4602	(2-2)	Test and Evaluation Management

GB4090   (0-6)   Application Project or Thesis

Quarter 6*
MN4307   (4-0)   Program Management Policy and
                     Control
MN3315   (4-0)   Contract Administration
MN4470   (4-0)   Life Cycle Support
GB4090   (0-6)   Application Project or Thesis

* Selected from three or four available courses offered in the 4th quarter.

Educational Skills Requirements (ESR)
Systems Acquisition Management - Curriculum 816

1. **Management Fundamentals:** The graduate will understand the theory of and have an ability to apply accounting, economic, mathematical, statistical, managerial, and other state-of-the-art management techniques and concepts to problem solving and decision-making responsibilities as Department of Defense managers. The graduate will have the ability to think creatively, addressing issues and problems in a dynamic, challenging environment.

2. **Advanced Leadership and Management Concepts:** The graduate will have the ability to apply advanced leadership, management and operations research techniques to defense problems. This includes policy formulation and execution, strategic planning, defense resource allocation, project leadership, cost benefit and cost effectiveness analysis, federal fiscal policy, computer-based information and decision support systems, and complex managerial situations requiring comprehensive integrated leadership abilities.

3. **Program Leadership and Management Principles:** The graduate will have an understanding of and will be able to apply the principles, concepts, and techniques of Program Leadership and Program Management to the acquisition of major defense weapon systems. This includes the principles of risk management and tradeoff decision analysis using Total Ownership Cost, schedule and performance dynamics from a total life cycle management perspective.

4. **Program Management Policies:** The graduate will have an ability to formulate and execute defense acquisition policies, strategies, plans and procedures; an understanding of the policy-making roles of various federal agencies of the executive, legislative and judicial branches of the U.S. government, particularly the Department of Defense (DoD), the General Accounting Office (GAO), congressional committees, the Office of Management and Budget (OMB); and an understanding of the strategies necessary to influence policy development and implementation.

5. **Systems and Acquisition Process:** The graduate will understand the theory of and have an ability to lead program teams and manage the systems acquisition process. This involves the system life cycle process for requirements determination, research and development, funding and budgeting, procurement, systems engineering, including systems of systems, test and evaluation, manufacturing and quality control, integrated logistics support, ownership and disposal; the interrelationship between reliability, maintainability and logistics support as an element of system effectiveness in defense system and equipment design; and embedded weapon system software, particularly related to current policies and standards, software metrics, risk management, inspections, testing, integration, and post-deployment software support.

6. **Contract Management:** The graduate will understand the role of the contracting process within the acquisition environment, including financial, legal, statutory, technical, and managerial constraints in the process.

7. **Business Theory and Practices:** The graduate will have an understanding of the business and operating philosophies, concepts, practices and methodologies of defense industry with regard to major weapon systems acquisition, particularly the application of sound business practices.

8. **Government and Industry Budgeting and Financial Management:** The graduate will have an understanding of and an ability to apply the principles of government and private organizational financing, including corporate financial structures, cost and financial accounting, capital budgeting techniques, financial analysis, and Defense financial management and budgeting processes to include the Planning, Programming, Budgeting Execution System (PPBES).

9. **Acquisition Work force:** The graduate will satisfy all requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) and mandatory program management courses required by the Defense Acquisition University (DAU) at Levels I, II, and III.

10. **Ethics and Standards of Conduct:** The graduate will have an ability to manage and provide leadership in the ethical considerations of defense acquisition, including the provisions of procurement integrity, and to appropriately apply defense acquisition standards of conduct.

11. **Analysis, Problem Solving, and Critical Thinking:** The graduate will demonstrate the ability to conduct research and analysis, and proficiency in presenting the results in writing and orally by means of an applied

project and a command-oriented briefing appropriate to this curriculum.

Financial Management Curriculum

Program Officer

Jefferson E. McCollum, CDR, SC, USN
Ingersoll Hall, Room 201

(831) 656-3953, DSN 756-3953
jemccoll@nps.edu

Academic Associate (837)

Wythe Davis
Ingersoll Hall, Room 314

(831) 656-2672
rwdavis@nps.edu

Master of Arts in Management Program (MAM) - 834

Brief Overview

The objective of the MAM with Financial Management focus – is to expose officers to and to teach business, financial, and analysis practices, techniques, and policies. From staff to line, career fields within DON increasingly require some aspect of financial management. This degree does not create FM experts but rather provides a solid basis for DoN decision makers to be aware of and be able to use the available accurate, timely and relevant information and analysis to inform their decisions. Managers concerned with the optimal allocation of resources to achieve the DoN's goals and objectives while assuring efficient and effective expenditure of public funds will benefit from this degree. Graduates of the MAM with FM focus curriculum will be prepared to return to the fleet with a greater understanding of strategic planning, business analysis, financial analysis, budgeting, accounting, business and financial management.

Graduate courses cover topics such as FM policy and practice; cost, operations, supply chain, IT, and strategic management; organizational effectiveness; ethics and communications for managers; business statistics, economic analysis and financial reporting.

Requirements for Entry

A baccalaureate degree with above-average grades and an APC of 245 is required for entry.

Entry Dates

January

Program Length

18 months (6 months DL + 12 months Resident)

Degree

Requirements for the degree of Master of Arts in Management are met by:

1. Completion (excluding by validation) of a minimum of 44 credit hours of graduate-level GB/MN courses, at least 18 of which are at the 4000 level. (Credit hours required for the degree project do not count toward the 44 credit hour minimum requirement.)
2. Completion of the core MBA management, ethics, acquisition, economics, and quantitative GB/MN courses
3. Completion of an approved sequence of financial management courses totaling at least 14 credit hours
4. Completion of an acceptable application project or thesis.
5. Approval of the candidate's program by the Dean, GSBPP.

Curriculum Sponsor

N-82, Director, Office of Budget and Fiscal Management Division.

Typical Course of Study: Curriculum 834

GB3010	(4-0)	Managing for Organizational Effectiveness
GB3050	(4-0)	Financial Reporting and Analysis
GB4070	(4-0)	Energy Economics
GB3051	(3-0)	Cost Management
GB4053	(4-0)	Defense Budget and Financial Management Policy
GB3014	(1-0)	Ethics for Public Managers
GB3012	(3-0)	Communication for Managers
GB3040	(4-0)	Managerial Statistics
NW3230	(4-2)	Strategy and War
GB4071	(4-0)	Economic Analysis & Defense Resource Allocation
MN3301	(4-0)	Systems Acquisition
GB4021	(3-0)	Strategic Management of Information Technology
NW3285	(4-0)	Theatre Security Decision Making
GB3510	(3-0)	Defense Financial Management Practice
GB3042	(4-0)	Operations Management
NW3275	(4-0)	Joint Maritime Operations (Part 1)
GB4090	(3-0)	Capstone Project (taken twice)
GB4014	(4-0)	Strategic Management
GB4043	(3-0)	Business Modeling & Analysis
NW3276	(4-0)	Joint Maritime Operations (Part 2)

Curriculum Sponsor and Educational Skill Requirements Approval Authority

Chief of Naval Operations (N8/N82)

Financial Management - Curriculum 837

Brief Overview

The objective of the Financial Management Curriculum is to prepare officers for business, financial, and analysis positions within the DoN and DoD. Financial Managers assist the DoN's decision-making processes at all levels by providing accurate, timely and relevant information and analysis. They are concerned with the optimal allocation of human, physical and financial resources to achieve the DoN's goals and objectives while assuring efficient and effective expenditure of public funds. Graduates of the Financial Management Curriculum will be prepared for assignment to positions in strategic planning, business analysis, financial analysis, budgeting, accounting, business and financial management, and internal control systems and auditing.

Graduate courses cover topics such as financial reporting standards, cost standards, cost analysis, budgeting and financial management, internal control, auditing, management planning and control systems, strategic resource management, quantitative techniques used in planning and control, system acquisition and program management, and the Planning Programming, Budgeting Execution System (PPBES) used within the Department of Defense.

Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. International students should refer to the Admissions section for current TOEFL and entrance requirements.

Entry Dates

January and July

Program Length

Six Quarters

Degree

Requirements for the Master of Business Administration (MBA) degree are met en route to satisfying the Educational Skills Requirements.

Financial Management Subspecialty

Completion of this curriculum qualifies a U.S. Navy officer as a Financial Management Subspecialist, subspecialty code 3110P. Completion qualifies a U.S. Marine Corps officer for MOS 9644.

Typical Subspecialty Jobs

Comptroller: Naval Bases/Naval Air Stations/SYSCOMs
Budget Analyst: Office of Budget, N-82 SYSCOMS, U.S. STRATCOM
Public Works Officer: CONUS/OUTCONUS
Comptroller: Naval Hospitals
Business Financial Managers: Program Offices
Action Officer/Program Analyst: OSD
Budget Analyst: OPNAV
Fiscal Officer: BUMED
Budget Officer: CINPACFLT/CINCLANTFLT

Curriculum Sponsor

N-82, Director, Office of Budget and Fiscal Management Division.

Typical Course of Study: Curriculum 837

Quarter 1

GB3014	(1-0)	Ethics for Public Managers
GB3010	(4-0)	Managing for Organizational Effectiveness
GB3020	(3-0)	Fundamentals of Information Technology
GB3050	(4-0)	Financial Reporting and Analysis
GB3070	(4-0)	Economics of the Global Defense Environment
GB1000	(0-3)	Quantitative Skills for Graduate Management Studies

Quarter 2

GB3040	(4-0)	Managerial Statistics
GB3051	(3-0)	Cost Management
GB4052	(3-0)	Managerial Finance
GB4071	(4-0)	Economic Analysis & Defense Resource Allocation
NW3230	(4-2)	Strategy and Policy***

Quarter 3

GB3012	(3-0)	Communication for Managers
GB3042	(4-0)	Operations Management
GB4043	(3-0)	Business Modeling Analysis
GB4053	(4-0)	Defense Budget and Financial Management Policy
GB4550	(4-0)	Advanced Financial Reporting

Quarter 4

GB4014	(4-0)	Strategic Management
GBXXXX	(2-0)	MBA Core Elective **
GB4530	(3-0)	Management Control Systems
MN3301	(4-0)	Systems Acquisition*
GB3510	(3-0)	Defense Financial Management Practice

Quarter 5

GB4510	(4-0)	Strategic Resource Management
GB4540	(2-0)	Financial Management Seminar
OA4702	(4-0)	Cost Estimation
GB4090	(0-6)	Application Project ****

Quarter 6

GB4520 (3-0) Internal Control and Audit
MN4157 (3-0) Seminar in Management Accounting
GB4560 (3-0) Defense Financial Management
GB4090 (0-6) Application Project ****

* Equivalent to DAU courses ACQ101 & ACQ102. May be replaced by MN3331. May be replaced by GB3031 for international students.

** Selected from four available courses offered in the 4ᵗʰ quarter.

*** Not required for International students, US Army or USAF. International students take American Life and Institutions (IT1500) and Communication Skills for International Officers (IT1600) in quarters 1 and 2.

**** Students may elect to complete a thesis.

Educational Skills Requirements (ESR)
Financial Management - Curriculum 837
Subspecialty Code 3110P

1. **Management Fundamentals:** The graduate will have the ability to apply quantitative techniques, accounting, economics, finance, organization theory, information technology, and other state-of-the-art management techniques and concepts to military management problems. Also, the graduate will know basic management theory and practice, embracing leadership, ethics, written and oral communication, organization design, team building, human resource management, conflict resolution, quality assurance, cost-benefit analysis, risk analysis, stakeholder analysis, and planning within military organizations, as well as military sub-units and activities. This ensures internal and external constituencies are considered in resource management.

2. **Strategic Vision and Defense Budgeting:** The graduate will understand the roles of the executive and legislative branches in strategic planning, setting federal fiscal policy, allocating resources to national defense, budget formulation, budget negotiation, budget justification, and budget execution strategies, including the principles of Federal Appropriations Law. In addition, the graduate will have knowledge of all aspects of the federal, Defense, and Navy budget cycles including the Planning, Programming, Budgeting, and Execution System with emphasis on budget formulation and execution.

3. **Funds Management:** In support of approved programs, the graduate will be able to manage appropriated, revolving, and non-appropriated funds in compliance with regulations of the Comptroller of the Navy and the federal government. Also, the graduate will be able to develop and review financial reports, analyze budget execution against operating and financial plans, develop alternate plans based on analyses of an activity's financial performance, and prepare recommendations or make decisions regarding the reallocation or reprogramming of funds. The guidelines of the Defense Finance and Accounting System and the Federal Accounting Standards Advisory Board are relevant.

4. **Accountability, Control, and Auditing:** The graduate will be able to acquire and analyze financial data and communicate the results to a diverse audience, including maintaining an integrated financial information system and appropriate internal controls to ensure timely, accurate, and consistent financial information. In accordance with the auditing standards of the U.S. Government Accountability Office, the Defense and Navy audit organizations, and the professional standards of the American Institute of Certified Public Accountants, the graduate will learn to apply audit techniques that enforce sound internal accounting and administrative controls, safeguard defense assets, and assure the completeness and integrity of financial reports.

5. **Acquisition and Program Management:** The graduate will understand the purpose and concepts, fundamentals and philosophies of the defense systems acquisition process, and the practical application of program management methods within this process. This includes systems acquisition management; the systems acquisition life cycle; user-producer acquisition management disciplines and activities; and program planning, organizing, staffing, directing, and controlling. This satisfies the Defense Acquisition University education equivalency requirements for defense acquisition professionals as specified in Congress' Defense Acquisition Workforce Improvement Act (DAWIA)

6. **Economy, Efficiency, and Effectiveness:** The graduate will have the skills for solving complex and unstructured management problems in which alternatives must be identified, evaluated, and selected in accordance with economical procurement of resources, efficient utilization of resources, and effective accomplishment of overall Defense and Navy goals and objectives. This includes cost/benefit analysis, systems analysis, cost estimation, value engineering, business process reengineering, and application of relevant OMB and Defense regulations.

7. **Cost Management and Analysis**: The graduate will be able to design, implement, and evaluate different costing systems encountered within Defense and Navy organizations and activities, as well as those found in

private sector organizations conducting business with the federal government. In addition to private sector cost management policies and practices, the graduate will understand the application of Defense unit costing guidelines to functional business areas, and the Office of Management and Budget's Cost Accounting Standards for major suppliers of goods and services to the federal government.

8. **Strategic Resource Management**: The graduate will have knowledge of strategic vision and strategic core competency concepts for setting long-range goals and objectives; designing programs to achieve objectives; assigning individual responsibility for resource management, actions, and decision making; measuring performance; reporting results; and evaluating and rewarding performance. This includes assessing customer needs and customer satisfaction, making recommendations, and implementing improvements in the effective delivery of goods and services to customers or users.

9. **Innovation and Creativity**: The graduate will demonstrate innovation and creativity in developing solutions to complex financial, budget, and program management issues that increase program effectiveness and customer satisfaction, while controlling the efficient utilization of financial, physical, and human resources. This involves the ability to identify problems and potential concerns, providing leadership, and teaming with others in the decision making process, and obtaining support for recommended decisions or courses of action.

10. **Strategy and Policy**: Officers develop a graduate-level ability to think strategically, critically analyze past military campaigns, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's policies and goals and the ways military power may be used to achieve them. Fulfilled by completing the first of the Naval War College series leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit.

Curriculum Sponsor and Educational Skill Requirements Approval Authority:

Financial Management (837):
Chief of Naval Operations (N8/N82)

Financial Management (Energy Specialty) - 838

Brief Overview

The objective of the Financial Management – Energy Specialty Curriculum is to prepare officers for business, financial, and analysis positions within the DoN and DoD and also to provide an advanced education in energy-related problem solving. Financial Managers assist the DoN's decision-making processes at all levels by providing accurate, timely and relevant information and analysis. They are concerned with the optimal allocation of human, physical, financial, and energy resources to achieve the DoN's goals and objectives while assuring efficient and effective expenditure of public funds. Graduates of the Financial Management – Energy Specialty curriculum will be prepared for assignment to positions in strategic planning, business analysis, financial analysis, budgeting, accounting, business and financial management, and internal control systems and auditing.

Graduate courses cover topics such as energy economics, energy strategy and policy, financial reporting standards, cost standards, cost analysis, budgeting and financial management, internal control, auditing, management planning and control systems, strategic resource management, quantitative techniques used in planning and control, system acquisition and program management, and the Planning Programming, Budgeting Execution System (PPBES) used within the Department of Defense.

Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. International students should refer to the Admissions section for current TOEFL and entrance requirements.

Entry Dates

January and July

Program Length

18 months (six quarters)

Degree

Requirements for the Master of Business Administration (MBA) degree are met en route to satisfying the Educational Skills Requirements.

Financial Management Subspecialty

3113-P: Financial Management with Energy Focus

Typical Subspecialty Jobs
AVIATOR/N432D FLY HRS PROGRAM
SUP PLN/SPEC ASST TASK FORCE ENERGY/N43E
LIAISON R&D/N402B LOG TECH
LOGISTICS/SPECIAL ASSIST FOR OPER LOGS
SUP LOG/LOGISTICS/PLNS OFF (N412)
TRA PLN AVFLGT/AIROPS/FHP
PRCM MGMT/SURFACE MOBILITY PROG MGR

Curriculum Sponsor

N-82, Director, Office of Budget and Fiscal Management Division and N45, Energy and Environmental Readiness Division.

Typical Course of Study: Curriculum 838

GB3013	(0-2)	Problem Analysis and Ethical Dilemmas
GB3010	(4-0)	Managing for Organizational Effectiveness
GB3020	(3-0)	Fundamentals of Information Technology
GB3050	(4-0)	Financial Reporting and Analysis
GB4070	(4-0)	Energy Economics
GB3040	(4-0)	Managerial Statistics
GB3051	(3-0)	Cost Management
GB4052	(3-0)	Managerial Finance
GB4071	(4-0)	Economic Analysis & Defense Resource Allocation
NW3230	(4-2)	Strategy and War
GB3012	(3-0)	Communication for Managers
GB3042	(4-0)	Operations Management
GB4053	(4-0)	Defense Budget and Financial Management Policy
GB4550	(4-0)	Advanced Financial Reporting
GB4014	(4-0)	Strategic Management
GBXXXX	(4-0)	Energy Elective
GB4530	(3-0)	Management Control Systems
MN3301	(4-0)	Systems Acquisition*
GB3510	(3-0)	Defense Financial Management Practice
GB4510	(4-0)	Strategic Resource Management
OS3007	(4-0)	OR for Energy Systems Analysts
GB4090	(0-6)	MBA Project
GB4520	(3-0)	Internal Control and Audit
NS4053	(4-0)	Energy Security: History, Politics, and Policy
EN3000	(2-0)	Defense Energy Seminar
PH3700	(4-0)	Energy Fundamentals

Educational Skills Requirements (ESR)

Management Fundamentals; Strategic Vision and Defense Budgeting; Funds Management; Accountability, Control and Auditing; Acquisition and Program Management; Economy, Efficiency, and Effectiveness; Cost Management and Analysis; Strategic Resources Management; Innovation and Creativity; Strategy and Policy; Energy Emphasis.

Curriculum Sponsor and Educational Skill Requirements Approval Authority

Chief of Naval Operations (N8/N82) and (N45)

Information Management Curriculum

The Information Age has generated a revolution in the means in which we conduct business and warfare. New technologies have changed the traditional views of the marketplace, supply chain management, and logistics. As the range and complexity of computer applications have grown, the need to manage and exploit those resources has increased. This curriculum provides both the technical skills and business acumen to deal with a constantly evolving digital world.

Program Officer

Jefferson E. McCollum, CDR, SC, USN
Code GB, Ingersoll Hall, Room 201

(831) 656-3953, DSN 756-3953
jemccoll@nps.edu

Academic Associate

Glenn R. Cook
Code IS, Glasgow West, Room GW-3012

(831) 656-2778, DSN 756-2778
grcook@nps.edu

Information Management - Curriculum 870

Brief Overview

The Information Systems Management graduate shall have the knowledge skills and competencies to: 1) Manage the acquisition of Information Systems; 2) Manage Information Systems and infrastructure support afloat and ashore; 3) Solve Information Systems engineering and management problems individually and in teams; 4) Effectively manage and lead in today's constantly changing digital world; 5) Develop and implement effective strategies and policies to take advantage of technological opportunities and mitigate risk; 6) Assimilate new technologies and transform organizations, processes, and strategies to compete in the marketplace or on the battlefield.   These general education skill requirements are supported by the following topical educational skill requirements.

Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. International students should refer to the Admissions section for current TOEFL and entrance requirements.

Entry Dates

July

Program Length

Six Quarters (no P-Code); Seven Quarters (1309P with JPME I)

Degree

Requirements for the Master of Business Administration (MBA) degree are met en route to satisfying the Educational Skills Requirements.

Subspecialty

Completion of this curriculum qualifies a U.S. Navy officer as a Logistics - Information Technology subspecialist (subspecialty code 1309P). The 1309P code is applicable only to Supply Corps Officers (3100/3105/3107).

Typical Subspecialty Jobs

Project /Program Manager, Hardware Systems Command

Business Systems Center, Project Officer
Business Manager, PEO
CIO, Acquisition Office

Curriculum Sponsor

Naval Supply Systems Command

Typical Course of Study: Curriculum 870

Quarter 1

GB3014	(1-0)	Ethics for Public Managers
GB3010	(4-0)	Managing for Organizational Effectiveness
GB3050	(4-0)	Financial Reporting and Analysis
GB3070	(4-0)	Economics of the Global Defense Environment
IS3502	(4-2)	Network Operations I
GB1000	(0-3)	Quantitative Skills for Graduate Management Studies

Quarter 2

GB3040	(4-0)	Managerial Statistics
GB3051	(3-0)	Cost Management
GB4052	(3-0)	Managerial Finance
GB4071	(4-0)	Economic Analysis & Defense Resource Allocation

Quarter 3

GB3012	(3-0)	Communication for Managers
GB3042	(4-0)	Operations Management
GB4043	(3-0)	Business Modeling Analysis
GB4053	(4-0)	Defense Budget and Financial Management Policy

Quarter 4

GB4014	(4-0)	Strategic Management
GBXXXX	(3-0)	MBA Core Elective **
IS4300	(3-2)	Software Engineering/Project Mgmt
NW3230	(4-2)	Strategy & War

Quarter 5

IS3200	(3-2)	Enterprise Systems Analysis and Design
IS3201	(4-2)	Enterprise Database Management Systems
IS4220	(3-2)	Technology Enabled Process Improvement
GB4090	(0-6)	Application Project ***

Quarter 6

CS3600	(4-2)	Information Assurance
IS3301	(3-2)	Decision Support Systems
IS4182	(4-0)	Enterprise Information Systems Strategy and Policy
GB4090	(0-6)	Application Project ***

* NW3230 required for USN and USMC; students completing JPME take all four Naval War College classes.

** Selected from four available courses offered in the 4ᵗʰ quarter.

*** Students may elect to complete a thesis.

International students take American Life and Institutions (IT1500) and Communication Skills for International Officers (IT1600) in quarters 1 and 2.

Educational Skills Requirements for Information Systems Management - Curriculum 870 Subspecialty 1309P

1. **Management Fundamentals**: The graduate will have the ability to apply quantitative accounting, economics, information technology, and other management techniques and concepts to military management problems. Also, the graduate will know management theory and practices, including leadership, communications, organizational design, staffing, quality and planning within large public and private sector organizations with a focus on military sub-units and activities.

2. **Information Systems Technology:** The officer will have a thorough knowledge of information systems management to include: 1) computer system components; 2) computer networks: network architectures, protocols and standards; 3) database management systems: database technologies, object-oriented databases, data warehouses, OLAP, technical and administrative issues involved in the design, implementation and maintenance of database management systems.

3. **Decision Support and Knowledge Management Systems:** The student will have a thorough knowledge of problem identification, formulation, and application of systems to support decision making. The student will understand the purpose of executive information

systems, group decision support systems, and contingency management systems and their potential impacts on public organizations and missions. The student will also be familiar with knowledge collection technologies designed to capture, categorize, store, retrieve and present knowledge.

4. **Computer Security:** The student will gain fundamental knowledge of the methods for ensuring integrity, confidentiality, authentication, and availability of computer resources, distributed databases, and networks.

5. **Information Systems Analysis and Management:** The officer will have a thorough knowledge of the following concepts to effectively manage the application of information systems to organizational goals: 1) Managerial Concepts: decision-making theory, microeconomics, marketing, operations analysis, statistics, financial management, organizational development, and research methodologies; 2) Evaluation of Information Systems: cost-performance (effectiveness) analysis; selection, evaluation, acquisition, installation and effective utilization of information systems hardware and software risk assessment; 3) Systems Analysis and Design: information systems feasibility, life cycle management, system requirements determination, system performance evaluation, conversion and maintenance of legacy systems, post-implementation evaluation; 4) Management of Information Systems: metrics evaluation, monitoring, capacity planning, human resource management, budgeting and financial control of computer centers, design of effective organization structure, understanding architectural constraints, control and security (INFOSEC) policies, and training requirements for both the user and support staff; 5) Adapting to Technological, Organizational, and Economic Changes: Evaluation of potential impacts of new technology on information systems and organizational strategy.

6. **Military Applications:** The officer must be able to combine analytical methods and technical expertise with operational experience for effective military applications to include: 1) DoD Decision-Making Process on Information Systems: DoD, DoN, OMB, and congressional decision making on information systems matters; 2) Information Technology Acquisition Management: Acquisition policies and procedures of the DoD, including: statutory framework, acquisition planning, contracting, and the planning, programming, and budgeting system; 3) Joint Professional Military Education (JPME) Level 1.

7. **Independent Research:** The graduate will demonstrate the ability to conduct independent research analysis and proficiency in communicating the results in writing and orally by means of a field application study. The research in information technology and its management will include problem formulation, decision criteria specification, decision modeling, data collection and experimentation, analysis, and evaluation.

Defense Management Curricula

The Defense Management Curricula serve U.S. and international officers. The overriding objective of the curricula is to provide students with the analytical skills and critical thinking ability to solve problems and make decisions they confront in both operational and staff jobs. Students may design their own concentrations to meet their organizations' unique staffing and operational needs. International officers in the Resource Planning and Management for International Defense curriculum blend courses from the Graduate School of Business and Public Policy and the National Security Affairs Department into an integrated Defense Resource program of study.

Program Officer

Jefferson E. McCollum, CDR, SC, USN
Code GB, Ingersoll Hall, Room 201

(831) 656-3953, DSN 756-3953
jemccoll@nps.edu

Defense Business Management - Curriculum 809

Academic Associate

James Suchan, Ph.D.
Code GB/Su, Ingersoll Hall, Room 313

(831) 656-2905, DSN 756-2905
jsuchan@nps.edu

Brief Overview

This interdisciplinary curriculum integrates within the defense context coursework in accounting, economics, mathematics, communications, management theory, and operations/systems analysis. As a result, students develop the analytical, critical thinking, and problem-solving skills not only to understand and critically assess the processes by which management in a defense organization is accomplished, but also to manage and allocate wisely defense resources, evaluate written research, and analyze products of others throughout their careers.

In addition, this curriculum permits students to design their own concentration. Students work with their Academic Associate to determine the concentration areas

and courses that meet their sponsoring agency needs. Students are free to choose among any of the specific management areas available. For example, a student may elect to specialize in the relevant portion of a functional area, such as financial management, logistics, human resources and organization management, acquisition, or manpower and personnel analysis. Or, the student may choose to follow a general management program, which would include an overall balance of courses from many functional areas.

Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. International students should refer to the Admissions section for current TOEFL and entrance requirements.

Entry Dates

January and July

Program Length

Six Quarters

Degree

Requirements for the Master of Business Administration degree are met en route to satisfying the Educational Skills Requirements.

Subspecialty

Determined in consultation with the Academic Associate.

Typical Course of Study: Curriculum 809

Quarter 1

GB3014	(1-0)	Ethics for Public Managers
GB3010	(4-0)	Managing for Organizational Effectiveness
GB3020	(3-0)	Fundamentals of Information Technology
GB3050	(4-0)	Financial Reporting and Analysis
GB3070	(4-0)	Economics of the Global Defense Environment
GB1000	(0-3)	Quantitative Skills for Graduate Management Studies

Quarter 2

GB3040	(4-0)	Managerial Statistics
GB3051	(3-0)	Cost Management
GB4052	(3-0)	Managerial Finance
GB4071	(4-0)	Economic Analysis & Defense Resource Allocation

Quarter 3

| GB3012 | (3-0) | Communication for Managers |
| GB3042 | (4-0) | Operations Management |

GB4043	(3-0)	Business Modeling Analysis
GB4053	(4-0)	Defense Budget and FM Policy
GB4999	(V-0)	Curriculum Elective Course

Quarter 4

GB4014	(4-0)	Strategic Management
GBXXXX	(2-0)	MBA Core Elective *
GB3031	(2-0)	Principles of Acquisition Management
GB4999	(V-0)	Curriculum Elective Course
GB4999	(V-0)	Curriculum Elective Course

Quarter 5

GB4999	(V-0)	Curriculum Elective Course
GB4999	(V-0)	Curriculum Elective Course
GB4999	(V-0)	Curriculum Elective Course
GB4090	(0-6)	Application Project **

Quarter 6

GB4999	(V-0)	Curriculum Elective Course
GB4999	(V-0)	Curriculum Elective Course
GB4999	(V-0)	Curriculum Elective Course
GB4090	(0-6)	Application Project **

* Selected from four available courses offered in the 4th quarter.

** Students may elect to complete a thesis.

Educational Skills Requirements (ESR)
Defense Business Management - Curriculum 809

1. **Management Fundamentals**: The graduate will have the ability to apply quantitative techniques, accounting, economics, finance, organization theory, information technology, and other state-of-the-art management techniques and concepts to military management problems. Also, the graduate will know basic management theory and practice, embracing leadership, ethics, written and oral communication, organization design, team building, human resource management, conflict resolution, quality assurance, cost-benefit analysis, risk analysis, stakeholder analysis, and planning within military organizations, as well as military sub-units and activities. This ensures internal and external constituencies are considered in resource management.

2. **Strategic Vision and Defense Budgeting:** The graduate will understand the roles of the executive and legislative branches in strategic planning, setting federal fiscal policy, allocating resources to national defense, budget formulation, budget negotiation, budget justification, and budget execution strategies, including the principles of Federal Appropriations Law. In addition, the graduate will have knowledge of all aspects of the federal, Defense, and Navy budget cycles including the Planning, Programming,

Budgeting, and Execution System with emphasis on budget formulation and execution.

3. **Funds Management:** In support of approved programs, the graduate will be able to manage appropriated, revolving, and non-appropriated funds in compliance with regulations of the Comptroller of the Navy and the federal government. Also, the graduate will be able to develop and review financial reports, analyze budget execution against operating and financial plans, develop alternate plans based on analyses of an activity's financial performance, and prepare recommendations or make decisions regarding the reallocation or reprogramming of funds. The guidelines of the Defense Finance and Accounting System and the Federal Accounting Standards Advisory Board are relevant.

4. **Accountability, Control, and Auditing**: The graduate will be able to acquire and analyze financial data and communicate the results to a diverse audience, including maintaining an integrated financial information system and appropriate internal controls to ensure timely, accurate, and consistent financial information. In accordance with the auditing standards of the U.S. Government Accountability Office, the Defense and Navy audit organizations, and the professional standards of the American Institute of Certified Public Accountants, the graduate will learn to apply audit techniques that enforce sound internal accounting and administrative controls, safeguard defense assets, and assure the completeness and integrity of financial reports.

5. **Acquisition and Program Management**: The graduate will understand the purpose and concepts, fundamentals and philosophies of the defense systems acquisition process, and the practical application of program management methods within this process. This includes systems acquisition management; the systems acquisition life cycle; user-producer acquisition management disciplines and activities; and program planning, organizing, staffing, directing and controlling. This satisfies the Defense Acquisition University education equivalency requirements for defense acquisition professionals as specified in Congress' Defense Acquisition Workforce Improvement Act (DAWIA)

6. **Economy, Efficiency, and Effectiveness:** The graduate will have the skills for solving complex and unstructured management problems in which alternatives must be identified, evaluated, and selected in accordance with economical procurement of resources, efficient utilization of resources, and effective accomplishment of overall Defense and Navy goals and objectives. This includes cost/benefit analysis, systems analysis, cost estimation, value engineering, business process reengineering, and application of relevant OMB and Defense regulations.

7. **Cost Management and Analysis**: The graduate will be able to design, implement, and evaluate different costing systems encountered within Defense and Navy organizations and activities, as well as those found in private sector organizations conducting business with the federal government. In addition to private sector cost management policies and practices, the graduate will understand the application of Defense unit costing guidelines to functional business areas, and the Office of Management and Budget's Cost Accounting Standards for major suppliers of goods and services to the federal government.

8. **Strategic Resource Management**: The graduate will have knowledge of strategic vision and strategic core competency concepts for setting long-range goals and objectives; designing programs to achieve objectives; assigning individual responsibility for resource management, actions, and decision making; measuring performance; reporting results; and evaluating and rewarding performance. This includes assessing customer needs and customer satisfaction, making recommendations, and implementing improvements in the effective delivery of goods and services to customers or users.

9. **Innovation and Creativity:** The graduate will demonstrate innovation and creativity in developing solutions to complex financial, budget, and program management issues that increase program effectiveness and customer satisfaction, while controlling the efficient utilization of financial, physical, and human resources. This involves the ability to identify problems and potential concerns, providing leadership, and teaming with others in the decision-making process, and obtaining support for recommended decisions or courses of action.

10. **Strategy and Policy**: Officers develop a graduate-level ability to think strategically, critically analyze past military campaigns, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's policies and goals and the ways military power may be used to achieve them. Fulfilled by completing the first of the Naval War College series leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit.

Defense Systems Management-International - Curriculum 818

Academic Associate

Simonia Blassingame, CDR, USN
Code GB, Ingersoll Hall, Room 238

(831) 656-2697, DSN 756-2697

slblassi@nps.edu

Brief Overview

This curriculum is designed for international students. It provides international officers with the core MBA interdisciplinary techniques of quantitative problem-solving methods, management theory, management science, economic analysis, and financial management. These skills enable the officers to manage and allocate defense resources, evaluate written research, and analyze products of others throughout their careers. The curriculum will further provide the officers with the specific functional skills required for effective leadership and defense resources management.

This curriculum permits students the opportunity to design their own concentration. Concentration areas and courses are determined after consultation with the Academic Associate. The 818 program allows students to design a program of course work specific to management effectiveness in the host country's military system. The student may elect to specialize in the relevant portion of a functional area, such as financial management, logistics, human resources and organization management, or manpower and personnel analysis. Or, the student may choose to follow a general management program, which would include an overall balance of courses from many functional areas. International students are free to choose any of the specific management curricula available.

Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. International students should refer to the Admissions section for current TOEFL and entrance requirements.

Entry Dates

January and July

Program Length

Six Quarters

Degree

Requirements for the Master of Business Administration (MBA) degree are met en route to satisfying the Educational Skills Requirements.

Subspecialty

Determined in consultation with the Academic Associate.

Typical Course of Study

Quarter 1

GB3014	(1-0)	Ethics for Public Managers
GB3010	(4-0)	Managing for Organizational Effectiveness
GB3020	(3-0)	Fundamentals of Information Technology
GB3050	(4-0)	Financial Reporting and Analysis
GB3070	(4-0)	Economics of the Global Defense Environment
GB1000	(0-3)	Quantitative Skills for Graduate Management Studies
IT1600	(3-0)	Communication Skills for International Officers (if needed)

Quarter 2

GB3040	(4-0)	Managerial Statistics
GB3051	(3-0)	Cost Management
GB4052	(3-0)	Managerial Finance
GB4071	(4-0)	Economic Analysis & Defense Resource Allocation
IT1500	(4-0)	American Life and Institutions

Quarter 3

GB3012	(3-0)	Communication for Managers
GB3042	(4-0)	Operations Management
GB4043	(3-0)	Business Modeling Analysis
GB4053	(4-0)	Defense Budget and Financial Management Policy

Quarter 4

GB4014	(4-0)	Strategic Management
GBXXXX	(3-0)	MBA Core Elective *
GB3031	(2-0)	Principles of Acquisition Management
MN4999	(4-0)	Curriculum Elective Course

Quarter 5

MN4999	(4-0)	Curriculum Elective Course
MN4999	(4-0)	Curriculum Elective Course
MN4999	(4-0)	Curriculum Elective Course
GB4090	(0-6)	Application Project **

Quarter 6

MN4999	(4-0)	Curriculum Elective Course
MN4999	(4-0)	Curriculum Elective Course
GB4090	(0-6)	Application Project **

* Selected from four available courses offered in the 4th quarter.

** Students may elect to complete a thesis.

Resource Planning and Management - International - Curriculum 820

Academic Associate

Simonia Blassingame, CDR, USN
Code GB, Ingersoll Hall, Room 238

(831) 656-2697, DSN 756-2697

slblassi@nps.edu

Brief Overview

The Resource Planning and Management for International Defense curriculum is an interdisciplinary program designed exclusively for officers and civilian employees in defense agencies of other countries. The program focuses on economic analysis, the management of financial, material, and human resources, domestic and international political institutions, civil-military relations, and the role of international law. The curriculum includes a combination of existing courses within the Graduate School of Business and Public Policy and the Department of National Security Affairs, and courses especially designed for this program. In the majority of courses, international students will study and learn with U.S. students from several other management and national security affairs curricula.

Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. International students should refer to the Admissions section for current TOEFL and entrance requirements.

Entry Dates

January and July

Program Length

Six Quarters

Degree

Requirements for the Master of Business Administration (MBA) degree are met en route to satisfying the Educational Skills Requirements.

Typical Course of Study: Curriculum 820

Quarter 1

GB3014	(1-0)	Ethics for Public Managers
GB3010	(4-0)	Managing for Organizational Effectiveness
GB3020	(3-0)	Fundamentals of Information Technology
GB3050	(4-0)	Financial Reporting and Analysis
GB3070	(4-0)	Economics of the Global Defense Environment
GB1000	(0-3)	Quantitative Skills for Graduate Management Studies
IT1600	(3-0)	Communication Skills for International Officers (if needed)

Quarter 2

GB3040	(4-0)	Managerial Statistics
GB3051	(3-0)	Cost Management
GB4052	(3-0)	Managerial Finance
GB4071	(4-0)	Economic Analysis & Defense Resource Allocation
IT1500	(4-0)	American Life and Institutions

Quarter 3

GB3012	(3-0)	Communication for Managers
GB3042	(4-0)	Operations Management
GB4043	(3-0)	Business Modeling Analysis
GB4053	(4-0)	Defense Budget and Financial Management Policy
NS3023	(4-0)	Introduction to Comparative Politics

Quarter 4

GB4014	(4-0)	Strategic Management
GBXXXX	(3-0)	MBA Core Elective *
NS3900	(4-0)	International Law and Organizations
NS3030	(4-0)	American National Security Policy

Quarter 5

NS3041	(4-0)	Comparative Economic Systems
NS3025	(4-0)	Introduction to Civil-Military Relations
GB4090	(0-6)	Application Project **

Quarter 6

NS4235	(4-0)	Diplomacy & Strategic Coalitions - Operations other than War
GB4090	(0-6)	Application Project **
MN4999	(4-0)	Elective

* Selected from four available courses offered in the 4th quarter.

** Students may elect to complete a thesis.

Master of Science in Management Programs

Program Officer

Jefferson E. McCollum, CDR, USN, SC
Code GB, Ingersoll Hall, Room 201

(831) 656-3953, DSN 756-3953
jemccoll@nps.edu

The Master of Science in Management program prepares graduates to manage in complex defense organizations and to conduct rigorous analyses of organizational problems, policies and operations. To accomplish these goals, the program places particular emphasis on developing students' mathematical and statistical skills and their ability to analyze and model complex phenomena. Program graduates will:

- Be well grounded in fundamental areas of management, including accounting, financial management, operations, economics, acquisition, strategy and organizational management.
- Understand the economic, political, governmental, defense and organizational environments that influence their decisions and the organizations in which they work.
- Possess the specialized knowledge, skills and abilities to serve in positions of significant responsibility within a specified Defense Management field (Manpower Systems Analysis, Defense Systems Analysis).
- Be able to apply advanced quantitative, statistical and modeling methodologies to analyze significant defense-related problems in a rigorous manner
- Be capable of think in a critical, creative, integrative and strategic manner

The Master of Science in Management degree requires:

1. Completion or validation of the Management Fundamentals program, which consists of a total of 32 quarter-hours of 2000 and 3000 level courses, including a minimum of the following hours by discipline:

Accounting and Financial Management	(6)
Economics	(6)
Organization and Management	(6)
Quantitative Methods	(8)

2. In addition to the above, completion of a minimum of 48 hours of graduate-level courses, at least 12 hours of which are at the 4000 level.
3. Completion of an approved sequence of courses in the student's area of concentration.
4. Completion of an acceptable thesis.
5. Approval of the candidate's program by the Dean, GSBPP.

Defense Systems Analysis - Curriculum 817

Academic Associate

Donald E. Summers, M.S.
Code GB/Ds, Ingersoll Hall, Room 337

(831) 656-3632, DSN 756-3632
desummer@nps.edu

Brief Overview

This curriculum provides officers with the fundamental interdisciplinary techniques of quantitative problem-solving methods, behavioral and management science, economic analysis, and financial management. The curriculum educates students to evaluate others' research

and analysis and to develop in them sound management and leadership skills. This curriculum is an interdisciplinary program that integrates mathematics, accounting, economics, behavioral science, management theory, operations/systems analysis, and a subspecialty into an understanding of the process by which the defense mission is accomplished.

Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry. International students should refer to the Admissions section for current TOEFL and entrance requirements.

Entry Dates

January and July

Program Length

Six Quarters

Degree

Requirements for the Master of Science in Management (MSM) degree are met en route to satisfying the Educational Skills Requirements.

Subspecialty

U.S. Marine Corps officers completing this curriculum fulfill the requirements for MOS 8852.

Curriculum Sponsor

Programs and Resources, Headquarters Marine Corps

Typical Course of Study: Curriculum 817

Quarter 1

GB3014	(1-0)	Ethics for Public Managers
GB3010	(4-0)	Managing for Organizational Effectiveness
GB3020	(3-0)	Fundamentals of Information Technology
GB3050	(4-0)	Financial Reporting and Analysis
GB3070	(4-0)	Economics of the Global Defense Environment
GB1000	(0-3)	Quantitative Skills for Graduate Management Studies

Quarter 2

GB3040	(4-0)	Managerial Statistics
GB3051	(3-0)	Cost Management
GB4052	(3-0)	Managerial Finance
GB4071	(4-0)	Economic Analysis & Defense Resource Allocation
MN2039	(4-0)	Basic Quant Methods in Econ Analysis

Quarter 3

GB3012	(3-0)	Communication for Managers
GB3042	(4-0)	Operations Management
GB4043	(3-0)	Business Modeling Analysis
GB4053	(4-0)	Defense Budget & FM Policy
MN4110	(4-1)	Multivariate Manpower Data Analysis I

Quarter 4

GB4014	(4-0)	Strategic Management
GB4044	(3-0)	Defense Focused Managerial Inquiry
MN3331	(5-1)	Systems Acquisition & Project Management
MN0810	(0-8)	Thesis

Quarter 5

GB4510	(4-0)	Strategic Resource Management
OA4702	(4-0)	Cost Estimation
GB4440	(4-0)	Simulation Modeling for Management Decision Making
MN0810	(0-8)	Thesis

Quarter 6

NW3230	(4-2)	Strategy & Policy
MN0810	(0-8)	Thesis
GB4999	(V-0)*	Curriculum Elective Course
GB4999	(V-0)*	Curriculum Elective Course

*V=variable. May be 3000 or 4000 level course.

Educational Skills Requirements (ESR)
Defense Systems Analysis - Curriculum 817

1. **Management Fundamentals**: The graduate will have the ability to apply quantitative techniques, accounting, economics, finance, organization theory, information technology, and other state-of-the-art management techniques and concepts to military management problems. Also, the graduate will know basic management theory and practice, embracing leadership, ethics, written and oral communication, organization design, team building, human resource management, conflict resolution, quality assurance, cost-benefit analysis, risk analysis, stakeholder analysis, and planning within military organizations, as well as military sub-units and activities. This ensures internal and external constituencies are considered in resource management.

2. **Strategic Vision and Defense Budgeting:** The graduate will understand the roles of the executive and legislative branches in strategic planning, setting federal fiscal policy, allocating resources to national defense, budget formulation, budget negotiation, budget justification, and budget execution strategies, including the principles of Federal Appropriations Law. In addition, the graduate will have knowledge of all aspects of the federal, Defense, and Navy budget cycles including the Planning, Programming, Budgeting, and Execution System with emphasis on budget formulation and execution.

3. **Modeling and Analysis:** The graduate will be well-versed in applications of probability and statistics to the modeling, simulation, and analysis of military decision problems. The graduate will have gained knowledge in all aspects of analytical studies, including reviewing, critiquing, highlighting critical assumptions, recognizing strengths and weakness of applied analytical methodologies, and evaluating study recommendations. In addition, the graduate will be able to design and conduct analytical studies. This includes formulating problems, using the analytical process to define study requirements, applying appropriate analytical methodologies, and presenting the results effectively both orally and in writing.

4. **Acquisition and Program Management**: The graduate will understand the purpose and concepts, fundamentals and philosophies of the defense systems acquisition process, and the practical application of program management methods within this process. This includes systems acquisition management; the systems acquisition life cycle; user-producer acquisition management disciplines and activities; and program planning, organizing, staffing, directing and controlling. This satisfies the Defense Acquisition University education equivalency requirements for defense acquisition professionals as specified in Congress' Defense Acquisition Workforce Improvement Act (DAWIA)

5. **Economy, Efficiency, and Effectiveness:** The graduate will have the skills for solving complex and unstructured management problems in which alternatives must be identified, evaluated, and selected in accordance with economical procurement of resources, efficient utilization of resources, and effective accomplishment of overall Defense and Navy goals and objectives. This includes cost/benefit analysis, systems analysis, cost estimation, value engineering, business process reengineering, and application of relevant OMB and Defense regulations.

6. **Cost Management and Analysis**: The graduate will be able to design, implement, and evaluate different costing systems encountered within Defense and Navy organizations and activities, as well as those found in private sector organizations conducting business with the federal government. In addition to private sector cost management policies and practices, the graduate will understand the application of Defense unit costing guidelines to functional business areas, and the Office

of Management and Budget's Cost Accounting Standards for major suppliers of goods and services to the federal government.

7. **Strategic Resource Management**: The graduate will have knowledge of strategic vision and strategic core competency concepts for setting long-range goals and objectives; designing programs to achieve objectives; assigning individual responsibility for resource management, actions, and decision making; measuring performance; reporting results; and evaluating and rewarding performance. This includes assessing customer needs and customer satisfaction, making recommendations, and implementing improvements in the effective delivery of goods and services to customers or users.

8. **Innovation and Creativity:** The graduate will demonstrate innovation and creativity in developing solutions to complex financial, budget, and program management issues that increase program effectiveness and customer satisfaction, while controlling the efficient utilization of financial, physical, and human resources. This involves the ability to identify problems and potential concerns, providing leadership, and teaming with others in the decision-making process, and obtaining support for recommended decisions or courses of action.

9. **Strategy and Policy**: Officers develop a graduate-level ability to think strategically, critically analyze past military campaigns, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's policies and goals and the ways military power may be used to achieve them. Fulfilled by completing the first of the Naval War College series leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit.

Curriculum Sponsor and ESR Approval Authority:

Programs and Resources (P&R), HQ, USMC

Manpower Systems Analysis - Curriculum 847

Academic Associate

Yu-Chu Shen, Ph.D.
Ingersoll Hall, Room 204

(831) 656-2951, DSN 756-2951
yshen@nps.edu

Brief Overview

The Manpower Systems Analysis Curriculum (MSA) leading to the MSM degree is designed for U.S. and international officers. Officers enrolled in the Manpower

Systems Analysis curriculum at the Naval Postgraduate School undertake the challenge of an academic program designed to fill leadership and analytical roles in military manpower personnel, training, and education management. MSA subspecialists are responsible for developing and analyzing policies to ensure that the Navy and DoD are recruiting, training, utilizing and retaining personnel in the most efficient and effective ways possible. MSA is an analytical curriculum intended to develop skills necessary to perform and evaluate manpower analyses and manage the Navy's Human Resource community of interest. As such, the curriculum emphasizes mathematical, statistical, and other quantitative and qualitative analysis methods. Successful completion of the curriculum yields an officer skilled in conducting manpower personnel, training, and education policy analysis. The areas covered in the MSA curriculum include an understanding of manpower, personnel, training, education policy development, managing diversity, compensation systems, enlistment supply and retention models, manpower training models, manpower requirements determination processes, career mix, enlistment and reenlistment incentives, training effectiveness measures, and hardware/manpower trade-offs. Students gain familiarity with current models and methods of manpower analysis and economics as well as military manpower organizations, information systems and issues. The curriculum directly supports the Navy Human Resource Community of Interest.

Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. Additional preparation in calculus and statistics is advisable. An APC of 345 is required for entry. International students should refer to the Admissions section for current TOEFL and entrance requirements. Prospective students electing MSA as a curriculum must be adequately prepared by their undergraduate course work and comfortably oriented to a quantitatively and analytically rigorous graduate curriculum.

Entry Date

July

Program Length

Seven Quarters

Degree

Requirements for the Master of Science in Management (MSM) degree are met en route to satisfying the Educational Skills Requirements.

Subspecialty

Completion of this curriculum qualifies an officer as a Manpower Systems Analysis Subspecialist, subspecialty

code 3130P. U.S. Marine Corps officers qualify for MOS 9640.

Curriculum Sponsors

OPNAV, N-1, Chief of Naval Personnel and Subject Matter Expert, OPNAV, N14, Director of Strategic Planning and Analysis

Military Personnel Plans and Policy and Headquarters - United States Marine Corps (Manpower & Reserve Affairs)

Typical Subspecialty Jobs

Military Personnel Policy and Career Progression (N13)
Joint Manpower Management Branch, JCS (J-1)
Manpower Resources Branch, Director Total Force Programming/Manpower (N12)
Manpower and Training Analyst, DCNO (Resources, Warfare Requirements and Assessment (N801D)
Manpower Plans, COMCDRPAC/COMCDRLANT (N1)
Naval Manpower Analysis Center (NAVMAC)
Bureau of Medicine and Surgery, BUMED
Marine Corps MCCDC and M&RA
Headquarters - United States Marine Corps Manpower & Reserve Affairs (M&RA)
Marine Corps Combat Development Command (MCCDC)

Typical Course of Study: Curriculum 847

Quarter 1
GB3014	(1-0)	Ethics for Public Managers
GB3010	(4-0)	Managing for Organizational Effectiveness
GB3050	(4-0)	Financial Reporting and Analysis
GB3070	(4-0)	Economics of the Global Defense Environment
GB1000	(0-3)	Quantitative Skills for Graduate Management Studies
NW3230	(4-2)	Strategy and War

Quarter 2
GB3040	(4-0)	Managerial Statistics
GB3051	(3-0)	Cost Management
GB4071	(4-0)	Economic Analysis & Defense Resource Allocation
MN2111	(2-0)	Navy Manpower, Personnel, and Training Systems I
MN2039	(4-0)	Basic Quantitative Methods in Econ Analysis

Quarter 3
GB3012	(3-0)	Communication for Managers
GB4043	(3-0)	Business Modeling Analysis
GB4053	(4-0)	Defense Budget and Financial Management Policy
MN4110	(4-1)	Multivariate Manpower Data Analysis I

MN3111	(4-0)	Human Resource Management

Quarter 4
GB4014	(4-0)	Strategic Management
MN4760	(4-0)	Manpower Economics
MN4111	(4-1)	Multivariate Data Analysis II
NW3275*	(4-0)	JPME Requirement
Elective	(4-0)	Elective Course

Quarter 5
MN4119/ MN4130	(3-0)	Manpower Requirements Determination
OS4701	(4-0)	Manpower and Personnel Models
MN4106	(4-0)	Manpower and Personnel Policy Analysis
MN4761	(4-0)	Applied Manpower Analysis
MN2112	(4-0)	HR Issues II
NW3276*	(2-2)	JPME Requirement

Quarter 6
MN0810	(0-8)	Thesis Research
MN4115	(4-0)	Training Development
Elective	(4-0)	Elective Course
NW3285*	(4-0)	JPME Requirement

Quarter 7
MN0810	(0-8)	Thesis Research
MN0810	(0-8)	Thesis Research
MN0810	(0-8)	Thesis Research
Elective	(4-0)	Elective Course

* Not required for International students, US Army or USAF. International students take American Life and Institutions (IT1500) and Communication Skills for International Officers (IT1600) in quarters 1 and 2. USN students can complete JPME by taking four Naval War College courses.

Course Elective Options
GB3020	(3-0)	Fundamentals of Information Technology
OA3411	(3-0)	Introduction to Human Systems Integration
MN4114	(4-0)	Sociological and Psychological Perspectives on Military Service
MV4002	(4-1)	Simulation and Training
OA4109	(4-2)	Survey Research Methods
IS3201	(4-2)	Fundamentals of Database Management Systems
IS3210	(4-0)	Defense Knowledge & Information Management
DA4110	(4-0)	Culture and Influence
GB4480	(4-0)	Supply Chain Management
GB4015	(3-0)	Management of Change

**Educational Skills Requirements (ESR)
Manpower Systems Analysis -
Curriculum 847 Subspecialty Code 3130P**

1. **Management Fundamentals - Organization and Management:** The graduate will have the ability to apply contemporary management principles, organizational theory, and social science methodology to the development, implementation, and management of effective MPT&E policies and programs throughout DoN/DoD. The graduate will have the ability to use and understand computer systems in problem solving and will have a basic understanding of management information systems and E-Business.

2. **Budgeting and Financial Controls:** The graduate will have an understanding of basic financial management practices of DoN/DoD and will be able to conduct cost benefit analyses and participate in the budgetary planning of commands and/or DoN programs. The graduate will have an understanding of the Planning, Programming, Budgeting Execution System (PPBES) and the ability to analyze the impact of budgetary changes on DoN/DoD manpower and personnel programs and policies.

3. **Automated Data Analysis:** The graduate will possess the skills in data manipulation, statistics, and exploratory data analysis to be able to formulate and execute analyses of a wide variety of manpower, personnel, and training issues. The graduate will have proficiency in computing and interactively apply a variety of methods to large-scale DoN and DoD databases. The graduate will have a working understanding of the manpower information systems.

4. **Management Fundamentals - Analytical Techniques:** The graduate will be able to apply mathematical, statistical, accounting, economic and other analytical techniques and concepts to day-to-day military management issues. The graduate will be able to gather and analyze qualitative data. The graduate will also be able to use these techniques and concepts as a participant in the long-range strategic planning efforts of the Navy and DoD.

5. **Advanced Quantitative and Qualitative Analysis:** The graduate will have the ability to apply a wide range of advanced organizational, economics, statistical, and mathematical techniques and concepts to manpower and personnel policies and issues. These include the use of econometric techniques in the quantitative analysis of large-scale DoN/DoD manpower and personnel databases, of qualitative techniques in the analysis of survey and personnel data, of manpower decision support systems, and of Markov models in the analysis of force structure and manpower planning, forecasting, and flow models.

6. **Manpower Systems Analysis Fundamental Concepts:** The graduate will have an understanding of the fundamental concepts and basic functional areas of manpower, personnel, training, and education (MPT&E) within DoN/DoD as listed below, as well as an understanding of the MPT&E systems and their interrelationships.

   1. **Manpower**: Requirements determination; billet authorizations; billet costs; end strength planning; and total force planning and programming.

   2. **Personnel**: Recruiting; accession plans and policies; officer and enlisted community management; attrition; retention; compensation; and readiness.

   3. **Training**: Applications of theories of learning; instructional technologies; the systems approach to training; evaluation of training effectiveness and cost; and the relationship between training and fleet readiness.

7. **Manpower Systems Policy Analysis:** The graduate will have the ability to analyze critically the strengths and weaknesses of proposed manpower, personnel, and training policies and to suggest alternatives that recognize the potential impact on DoN/DoD program planning, resources, and objectives.

8. **Joint Military Strategic Planning:** The graduate will have an understanding of the development and execution of military strategy, the effects of technical developments on warfare, and the processes for formulating U.S. policy, the roles of military forces, joint planning, and current issues in the defense organization. This understanding will include expertise on the combined use of active and reserve forces in joint warfare.

9. **Evaluation, Innovation, and Creativity:** The graduate will demonstrate individual initiative and creativity in the application of the skills and knowledge gained from the Manpower Systems Analysis program. The graduate will select a manpower, personnel, training, or education policy or management issue of importance to DoN/DoD, develop a plan to investigate the issue, analyze all of its aspects, suggest a solution as appropriate, and report the significant findings and recommendations in writing by means of a thesis.

Curriculum Sponsor and ESR Approval Authority

Chief of Naval Operations (N14)

Executive Degree Programs

Program Officer

Jefferson E. McCollum, CDR, SC, USN
Code GB, Ingersoll Hall, Room 201

(831) 656-3953, DSN 756-3953
jemccoll@nps.edu

Executive Master of Business Administration (for Military students) - Curriculum 805

Academic Associate
William D. Hatch II, CDR, USN (Ret.)
Code GB/Hh, Ingersoll Hall, Room 339
(831) 656-2463, DSN 756-2463
whatch@nps.edu

Program Manager
William D. Hatch II, CDR, USN (Ret.)
Code GB/Hh, Ingersoll Hall, Room 339
(831) 656-2463, DSN 756-2463
whatch@nps.edu

Brief Overview

The Executive Master of Business Administration (EMBA) is a defense-focused general management program for more senior DoN officers (805) and senior DoN civilians (see 807 curriculum). The program design and coursework capitalizes on the current managerial and leadership experience of program participants. Specifically, the EMBA goals are to provide participants with

· A solid background in management fundamentals
· Focus on financial management and acquisition knowledge and abilities
· Analytical and critical thinking skills to make decisions under conditions of extreme uncertainty
· Opportunities for interaction so that managers can learn from each other
· Projects and activities relevant for today's knowledge-driven, team-based environment

The EMBA is a 24-month, part-time, distance learning degree program. Classes meet once a week, approximately 6-7 hours per day, depending on course units.

Requirements for Entry
The program has the following admissions criteria:

Undergraduate degree from an accredited four-year college or university

APC of 245 (GPA > 2.6)

Entry Dates

The 805 EMBA program entry dates are March and September (807 entry date is January).

Degree

Completion of this program results in an Executive Master of Business Administration degree. Requirements for the degree are met by:

· Completing 37 hours of core EMBA courses and 17 hours of an approved sequence of BPP electives
· The 17 hours of approved electives can be tailored to meet student sponsor needs
· Remaining a student in "good academic standing" as defined by NPS criteria

Curriculum Subspecialty

Completion of the EMBA degree program qualifies an officer for subspecialty code 3100P, Resource Management-Defense Focus.

Curriculum Sponsor

Educational Skill Requirements Approval Authority: N8/N82

Typical Course of Study: Curriculum 805

Orientation Week
GE3011   (2-0)   Management of Teams

Quarter 1
GE3109   (3-0)   Ethics and Moral Development
GE3050   (3-0)   Financial Reporting and Analysis

Quarter 2
GE3010   (3-0)   Organizations as Systems and Structures
GE3051   (3-0)   Cost Management

Quarter 3
GE3070   (3-0)   Economics for Defense Managers
GE3221   (3-0)   Principles of Acquisition and Program Management I

Quarter 4
GE3222   (3-0)   Principles of Acquisition and Program Management II
GE4043   (3-0)   Business Modeling and Analysis

Quarter 5
GE3042   (4-0)   Operations Management
GE4052   (3-0)   Managerial Finance

Quarter 6
GE4480   (3-0)   Defense Supply Chain Management
GE4053   (4-0)   Defense Budget and Financial Management Policy

Quarter 7

GE3510	(3-0)	Defense Financial Management Practice
GE4016	(4-0)	Managing Strategic Change

Quarter 8

GE4101	(3-2)	Collaborative Problem Solving II
GE4102	(3-2)	Collaborative Problem Solving II

Educational Skills Requirements (ESR)
Executive MBA - Curriculum

805 Subspecialty Code 3100P

1. **Business Ethics and Moral Development:** The graduate will understand the ethical challenges of the global Defense business environment facing senior Navy corporate business leaders and resource managers, and develop the critical thinking and analytical skills required to address complex issues. In addition, the students will develop a personal approach to achieve ethical outcomes in the decision making process.

2. **Complex Systems Thinking**: The graduate will be able to diagnose complex Navy and DoD problems from a systems perspective and offer solutions that maintain system alignments.

3. **Managing and Leading Complex Change**: The graduate will understand the managerial and leadership levers required to institute and manage complex change and the implementation strategies necessary to ensure change initiatives reach all organizational levels.

4. **Strategic Thinking**: The graduate will have knowledge of senior-level decision-making processes under conditions of significant uncertainty within the unique context of DoD organizations. In addition, students will learn how to implement these decisions, evaluate their effectiveness, and determine steps to take if desired outcomes aren't reached.

5. **Analysis for Efficiency and Effectiveness:** The graduate will be able to use various statistical methods to solve complex and unstructured problems in which alternatives will be evaluated and selected based on cost and systems analysis factors. This includes the use of probability theory, decision models and decision analysis, decision trees, forecasting, and simulation to make decisions under conditions of uncertainty with competing objectives.

6. **Program Management Policies:** The graduate will have an ability to execute Defense acquisition policies, strategies, plans and procedures; an understanding of the policy-making roles of various federal agencies of the executive, legislative and judicial branches of the Government, particularly the Department of Defense (DoD), the General Accounting Office (GAO),

congressional committees, the Office of Management and Budget (OMB); and an understanding of the strategies necessary to influence policy development and implementation.

7. **System Acquisition Process:** The graduate will understand the theory of the systems acquisition process. This involves the major system life cycle process for requirements determination, research and development, funding and budgeting, procurement, systems engineering, test and evaluation, manufacturing and quality control, integrated logistics support, ownership and disposal; the interrelationship between reliability, maintainability and logistics support as an element of system effectiveness in Defense system/equipment design; and embedded weapon system software, particularly related to current policies and standards, software metrics, risk management, inspections, testing, integration, and post-deployment software support.

8. **Federal and Defense Budgeting**: The graduate will understand the roles of the executive and legislative branches in setting Federal/Defense fiscal policy, allocating resources to national defense, budget formulation, negotiation, and execution strategies. In addition, the graduate will have knowledge of all aspects of the Federal, Defense, and Navy budget cycles including the Planning, Programming, Budgeting and Execution (PPBE) process with emphasis on budget formulation and execution of the budget authority provided by Congress in response to DoD budget requests, including an evaluation of the expected benefits to be derived under funded programs.

9. **Defense Financial Management**: The graduate will understand how appropriated, revolving, and non-appropriated funds are to be managed in compliance with regulations of the Comptroller of the Navy and the federal government. Also, the graduate will understand and be able to review financial reports, ask pointed questions about budget execution against operating and financial plans, assess the quality of alternate plans based on analyses of an activity's financial performance, and determine the quality of recommendations regarding the reallocation or reprogramming of funds. The graduate will be familiar with federal and private sector financial reporting systems, standards, and practices.

10. **Cost Management and Analysis:** The graduate will be able to understand and evaluate different costing systems encountered within Defense and Navy organizations and activities as well as those found in private sector organizations conducting business with

the federal government. In addition to private sector cost management policies and practices, the graduate will understand cost accounting standards applicable to Federal organizations and to private sector suppliers of goods and service to the federal government.

11. **Defense Economics**: The graduate will be able to apply the fundamental tools of micro- and macroeconomic theory to Defense management and resource allocation decisions. Additionally, the student will understand markets and their interactions with Defense acquisition and contracting processes, the national security implications of globalization, and efficiency in Defense decision making.

12. **Operations/Supply Chain Management:** The graduate will understand the management of manufacturing and service operations and how Defense managers can effectively design and control operational processes to achieve world-class performance in these types of operations. The student will also have a knowledge of the use of strategic purchasing initiatives to derive a competitive advantage from Defense procurement and sourcing strategies to achieve increased efficiency and enhanced performance in the global Defense and commercial supply chain management environments.

13. **Evaluation, Innovation, and Creativity:** The graduate will demonstrate innovation and creativity in developing solutions to complex financial, budgetary, personnel, program management, or acquisition issues in response to the business need of a senior naval client/stakeholder. This involves the ability to identify and evaluate problems or opportunities, team with others to conduct in-depth analysis, and recommend courses of action for the client to better execute assigned Navy responsibilities. The solutions will be given to the client in a formal presentation and a technical report.

Executive Master of Business Administration (for Civilian students) - Curriculum 807

Academic Associate

William D. Hatch II, CDR, USN (Ret.)
Code GB/Hh, Ingersoll Hall, Room 339

(831) 656-2463, DSN 756-2463
whatch@nps.edu

Program Manager

William D. Hatch II, CDR, USN (Ret.)
Code GB/Hh, Ingersoll Hall, Room 339

(831) 656-2463, DSN 756-2463

whatch@nps.edu

Brief Overview

The Civilian Executive Master of Business Administration (EMBA) is a defense-focused general management program for more senior DoN civilians. The program design and coursework capitalizes on the current managerial and leadership experience of program participants. Specifically, the EMBA goals are to provide participants with

- A solid background in management fundamentals
- Focus on financial management and acquisition knowledge and abilities
- Analytical and critical thinking skills to make decisions under conditions of extreme uncertainty
- Opportunities for interaction so that managers can learn from each other
- Projects and activities relevant for today's knowledge-driven, team-based environment

The Civilian EMBA is a 24-month, part-time, distance learning degree program. Classes meet once a week, approximately 6-8 hours per day, depending on course units.

Requirements for Entry

The program has the following admissions criteria:
- GS-12 and above or equivalent
- Undergraduate degree from an accredited four-year college or university
- APC of 245 (GPA > 2.6)

Entry Dates

The Civilian EMBA program entry date is January.

Degree

Completion of this program results in an Executive Master of Business Administration degree. Requirements for the degree are met by:
- Completing 37 hours of core EMBA courses and 17 hours of an approved sequence of BPP electives
- The 17 hours of approved electives can be tailored to meet student sponsor needs
- Remaining a student in "good academic standing" as defined by NPS criteria

Curriculum Subspecialty

n/a

Curriculum Sponsor

Educational Skill Requirements Approval Authority: N8/N82

Typical Course of Study: Curriculum 807

Orientation Week
GE3011   (2-0)   Management of Teams

Quarter 1
GE3109   (3-0)   Ethics and Moral Development
GE3050   (3-0)   Financial Reporting and Analysis

Quarter 2
GE3010   (3-0)   Organizations as Systems and Structures
GE3051   (3-0)   Cost Management

Quarter 3
GE3070   (3-0)   Economics for Defense Managers
GE3221   (3-0)   Principles of Acquisition and Program Management I

Quarter 4
GE3222   (3-0)   Principles of Acquisition and Program Management II
GE4043   (3-0)   Business Modeling and Analysis

Quarter 5
GE3042   (4-0)   Operations Management
GE4052   (3-0)   Managerial Finance

Quarter 6
GE4460   (3-0)   Defense Supply Chain Management
GE4053   (4-0)   Defense Budget and Financial Management Policy

Quarter 7
GE3510   (3-0)   Defense Financial Management Practice
GE4016   (4-0)   Managing Strategic Change

Quarter 8
GE4100   (3-7)   Collaborative Problem Solving

Educational Skills Requirements (ESR)
Civilian Executive MBA - Curriculum

1. **Business Ethics and Moral Development:** The graduate will understand the ethical challenges of the global Defense business environment facing senior Navy corporate business leaders and resource managers, and develop the critical thinking and analytical skills required to address complex issues. In addition, the students will develop a personal approach to achieve ethical outcomes in the decision making process.

2. **Complex Systems Thinking**: The graduate will be able to diagnose complex Navy and DoD problems from a systems perspective and offer solutions that maintain system alignments.

3. **Managing and Leading Complex Change**: The graduate will understand the managerial and leadership levers required to institute and manage complex change and the implementation strategies necessary to ensure change initiatives reach all organizational levels.

4. **Strategic Thinking**: The graduate will have knowledge of senior-level decision-making processes under conditions of significant uncertainty within the unique context of DoD organizations. In addition, students will learn how to implement these decisions, evaluate their effectiveness, and determine steps to take if desired outcomes aren't reached.

5. **Analysis for Efficiency and Effectiveness:** The graduate will be able to use various statistical methods to solve complex and unstructured problems in which alternatives will be evaluated and selected based on cost and systems analysis factors. This includes the use of probability theory, decision models and decision analysis, decision trees, forecasting, and simulation to make decisions under conditions of uncertainty with competing objectives.

6. **Program Management Policies:** The graduate will have an ability to execute Defense acquisition policies, strategies, plans and procedures; an understanding of the policy-making roles of various federal agencies of the executive, legislative and judicial branches of the Government, particularly the Department of Defense (DoD), the General Accounting Office (GAO), congressional committees, the Office of Management and Budget (OMB); and an understanding of the strategies necessary to influence policy development and implementation.

7. **System Acquisition Process:** The graduate will understand the theory of the systems acquisition process. This involves the major system life cycle process for requirements determination, research and development, funding and budgeting, procurement, systems engineering, test and evaluation, manufacturing and quality control, integrated logistics support, ownership and disposal; the interrelationship between reliability, maintainability and logistics support as an element of system effectiveness in Defense system/equipment design; and embedded weapon system software, particularly related to current policies and standards, software metrics, risk management, inspections, testing, integration, and post-deployment software support.

8. **Federal and Defense Budgeting**: The graduate will understand the roles of the executive and legislative branches in setting Federal/Defense fiscal policy,

allocating resources to national defense, budget formulation, negotiation, and execution strategies. In addition, the graduate will have knowledge of all aspects of the Federal, Defense, and Navy budget cycles including the Planning, Programming, Budgeting and Execution (PPBE) process with emphasis on budget formulation and execution of the budget authority provided by Congress in response to DoD budget requests, including an evaluation of the expected benefits to be derived under funded programs.

9. **Defense Financial Management**: The graduate will understand how appropriated, revolving, and non-appropriated funds are to be managed in compliance with regulations of the Comptroller of the Navy and the federal government. Also, the graduate will understand and be able to review financial reports, ask pointed questions about budget execution against operating and financial plans, assess the quality of alternate plans based on analyses of an activity's financial performance, and determine the quality of recommendations regarding the reallocation or reprogramming of funds. The graduate will be familiar with federal and private sector financial reporting systems, standards, and practices.

10. **Cost Management and Analysis:** The graduate will be able to understand and evaluate different costing systems encountered within Defense and Navy organizations and activities as well as those found in private sector organizations conducting business with the federal government. In addition to private sector cost management policies and practices, the graduate will understand cost accounting standards applicable to Federal organizations and to private sector suppliers of goods and service to the federal government.

11. **Defense Economics**: The graduate will be able to apply the fundamental tools of micro- and macroeconomic theory to Defense management and resource allocation decisions. Additionally, the student will understand markets and their interactions with Defense acquisition and contracting processes, the national security implications of globalization, and efficiency in Defense decision making.

12. **Operations/Supply Chain Management:** The graduate will understand the management of manufacturing and service operations and how Defense managers can effectively design and control operational processes to achieve world-class performance in these types of operations. The student will also have a knowledge of the use of strategic purchasing initiatives to derive a competitive advantage from Defense procurement and sourcing strategies to achieve increased efficiency and enhanced performance in the global Defense and commercial supply chain management environments.

13. **Evaluation, Innovation, and Creativity:** The graduate will demonstrate innovation and creativity in developing solutions to complex financial, budgetary, personnel, program management, or acquisition issues in response to the business need of a senior naval client/stakeholder. This involves the ability to identify and evaluate problems or opportunities, team with others to conduct in-depth analysis, and recommend courses of action for the client to better execute assigned Navy responsibilities. The solutions will be given to the client in a formal presentation and a technical report.

Executive Degree Programs

Program Officer

Jefferson E. McCollum, CDR, SC, USN
Code GB, Ingersoll Hall, Room 201

(831) 656-3953, DSN 756-3953
jemccoll@nps.edu

Master of Science in Contract Management (DL) - Curriculum 835

Academic Associate

Elliott Cory Yoder, CDR, USN
Code GB/Yc, Ingersoll Hall, Room 205

(831) 656-3619
ecyoder@nps.edu

Program Manager

Walter E. Owen, D.P.A.
Code SE/Wo (located in St. Louis, MO)

(831) 402-6086 or (636) 925-2982
wowen@nps.edu

Brief Overview

The Master of Science in Contract Management (MSCM) degree is designed to provide civilians in the Department of Defense (DoD) and other federal government agencies an advanced education in the concepts, methodologies and analytical techniques necessary for successful management of acquisition and contracting within complex organizations. The curriculum focuses on problem solving and decision making within the acquisition environment utilizing case studies, teaming exercises, hands-on applications, active participation, and other similar activities. Lecture and laboratory tasks require the application of critical thinking to problem solving within

actual situations. The MSCM Program embodies an interdisciplinary approach to problem solving and analysis, including quantitative financial analysis, economics, and public and private sector operations. The curriculum is designed to provide civilians with the knowledge, skills, and abilities to manage and lead effectively in systems buying offices, field contracting offices, contract administration offices, and contracting policy offices.

Requirements for Entry

Candidates for the program must have achieved the following: a baccalaureate degree with a minimum undergraduate quality point rating (QPR) of 2.20.

Entry Dates

January, April, July, October. (Dependent on cohort availability)

Program Length

Eight Distance-Learning Quarters

Application Process

Navy Department civilians may apply for the MSCM by submitting an online application, and adhere to your service or agency application process. For further information, contact the Academic Associate for this curriculum or the Program Officer.

Degree

The Master of Science in Contract Management degree requires:

- · Completion of a minimum of 48 credit hours of graduate-level courses, at least 12 that are at the 4000 level. (Credit hour requirement does not include 4 hours assigned for the Joint Applied Project.)
- · Completion of an acceptable Joint Applied Project, with at least one advisor from the Graduate School of Business and Public Policy.
- · Approval of the candidate's program by the Dean, Graduate School of Business and Public Policy.

Typical Course of Study: Curriculum 835

Quarter 1
MN3012	(3-0)	Communications Strategies for Effective Leadership
MN3221	(3-0)	Principles of Acquisition and Program Management (part 1)

Quarter 2
MN3001	(3-0)	Economics for Acquisition Managers
MN3222	(3-0)	Principles of Acquisition and Program Management (part 2)

Quarter 3
MN3312	(4-0)	Government Contracts Law
MN4474	(3-1)	Organizational Analysis

Quarter 4
MN3172	(3-0)	Resourcing National Security: Policy and Process
MN3315	(4-0)	Acquisition Management and Contract Administration

Quarter 5
MN3304	(5-2)	Contract Pricing and Negotiations

Quarter 6
MN3318	(2-0)	Contingency Contracting
MN4105	(3-0)	Strategic Management

Quarter 7
MN4311	(3-0)	Contracting for Services
MN4090	(2-0)	Joint Applied Project

Quarter 8
MN4371	(4-0)	Acquisition and Contracting Policy
MN4090	(2-0)	Joint Applied Project

Educational Skills Requirements (ESR)
Contract Management - Curriculum 835

1. **Advanced Management Concepts**: The graduate will have the ability to apply advanced management theory and techniques to problems in both the public and private sectors. This includes policy formulation and execution, strategic planning, resource allocation, federal fiscal policy, computer-based information and decision support systems, and complex managerial situations requiring comprehensive integrated approaches. The graduate will have the ability to apply state-of-the-art management concepts and practices to problem solving and decision-making responsibilities as middle and senior managers.

2. **Acquisition and Contracting Principles**: The graduate will have an understanding of and will be able to apply the principles and fundamentals of acquisition and contracting within the federal government including knowledge of the acquisition laws and regulations, particularly the Federal Acquisition Regulation (FAR) and the Defense FAR Supplement (DFARS); the unique legal principles applied in government contract law and the Uniform Commercial Code; and the application of sound business principles and practices to Defense contracting problems. Further, the graduate will be able to apply innovative and creative approaches not only to resolve difficult acquisition and contracting issues but to significantly influence the legal and regulatory structure within which acquisition decision making occurs. Finally, the graduate will have the ability to conceptualize, develop and execute

strategic business alliances and relationships necessary to the successful acquisition of goods and services.

3. **Contracting Process**: The graduate will understand the theory of and have the ability to manage the field contracting, system acquisition and contract administration processes. This involves a knowledge of the defense system life cycle processes, including requirements determination, funding, contracting, ownership, and disposal; an ability to evaluate military requirements, specifications, and bids and proposals; an ability to utilize the sealed bid, competitive proposals and simplified acquisition methodologies; a comprehensive knowledge of all contract types and their application in Defense acquisition; an ability to conduct cost and price analyses; and an ability to negotiate various contracting actions including new procurement, contract changes and modifications, claims, equitable adjustment settlements, and noncompliance issues.

4. **Acquisition and Contracting Policy**: The graduate will have an ability to formulate and execute acquisition policies, strategies, plans and procedures; a knowledge of the legislative process and an ability to research and analyze acquisition legislation; and a knowledge of the government organization for acquisition, including Congress, the General Accounting Office, the Office of Federal Procurement Policy, the federal and military contracting offices, the Boards of Contract Appeals, and the court system.

5. **Business Theory and Practices**: The graduate will have an understanding of the business philosophy, concepts, practices and methodologies of the commercial industrial base (both domestic and global) and the ability to apply these to the federal government acquisition environment.

6. **Defense Financial Management and Budgeting**: The graduate will have an ability to apply sound financial management theories, principles and practices to defense acquisition and contracting issues, including fiscal and monetary policy.

7. **Production and Quality Management**: The graduate will have an understanding of principles and fundamentals of Production and Quality Management, with particular emphasis on the Procuring Contracting Officer's and Administrative Contracting Officer's roles and relationships with industry and the Government Program Manager.

8. **Analysis and Application**: The graduate will demonstrate an ability to apply acquisition, contracting and management principles in dealing with the significant issues encountered in managing the contracting process in one of the following areas: (1) major weapon systems acquisition, (2) research and development, (3) field procurement, and (4) facilities contracting.

9. **Ethics and Standards of Conduct**: The graduate will have an ability to manage and provide leadership in the ethical considerations of military acquisition, including the provisions of procurement integrity, and to appropriately apply Defense acquisition standards of conduct.

10. **Acquisition Work force**: The graduate will satisfy all requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) and mandatory contracting courses required by the Defense Acquisition University (DAU) at Level III.

11. **Analysis, Problem Solving and Critical Thinking**: The graduate will demonstrate the ability to conduct independent research and analysis, and proficiency in presenting the results in writing and orally by means of a thesis and a command-oriented briefing appropriate to this curriculum.

Master of Science in Program Management (MSPM) - Curriculum 836

Academic Associate

Brad R. Naegle
Code GB/Nb, Ingersoll Hall, Room 206

(831) 656-3620, DSN 756-3620
bnaegle@nps.edu

Program Manager

Walter E. Owen, D.P.A.
Code GB/On, Ingersoll Hall, Room 335

(831) 656-2048 or (636) 925-2982, DSN 756-2048
wowen@nps.edu

Brief Overview

The Master of Science in Program Management (MSPM) degree is designed to provide primarily civilians (officers may participate with sufficient time on station to complete the program) in the Department of Defense (DoD), other federal agencies, and a limited number of DoD contractor personnel, an advanced education in the concepts, methodologies and analytical techniques necessary for successful management of programs/projects within complex organizations. The curriculum focuses on leadership, problem solving and decision making within the acquisition environment utilizing case studies, teaming exercises, hands-on applications, active participation and integrative exercises. Lecture and laboratory tasks require the application of critical thinking to problem solving within notional and actual situations. Student input

includes civilians (officers) from all DoD services and other federal agencies. The curriculum is designed to provide graduates with the knowledge, skills and abilities to manage and lead effectively in the federal government acquisition environment.

Requirements for Entry

Candidates for the program must have achieved the following: a baccalaureate degree with a minimum undergraduate quality point rating (QPR) of 2.20; full certification at Level II or higher in any discipline under the provisions of the Defense Acquisition Workforce Improvement Act (DAWIA) (or equivalent certification for non-DoD personnel). In addition to institutional funding support, students must also provide a command endorsement letter of support from their command or home organization.

Entry Dates

April and October (dependent on sufficient demand)

Program Length

Eight Distance-Learning Quarters

Degree

The Master of Science in Program Management degree requires:
·   Completion of a minimum of 48 credit hours of graduate-level courses, at least 12 which are at the 4000 level.
·   Completion of an acceptable joint applied project, with at least one advisor from the Graduate School of Business and Public Policy.
·   Approval of the candidate's program by the Dean, Graduate School of Business and Public Policy.

Curriculum Sponsor

The Curriculum Sponsor is the Director, Acquisition Career Management (DACM) in the Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology). The curriculum satisfies the mandatory Level III Defense Acquisition University (DAU) in Program Management and provides numerous other DAU certifications satisfying requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) and provides qualifying training and education for critical acquisition positions. (For those who have not already obtained certification in the Test & Evaluation; Systems Engineering; and Manufacturing/Production, Quality Assurance career fields, this program achieves Level II in these career fields, as well as satisfying Intermediate Software Acquisition Management (SAM 201)).

Typical Course of Study: Curriculum 836

Quarter 1
MN3001   (4-0)   Economics for Defense Managers
MN3302   (2-0)   Advanced Program Management

Quarter 2
MN3303   (4-0)   Principles of Acquisition and Contract Management
MN4602   (2-0)   Test and Evaluation Management

Quarter 3
MN3172   (3-0)   Resourcing National Security Policy and Process
SE4011   (3-2)   Systems Engineering for Acquisition Managers

Quarter 4
MN3309   (4-1)   Acquisition of Embedded Weapon Systems Software
MN3012   (3-0)   Communications Strategies for Effective Leadership

Quarter 5
MN3384   (4-1)   Principles of Acquisition Production & Quality Management

Quarter 6
MN4470   (4-0)   Strategic Planning & Policy for the Logistics Manager
MN4474   (2-0)   Organizational Analysis
MN4090   (0-6)   Joint Applied Project

Quarter 7
MN3155   (2-0)   Financial Management for Acquisition Managers
MN4105   (3-0)   Strategic Management

Quarter 8
MN4307   (4-0)   Program Management Policy and Control
MN4090   (0-6)   Joint Applied Project

Educational Skills Requirements (ESR) Program Management - Curriculum 836

1. **Management Fundamentals**: The graduate will understand the theory of and have an ability to apply accounting, economic, mathematical, statistical, managerial and other state-of-the-art management techniques and concepts to problem solving and decision-making responsibilities as Department of Defense managers. The graduate will have the ability to think creatively, addressing issues and problems in a dynamic, challenging environment.

2. **Advanced Leadership and Management Concepts**: The graduate will have the ability to apply advanced leadership, management and operations research

techniques to defense problems. This includes policy formulation and execution, strategic planning, defense resource allocation, project leadership, cost benefit and cost effectiveness analysis, federal fiscal policy, computer-based information and decision support systems, and complex managerial situations requiring comprehensive integrated leadership abilities.

3. **Program Leadership and Management Principles**: The graduate will have an understanding of and will be able to apply the principles, concepts, and techniques of Program Leadership and Program Management to the acquisition of major defense weapon systems. This includes the principles of risk management and tradeoff decision analysis using Total Ownership Cost, schedule and performance dynamics from a total life cycle management perspective.

4. **Program Management Policies**: The graduate will have an ability to formulate and execute Defense acquisition policies, strategies, plans and procedures; an understanding of the policy-making roles of various federal agencies of the Executive, Legislative and Judicial branches of the Government, particularly the Department of Defense (DoD), the General Accounting Office (GAO), Congressional committees, the Office of Management and Budget (OMB); and an understanding of the strategies necessary to influence policy development and implementation.

5. **Systems Acquisition Process**: The graduate will understand the theory of and have an ability to lead program teams and manage the systems acquisition process. This involves the system life cycle process for requirements determination, research and development, funding and budgeting, procurement, systems engineering, including systems of systems, test and evaluation, manufacturing and quality control, integrated logistics support, ownership and disposal; the interrelationship between reliability, maintainability and logistics support as an element of system effectiveness in Defense system/equipment design; and embedded weapon system software, particularly related to current policies and standards, software metrics, risk management, inspections, testing, integration, and post-deployment software support.

6. **Contract Management**: The graduate will understand the role of the contracting process within the acquisition environment including financial, legal, statutory, technical and managerial constraints in the process.

7. **Business Theory and Practices**: The graduate will have an understanding of the business and operating philosophies, concepts, practices and methodologies of the defense industry with regard to major weapon systems acquisition, particularly the application of sound business practices.

8. **Government and Industry Budgeting and Financial Management**: The graduate will have an understanding of and an ability to apply the principles of government and private organizational financing including corporate financial structures, cost and financial accounting, capital budgeting techniques, financial analysis, and Defense financial management and budgeting processes to include the Planning, Programming, Budgeting Execution System (PPBES).

9. **Acquisition Workforce**: The graduate will satisfy all requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) and mandatory Program Management courses required by the Defense Acquisition University (DAU) at Levels I, II, and III.

10. **Ethics and Standards of Conduct**: The graduate will have an ability to manage and provide leadership in the ethical considerations of defense acquisition, including the provisions of procurement integrity, and to appropriately apply defense acquisition standards of conduct.

11. **Analysis, Problem Solving and Critical Thinking**: The graduate will demonstrate the ability to conduct research and analysis, and proficiency in presenting the results in writing and orally by means of an applied project and a command-oriented briefing appropriate to this curriculum.

Curriculum Sponsor and ESR Approval Authority

836 U. S. Army ASA/ALT (DDACM)

Non-Degree Professional Development Programs

The Graduate School of Business and Public Policy also administers several non-degree professional development programs consisting of both graduate education and professional courses taught in residence or via distance learning modes. Below is a brief explanation of each program.

Advanced Acquisition Program (AAP) - Certificate in Program Management - Curriculum 211

Program Manager

John T. Dillard
Code GB/Dj, Ingersoll Hall, Room 336

(831) 656-2650, DSN 756-2650
jtdillar@nps.edu

Brief Overview

The Advanced Acquisition Program (AAP) is a 12-month, part-time, distance learning graduate certificate program that can also earn graduate credit toward NPS master's degree programs. Designed for both the DoD acquisition workforce and other professionals working with system acquisition and program management processes, the Advanced Acquisition Program provides a flexible, on-site alternative for education and Defense Acquisition Workforce Improvement Act (DAWIA) Program Management Level III certification. The AAP provides Acquisition Professionals and those associated with the DoD acquisition process an education resource for achieving DAWIA Level III Certification in Program Management with no student travel. This program is funded by the student's parent command, and is designed to accommodate professionals who are unable to travel away from the office for weeks of education. Schedules are coordinated with sponsoring commands, avoiding conflicts with major projects and deadlines

The AAP is a three-phased graduate certificate program of seven courses delivered over four NPS academic quarters. While the three phases must be completed in sequence, there is no requirement to complete them in the normal one-year timeframe (four academic quarters). AAP is a graduate-level program of in-depth acquisition and program management education, earning successful students 19.5 graduate credit hours towards a master's degree. It also provides DoD students with up to 195 hours of Continuous Learning under the USD (AT&L) Continuous Learning Program (CLP), 31.5 Continuing Education Units (CEU), 6.33 Business Credits toward the requirement for 24 for the GS-1102 series. The combined courses are equivalent to Defense Acquisition University's ACQ101, ACQ201, PMT250 and PMT352.

Requirements for Entry

A baccalaureate degree with above-average grades is desired.

Entry Dates

At the beginning of any quarter throughout an academic year (Jan, Apr, Jul, Oct).

Program Length

Four Quarters

Graduate Certificate Requirements

Requirements for the graduate certificate in program management are met by successful completion of all seven courses. Graduate credit is obtained by maintenance of a 3.0 grade point average on a 4.0 scale. Should a graduate of the Advanced Acquisition Program matriculate into the

Master of Business Administration degree program in the Systems Acquisition Management (816) curriculum, or the Master of Science in Program Management (836), graduate credit for AAP courses will be applied to the curricula as appropriate.

Past Sponsors

U.S. Army Tank Automotive Command, Warren, MI; U.S. Army Soldier Support Center, Natick, MA; U.S. Navy Undersea Warfare Center, Newport, RI; U.S. Navy Surface Warfare Center, Dahlgren, VA.

Program Phases

The program is administered with a phased approach:
· Phase I is a full-quarter distance-learning course taught via VTC (6 hours in class per week) concentrating on Acquisition and Program Management breadth. Students who have completed ACQ101, 201, and PMT250 can omit this phase.
· Phase II is a series of five one-week courses (40 hours in class per week) taught on-site at the command.
· Phase III is a full-quarter, distance-learning course taught via VTC (4 hours of class per week) concentrating on Program Leadership through examination of case studies from actual Defense systems, IPT exercises, and application and written analysis of program management concepts.

Required Courses: Curriculum 211

Quarter 1

MN3331	(5-1)	Principles of Acquisition and Program Management

Quarter 2 and 3

MN3361	(2-0)	Information Technology and Software Acquisition Management
MN3362	(2-0)	Design Verification and System Assessment
MN3363	(2-0)	Manufacturing and Quality Management
MN3364	(2-0)	Business Financial Contract and Management
MN3365	(2-0)	Acquisition Logistics Management and Program Sustainment

Quarter 4

MN4366	(4-0)	Program Management and Leadership

Acquisition Management Distance Learning Program (AMDLP) - Curriculum 212

Program Manager

Walter E. Owen, D.P.A.
Code GB/On, Ingersoll Hall, Room 335

(831) 656-2048 or (636) 925-2982, DSN 756-2048
wowen@nps.edu

Brief Overview

The Naval Postgraduate School offers acquisition management distance education graduate acquisition courses that satisfy certain Defense Acquisition University (DAU) mandatory training requirements and Defense Acquisition Workforce Improvement Act (DAWIA) requirements for 24 semester-hours of business subjects. These courses can also be taken for continuing education that can lead to a master's degree program. These courses are offered primarily by video tele-education (VTE) distance learning methods.

Requirements for Entry

Courses are offered to both military and federal civilians. Undergraduate degree is preferred. Courses must be sponsored in full by a federal organization. Organizations interested in sponsoring courses must have a standards-based H.320- compatible system with a dial-up network capability at 384KPS (3- ISDN lines). The NPS AMDLP program manager can help arrange cost sharing partnerships between various interested organizations. Contact the AMDLP program manager for more information and the latest price list.

Available Program of Courses

NPS/DAU equivalent courses are listed in the below matrix.

Advanced Principles of Defense Acquisition and Program Management
DAU: ACQ101/201, PMT250
NPS: MN3331 (5-1)
Available: Every quarter

Fundamental Principles of Defense Acquisition and Program Management
DAU: ACQ101
NPS: MN3221 (2-1)
Available: Every quarter

Advanced Principles of Defense Acquisition and Program Management
DAU: ACQ201/PMT250
NPS: MN3222 (3-0)
Available: Every quarter

Fundamental Principles of Government Acquisition and Contracting
DAU: CON101
NPS: MN3303 (4-0)
Available: Fall/Spring

Management Functions and Decision-making Techniques for Best Value Competitively Negotiated Contracts
DAU: CON202
NPS: MN3315 (4-0)
Available: Fall/Spring

Examination of the Federal Government Legal Structure for Contracts with Private Industry
DAU: CON210
NPS: MN3312 (4-1)
Available: Winter/Summer

Concepts, Processes and Methods of Strategic Logistics Planning and Execution
DAU: LOG304
NPS: MN4470 (4-0)
Available: Winter/Summer

Principles and Concepts of Production and Quality Management in Defense Acquisition
DAU: PQM101/201
NPS: MN3384 (4-1)
Available: Fall/Spring

Management of Mission Critical Computer Resources In defense Software Acquisition
DAU: SAM201
NPS: MN3309 (4-0)
Available: Winter/Summer

Systems Engineering in the Defense Acquisition and Project Management Environment
DAU: SYS201
NPS: SE4011 (3-2)
Available: Fall/Spring

Management of Advanced Systems Engineering
DAU: SYS301
NPS: MN4012 (2-2)
Available: Every Quarter

Test and Evaluation of Defense Weapon Systems
DAU: TST202/301
NPS: OS4601 (4-0)
Available: Winter/Summer

Army Cost Management Certificate (Resident NPS Program) - Curriculum 213

Program Manager
Teresa (Terry) Rea
Code GB, Ingersoll Hall, Room 231A

(831) 656-7962, DSN

tmrea@nps.edu

Brief Overview

The Naval Postgraduate School offers this four-week resident graduate education program to prepare students to support improved cost measurement, management, and control efforts. The program of instruction provides 12 units of credit that may be applicable to further education programs.

Requirements for Entry

Courses are offered to selected Army military and civilians. Undergraduate degree is required.

For further information go to www.us.army.mil or contact Cecile Bachelor, Special Assistant for Enterprise Cost Strategy, Office of Deputy Assistant, Secretary of the Army for Cost & Economics, at (703) 692-7399 [DSN: 222-7399] or cecile.bachelor@us.army.mil.

Entry Dates

Ongoing basis.

Program Length

Four weeks.

Graduate Certificate Requirements

Completion of the following four courses.

MN3352 Managerial Costing

Content: Cost measurement concepts and techniques of cost analysis

Description: This course will explore the development and use of cost information by managers. Its focus will be on management applications and analyses rather than on bookkeeping techniques and methodologies. The course will examine accounting measurements and analyses that provide relevant information for management decision-making, operational control, and productivity improvement. These internally-oriented processes are fundamentally different from those used to comply with external financial accounting requirements. The primary objectives of the course are as follows: reinforce skills in reporting and analyzing managerial accounting information; develop experience in analyzing this information from the perspective of its various users, especially management; develop the ability to identify and communicate relevant managerial accounting information; and develop an appreciation of the usefulness and limitations of managerial accounting information. Prerequisite: Department of Army approval for enrollment.

Available: Per Army requirements six to eight times per year

MN3353 Operations Management

Content: Fundamentals of design, management, and control of operational processes

Description: This course is about the fundamentals of managing manufacturing and service operations and about how DoD managers can effectively design and control operational processes. Helping students understand the concepts and techniques necessary for attaining a world-class performance in manufacturing and service operations is the main learning objective of this course. Analyzing and continuously improving enterprise-wide processes is critically important for achieving such a performance and hence the course will adopt a "process management" viewpoint while addressing a variety of operational and strategic issues. The course begins by introducing the operations function and its "mission" in terms of cost, quality, speed, service, and flexibility. Several exercises and cases are used here to illustrate the concepts fundamental to process analysis, including capacity, bottleneck, cycle time, and inventory, and their implications to cost management. The book by Goldratt, The Goal, is also discussed to provide a real-world context to the variety of issues addressed in the course, and to introduce the Theory of Constraints (TOC). At this point the course will cover the topics of capacity planning, inventory management, MRP/ERP and project management. The course will end with an introduction to supply chain management, a topic integrating a number of concepts covered earlier in the course. Prerequisite: MN3352.

Available: Per Army requirements six to eight times per year

MN4354 Cost Control

Content: Control theory, practical examples of cost control issues and solutions including cost benefit analysis and case studies

Description: Provides an understanding of management control, management control structures and processes and how they are designed to control costs while also organizing work processes and motivating employees to work productively. Course objectives are understanding of (i) management control principles and processes, (ii) the application of cost management principles and processes, (iii) defense management control process events and timing, (iv) cost control and accounting data independence, (v) application of case study method to study of management control and cost management, (vi) cost control dynamics in budget execution, (vii) management and cost control reform initiatives and (viii) contemporary defense cost and resource policy issues. Prerequisite: MN3353.

Available: Per Army requirements six to eight times per year

MN3355 Organizational Effectiveness for Cost Managers

Content: Systems thinking, interpersonal communication, listening, motivation, leadership, message framing, decision making, persuasion, power and social influence, and negotiations

Description: This course teaches students to analyze, understand, and influence the organizations with which they work. To do this, the course introduces psychological, behavioral and communication principles that can be applied in organizations, with a focus on the introduction and maintenance of cost management programs. Throughout this course, we develop leadership skills and communication competencies, identify ways to increase individuals' and groups' performance, and practice organizational analysis and problem solving. As a crucial component of this process, we also explore social influence principles to work more effectively with individuals and groups. Prerequisites: MN4354.

Available: Per Army requirements six to eight times per year

Practical Comptrollership Course (PCC)

Program Manager

Lisa F. Potvin, CAPT, USN
Ingersoll Hall, Room 219

(831) 656-3628, DSN 756-3628
pcc@nps.edu; lfpotvin@nps.edu

Brief Overview

The Naval Postgraduate School offers an intensive two-week course in defense financial management under the sponsorship of the Assistant Secretary of the Navy (Financial Management and Comptroller). The course is part of the Department of the Navy Civilian Financial Management Career Program. The Practical Comptrollership Course (PCC) is specifically designed for individuals (civilians and military officers) who are either incumbent or about to report to responsible positions in financial management at the headquarters, major command, or field activity level. The course content reaches across all disciplines involved in financial management and comptrollership including: planning, budgeting, budget execution, fiscal law, accounting, and internal controls.

Requirements for Entry

The course is designed for civilian (GS-9 through GS-14 or equivalent pay plan) and military (0-2 and above) financial managers. Quotas are allocated to major commands by ASN(FM&C) through the Financial Management Education Services Specialist (FMB-59). Prospective students should contact their major command

comptroller's office for nomination procedures. NPS does not control quotas for this course.

Entry Dates, Location, Length of Course

The course is two weeks in length (8 classroom days) and is offered six times per year. Annual course schedules and quotas are announced in July each year by letter from ASN(FM&C) and published on the course website: http://www.nps.edu/Academics/Schools/GSBPP/Academics/ProfDev/PCC/index.html

Typical Topics of Study

The Congressional Budget Process
Significant Budget and Financial Management Legislation
Planning, Programming, Budgeting & Execution System
Budget Formulation & Review
Appropriations & Fiscal Law
Reimbursables & Support Agreements
Working Capital Fund Management
Overview of the Acquisition & Contracting Processes
DoD Accounting
Critical Aspects of Budget Execution
Management of Major Cost Drivers
Performance Measurement
Management Control and Auditing
Civilian Personnel
Ethics

GSBPP Courses

GB Courses (MBA Program)

GB1000 Quantitative Skills for Graduate Management Studies (0-3) Winter/Summer
This course is intended to help prepare students for graduate studies in defense management. It is administered online in three modules: quantitative skills, statistics and spreadsheets. The objective is to reduce your difficulties with quantitative tools in your core courses, and allow you to focus on subsequent course materials.

GB2000 MBA Group Meetings (0-2) Winter/Summer

GB3010 Managing for Organizational Effectiveness(4-0) Winter/Summer
Organizations, including defense organizations, are complex, purposive, open systems. As open systems, they face challenges of external adaptation and effectiveness and of internal coherence and efficiency. Our purpose is to understand the structures and processes that make up organizations in order to appreciate how they succeed and why they falter or fail. Our focus is on organizational diagnosis, which requires us to apply relevant theories to evaluate organizational performance. To do this, we will examine topics that include: organizational structure, motivation and reward systems, organizational culture, power and conflict, effective teams, and the leadership characteristics involved in effectively managing today's organizations. Although these topics are relevant to all organizations, we will pay special attention to their application in the context of the DoD and military

organizations. Prerequisite: Enrollment in GSBPP Degree Program.

GB3012 Communication for Managers (3-0) Winter/Summer

This course provides DoD and international military officers and civilians with the communication strategies and skills to manage and lead in the dynamic DoD environment. Instruction focuses on assessing various communication models, making strategic media choices, writing effective informative documents, developing associates' communication competencies through various feedback roles, and giving lucid briefings. Prerequisite: GB3010; Open to MBA students, or by consent of instructor.

GB3013 Problem Analysis & Ethical Dilemmas (0-2) Winter/Summer

The objective of the Problem Analysis and Ethical Dilemma (PAED) seminar is to provide an introduction to applied analytic decision making involving complex issues and applied ethical dilemmas in a wide variety of seemingly chaotic situations. Problem analysis and ethical dilemmas are two topics that are relevant in a variety of organizational settings. Thus, an essential part of a professional's education is the identification of issues, the analysis among alternatives, consideration of the implications and consequences of alternatives, and making a decision that confronts the specific issue at hand, is timely, and ethical. Analysis of problems is a vital competence for leaders in arriving at a decision that may affect their command, the local environment, and even the course of future events. Ethical dilemmas are those unclear situations that seem to have a series of diverse, chaotic variables and where having the facts is not enough. Facts may not take in values, rightness, culture, moral up-bringing, or even religious convictions. This seminar provides an orientation to the process of awareness, identification, contemplation and reflection, consideration of alternative actions, and decision making when presented with an unclear situation. Prerequisite: Open to MBA students, or by consent of instructor.

GB3014 Ethics for Public Managers (1-0) Winter/Summer

An introduction to problem analysis and moral reasoning in the context of business, commerce, and government service. Ethics is distinguished from routine requirements of legal compliance by emphasizing how classical forms of moral reasoning (such as utilitarianism, and the ethics of duty) can address and help resolve practical problems and case studies drawn from recent practice about which the law itself is largely silent. Free enterprise conceptions of profit-making are compared with government and public service conceptions of acquisition and contracting. Enrollment limited to 30 students per course section. Written assignments and final exam required. Five weeks of instruction (10 hours: 1-0). Prerequisite: none.

GB3020 Fundamentals of Information Technology (3-0) Winter/Summer

Successful organizations in today's Information Age are more dependent than ever on information technology (IT). This course provides business students and other non-IT majors a broad overview of computer technology, information systems, database/knowledge management, networks and information security. The course focuses on IT as a tool to support business processes throughout an organization, regardless of functional specialty. The study of principles and theory is combined with hands-on laboratory exercises to improve both IT literacy and competency. The knowledge and skills acquired will make the students more effective IT users and help them recognize

opportunities where the application of IT solutions can provide a strategic advantage. Prerequisite: Enrollment in the MBA Degree Program; Open to MBA students, or by consent of instructor.

GB3030 Marketing Management (3-0) Fall/Spring

Focuses on managerial skills, tools and concepts required to produce a mutually satisfying exchange between consumers/users/ organizations and providers of goods, services and ideas. Emphasis on understanding the marketplace, individual parts of the marketing program (product, pricing, distribution and communication), and strategic formulation (orientation, target segmentation, positioning). Prerequisite: Enrollment in the MBA Degree Program; Open to MBA students, or by consent of instructor.

GB3031 Acquisition Management for International Students (3-0) Fall/Spring

This is the MBA core acquisition course for MBA international students in non-acquisition curricula. It introduces principles of public procurement management by examining acquisition policy issues, management strategies, contracting decisions, and contract management processes. Major international procurement models and systems will be introduced, including the US Federal Acquisition Regulation, Transparency International's Integrity Pacts, the UN Model Law on Procurement, the EU Public and Defense Procurement Directives, the World Bank Procurement and Integrity Guidelines, and the World Trade Organization Agreement on Government Procurement. Concepts, strategies and tools for planning, organizing, staffing, directing and controlling acquisition programs are examined. Acquisition topical areas include: anti-corruption measures, acquisition planning, the competition requirements, source selection, risk management, quality assurance, protests, transparency and publicity mechanisms, research and development, and contracting management. While the US defense acquisition system may be examined for comparative purposes, the major emphasis through case studies and readings is on international perspectives and issues. Another major emphasis of the course is on Foreign Military Sales (FMS) and the application of international procurement law concepts to the FMS process. Prerequisite: None.

GB3040 Managerial Statistics (4-0) Fall/Spring

GB3040 is an introduction to the science and art of converting data into information for managerial and policy analysis. This course focuses on the descriptive and inferential statistical concepts useful for conducting basic managerial and policy analysis. Topics include measurement scales, descriptive statistics for quantitative and qualitative data, basic probability concepts and distributions, sampling theory and sample design, sampling distributions, point and interval estimation, hypothesis testing, goodness-of-fit tests, contingency table tests, correlation analysis, and multiple regression analysis. Excel statistical tools will be utilized for data analysis and presentation. Follow-on courses in GSBPP will build on the statistical foundations in GB3040. Prerequisites: College algebra and knowledge of Excel. Open to MBA students, or by consent of instructor.

GB3041 Analytical Tools for Managerial Decisions (4-0) Fall/Spring

GB3041 continues the development and understanding of the analytical process and the role of analysis in business. Building on skills from GB3040, students will expand their ability to formulate problems and identify solution methods. Topics and tools covered in GB3041 include sampling theory and sampling design strategies, survey methods, observational studies and experimentation,

measurement scales, process quality control, time series smoothing methods, probabilistic and risk analysis, assessing the implications of modeling assumptions, and presenting analyses in clear, comprehensive and convincing format. Prerequisite: GB3040.

GB3042 Operations Management (4-0) Winter/Summer

This course provides an overview of operations in military and commercial systems. The course has three sections: (1) Creating processes, including a survey of process types, capacity planning, and service system design; (2) Controlling processes, including MRP/ERP systems and the role of information; and (3) Coordinating processes, including inventory management, purchasing, and supply chain management. Prerequisite: None.

GB3050 Financial Reporting and Analysis (4-0) Winter/Summer

This course covers theory, concepts, and practices underlying financial Accounting and Financial Reporting. The conceptual structure underlying the reporting of economic events in the form of the balance sheet, the income statement, and the statement of cash flows is first presented. Accounting recognition and measurement issues surrounding revenues, expenses, assets, liabilities and equity are introduced and analyzed. Finally, different forms of financial analysis based on financial report information are addressed. Throughout the course, emphasis is placed on the manager or user perspective. Attention is given to the federal government financial reporting model and standards. Prerequisite: Enrollment in the GSBPP Degree Program.

GB3051 Cost Management (3-0) Fall/Spring (DL)

This course introduces students to cost management concepts and theories which are used by managers to make decisions on the allocation of financial, physical, and human resources to achieve strategic as well as short-term organizational goals and objectives and evaluate performance using financial and non-financial measures. The course is designed for those having a prior course in financial reporting and analysis or financial accounting. Cost management includes traditional tools and techniques such as cost behavior for decision making, activity costing, cost allocation, and standard costing. Prerequisite: GB3050.

GB3070 Economics of The Global Defense Environment (4-0) Winter/Summer (DL)

This course develops the fundamental tools of microeconomics and macroeconomics, and applies them to defense management and resource allocation. The course centers on defense applications of economic theory. Topics covered include: defense and the macro economy; markets and their interactions with defense acquisition and contracting; national security implications of globalization; and efficiency in defense decision making. Prerequisite: MA2XXX College algebra or equivalent.

GB3510 Defense Financial Management Practice (3-0) Fall/Spring

This course is designed for MBA students and presumes the student has a foundation including the PPBE system and Congressional Authorization and Appropriation processes. This course concentrates on financial management practices within DoD as distinct from policy and budgeting theory. The course covers the actors and activities and mechanics of building and defending budgets. It covers funding mechanisms for programs and activities, addressing the proper use and management of appropriated, reimbursable, and revolving funds. Basic principles of fiscal law are explored. It then addresses financial management and stewardship topics including budgetary accounting, management of cost drivers,

the relationship between comptrollership and contracting, and internal controls. Contemporary financial management issues are discussed. Exercises and case studies are used to develop the students' ability to apply financial management concepts to real life situations. Prerequisite: GB4053 or permission of the instructor.

GB4014 Strategic Management (4-0) Fall/Spring

Strategic Management entails the establishment of an organization's direction and the implementation and evaluation of that direction in view of the organization's external environment and its internal capabilities. The principal aim of this course is the transfer and adaptation of the principles of business strategic management to the Department of Defense and other government agencies. In previous courses, students concentrated on the functional elements of management (e.g., accounting, finance, acquisition, logistics, contracting, etc.). This course addresses the challenges of setting direction and implementing strategies for the total system or whole organization. Cases and approaches from the public and private sectors enable students to develop the knowledge, skills, and abilities to strategically think, plan, and manage. Prerequisite: GB3010, GB3012.

GB4015 Management of Change (3-0) Winter/Summer

This course recognizes and describes the dilemmas inherent in any effort to change a human system. Emphasis is placed on strategies and technologies for planning, managing, and implementing change. The course emphasizes approaches to planning and managing change that reflect the complexity of organizations comprised of several interdependent systems--technology, structure, task, culture, and people. The course is application-oriented and intended to enhance skill development. Prerequisite: GB4014.

GB4021 Strategic Management of IT (3-0) Spring/Fall

The management of Information Technology (IT) within the government and corporate environments has become a function that is shifting from the traditional IT management structure to the General Manager. In today's environment, it is imperative to understand the importance of and unique issues related to technology. Network Centric Warfare has been deemed mission critical to the success of the military now and in the future. This course provides the student with a general understanding of the key components and underlying concepts related to the valuation of technology within organizations. Topics include e-business, e-government, strategic outsourcing, software make vs. buy decisions, business process, re-engineering with technology, and the impacts of technology on force transformation. The course is not intended to be focused on the technical aspects of technology, but rather on the impact of technology on the manner in which DoD organizations function. Prerequisite: GB3020 or consent of instructor.

GB4043 Business Modeling and Analysis (3-0) Winter/Summer

This course introduces mathematical modeling for a sound conceptual understanding of the decision-making process. This course familiarizes the students with applications, assumptions, and limitations of the quantitative methods in modeling. It focuses on the development of mathematical and spreadsheet models, the verification of those models, sensitivity analysis of the solutions generated from a model, and the implementation of those solutions. Some of the topics covered include linear programming, non-linear and integer programming, simulation, and forecasting.

The process of modeling and particular modeling tools are applied to business problems in finance, acquisition, logistics and manpower planning. Prerequisite: GB3040 and GB4071.

GB4044 Defense-Focused Managerial Inquiry (3-0) Fall/Spring
Fundamentally, this is a course in thinking critically and analytically. It is also a unique, practical opportunity for students to develop a research question, methodology, and proposal for their MBA project or master's thesis. Indeed, many students can expect to complete the initial stages of their MBA project or thesis by fulfilling the course requirement for a team-based research report. As Cooper and Schindler write: "Research is any organized inquiry carried out to provide information for solving problems. Business research is a systematic inquiry that provides information to guide business decisions. This includes reporting, descriptive, explanatory, and predictive studies. The managers of tomorrow will need to know more than any managers in history. Research will be a major contributor to that knowledge. Managers will find knowledge of research methods to be of value in many situations. They may need to conduct research either for themselves or for others. As buyers of research services, they will need to be able to judge research quality. Finally, they may become research specialists themselves." Punch prefers to describe research as "organized common sense," since it "supports the idea that good research is within the grasp of many people." In this way, we can "simplify the more technical aspects of research methods, and enhance understanding, by showing the logic behind them." This course similarly seeks to examine the logic of research methods-- recognizing that these methods may differ across disciplines and subspecialties--rather than focus on detailed models or procedures that may hold little meaning for the military's managers. It is not a course in rules or required steps; rather, it is a course in understanding the principles, concepts, and range of techniques that define the craft of research. Prerequisite: None.

GB4052 Managerial Finance (3-0) Fall/Spring
This course provides an overview of the basic concepts and principles of financial management in the private sector and its implication on government contracting. It is designed to provide insights into the financial decision- making process encountered by commercial enterprises. The major emphasis is on financial environment, risk and return analysis, valuation models, cost of capital determination, optimal capital structure, and short-term and long-term financing. Prerequisite: GB3050.

GB4053 Defense Budget and Financial Management Policy (4-0) Winter/Summer
This course analyzes the resource requirements process within the Department of Defense (DoD) and in the executive and legislative branches of the federal government. It begins with a summary of the current threat situation and potential changes to it. Once the threat is defined, the study of the resource allocation process to meet the threat begins. The course covers the resource planning and budgeting processes of the Department of the Navy, DoD and the federal government. It includes the politics of executive and congressional budgeting, and DoD budget and financial management processes and procedures including budget formulation and execution. It also includes analysis of the Planning, Programming, Budgeting Execution System (PPBES) used by DoD to plan, budget and implement national defense resource management policy and programs. Other areas included are budget process and fiscal policy reform and the dynamics of internal DoD competition for resources. Executive and congressional budget processes are assessed to indicate how national security policy is resourced and implemented through the budget process. Spending for national security policy is tracked from budget submission through resolution, authorization and appropriation. Budget formulation, negotiation, and execution strategies are evaluated to indicate the dynamics of executive-legislative competition over resource allocation priorities. Supplemental appropriation patterns and current year budget execution patterns and problems are also considered. Prerequisite: GB3010 and GB3070, or GB4070.

GB4071 Economic Analysis and Defense Resource Allocation (4-0) Fall/Spring
Develops the tools and techniques of economic efficiency to assist public sector decision makers in analyzing resource allocation in government activities. Focuses on developing the principles of cost-benefit analysis (CBA) and cost-effectiveness analysis (CEA). Stresses the application of CBA and CEA to specific investment projects, programs and policies in the federal government, especially in the Department of Defense. Prerequisites: GB3070 or GB4070.

GB4090 MBA Project (0-6) Winter/Summer
MBA Project. Prerequisite: Open to MBA students, or by consent of instructor.

GB4210 Knowing Management (3-0) Fall/Spring
Online course. This elective course on knowing management integrates theory with practice to help prepare current and future leaders to manage knowledge and lead knowers in learning organizations. Knowing refers to knowledge in action, and is concerned with activities (e.g., decision, behaviors, work) in the organization. Using emerging knowledge-flow theory as its intellectual base, the theoretical part of the course helps professionals understand how knowledge is both critical and unique, and equips them to design effective knowledge management (KM) programs around knowledge flows. Using real-time cases for group critique, the problem-based learning part of the course examines a diverse set of KM programs in operation today, and offers both principles for and experience in identifying strengths and weaknesses. Students also select new or operational KM programs for evaluation, and work individually as consultants to assess and redesign them based on knowledge flows. This asynchronous (e.g., Web-based) course offers opportunities for cutting-edge graduate education beyond the classroom. Prerequisites: GB3020, IS3301, IS3302 or by consent of instructor.

GB4410 Logistics Engineering (4-0) Winter/Summer
The concept of integrated logistics support in the design and maintenance of weapon systems. Operational requirements, reliability, system maintenance concept, functional analysis, life cycle costs, logistics support analysis, systems design, test and evaluation, production, spare/repair parts management are discussed. This course also covers topics in logistics information technology, inventory management culture and commercial-sector best practices for military. Case studies include logistics life-cycle cost, reliability and readiness analysis for major weapon systems. Prerequisite: GB3042 or equivalent.

GB4420 Technology and Information Systems for Logistics and Operations (3-0) Fall/Spring
Overview of the use and value of information systems and technology applied to logistics and operations management. Examines the cost-benefit analysis of technology, and the evaluation of technological alternatives. Surveys commercial software available to facilitate logistics and operations management,

including enterprise resource planning systems. Explores typical difficulties confronted when implementing technological solutions. Prerequisite: None.

GB4430 Defense Transportation System (4-0) Winter/Summer
This course examines how the Defense Transportation System supports the DoD mission, including the responsibilities of USTRANSCOM and its Transportation Component Commands, CONUS transportation and strategic lift, as well as institutional constraints and other managerial issues. Prerequisite: None.

GB4440 Simulation Modeling for Management Decision Making (4-0) Winter/Summer
Modeling and risk analysis for managerial decision making. Case studies of simulation modeling applications to weapon system acquisition, logistics, transportation, distribution, communications and production systems. Prerequisite: GB3040 or other introductory probability and statistics (may be taken concurrently).

GB4450 Logistics Strategy (4-0) Fall/Spring
DAU Equiv: LOG 304. This is the logistics capstone course. The course explores and analyzes the concepts, processes and methods of strategic planning and execution emphasizing aggressive proactive techniques to ensure maximum logistics influence on major weapon systems acquisition as well as optimum life cycle management of fielded systems. Cultural constraints of the current logistics environment and how to succeed in it is a significant focus of the course. The course examines and analyzes key opportunities for maximum logistics influence in requirements, development, contracting, test and evaluation, reliability, and maintainability as well as financial management and communications. The course features logistics management relevance to service roles and missions. The course employs lectures, guided discussions, case studies, role-playing, panel discussions, and lessons learned in the DoD acquisition environment. For the final examination project, the class is divided into teams and produces a comprehensive strategic plan for logistics for a fictitious major program. Prerequisite: GB3051 and GB4052; recommend GB3510 unless enrolled in the MBA Energy Program.

GB4460 Logistics Risk Assessment and Control (4-0) Fall/Spring
This course addresses the risk assessment and control issues that are inherent in most logistics decisions. Risk control topics include Safety Stock, Safety Capacity and Safety Lead Time, as well as Statistical Process Control. Risk assessment and valuation topics include Portfolio Selection, Real Options and Value-At-Risk. Monte Carlo Simulation will be used as a primary tool for assessing risk, and will be contrasted with Discounted Cash Flow approaches. Students should also develop an understanding of the theoretical underpinnings of risk assessment through a comparison of prescriptive versus descriptive (e.g., Prospect Theory) approaches to the study of risk judgments. Prerequisites: GB3040, and GB3042 or permission of instructor.

GB4480 Supply Chain Management I (4-0) Fall/Spring
This course is designed to provide an introduction to supply chain management Change Description (SCM). A supply chain is a network of organizations that supply and transform materials, and distribute final products to customers. Supply chain management is a broadly defined term for the analysis and improvement of flows of material, information, and money through this network of suppliers, manufacturers, distributors, and customers. SCM also plays a vital role in the military operations. The objective of SCM is to deliver the right product to the right customer at the right time. SCM emphasizes inventory-service level tradeoffs across the chain of players that, together, provide the product to a customer. Logistics has traditionally focused on materials issues within and downstream from the factory while SCM looks at the entire network of players, both up and down stream, and perhaps has more of an emphasis on information flows through the network. Logistics has traditionally been considered a more tactical topic while SCM has risen to prominence in recent years for addressing strategic aspects of product distribution. Ultimately, logistics and SCM activities are concerned with coordinating demand and supply. Common elements in that coordination are the management of materials (inventories), the location of materials (warehouses), and the movement of materials (transportation). As part of the coordination, an analyst must consider product and process designs as well as information flows between various players in the networks. These elements form the basis of this course. The two main objectives of this course are to help students understand: (1) the fundamental concepts and techniques necessary for attaining a world class performance in supply chain management, and (2) how these concepts and techniques can be applied to design, plan and operate supply chains supporting military operations. Prerequisites: GB3042 or permission from instructor.

GB4490 Special Topics in Supply Chain Networks (4-0) Fall
This course focuses on conceptual understanding of the Supply Chain Networks for decision-making. The course builds the knowledge for identifying distribution and transportation networks and to optimize it using advanced analytical tools. To incorporate the bigger picture of network optimization problem, the course includes real applications in private sector as well as in military and non-governmental organizations. This is done with the analysis and discussion of articles of diverse applications such as (1) Ammunition requirement planning for the Canadian army; (2) Elkem (a Norwegian company) redesigning its supply chain using optimization; (3) SCM at the USCG repair and supply center; (4) Location of disaster recovery centers in Florida County.

GB4510 Strategic Resource Management (4-0) Winter/Summer
The objective of this course is to integrate business analysis, financial analysis, and strategic analysis in solving complex management problems involving the allocation of scarce resources to achieve overall organization objectives. Resources here are not limited to financial resources but also include human and physical resources. The course will make use of a wide variety of management tools such as value chain analysis, competitive strategy, market positioning, supply chain management, activity analysis, target costing, cost of quality, and business process improvement techniques. Prerequisites: Completion of GB4530 Management Control Systems or permission of instructor.

GB4520 Internal Control & Audit (3-0) Fall/Spring
This course provides an introduction to the objectives of and activities related to internal control and audits, including design and evaluation of internal controls, auditing standards, audit reports, audit evidence, and audit tests. The course includes an overview of audits of financial reports and records and of government operations, with attention given to Government Auditing Standards. Prerequisite: GB3051, Management Accounting.

GB4530 Management Control Systems (4-0) Spring/Fall
Overview of internal controls processes. Study of the design, implementation, and evaluation of management planning and control systems in Navy and Defense organizations with comparisons to large, complex private sector organizations. Specific topics include the need for planning and control, strategic planning, the resource allocation process, organization of the management control function, measurement of inputs and outputs, budgeting, reporting, and performance evaluation. Prerequisite: GB3051.

GB4540 Conrad Seminar (2-0) Winter/Summer
This course provides DoD military officers with an awareness of real life implementation of the education they have received in the (MBA (FM) curriculum). There are lectures on the Budgeting process and pending changes thereto, and an exercise in taking a hypothetical budget reduction, . Senior level guest speakers from the Department of the Navy and Department of Defense discuss current Financial Management issues with the students. and five VTCs originated in the Pentagon by FMB, Director of Navy Resource Requirements (N-8), Resource Director for the JCS (J-8), ASN(FM&C) Counsel (FMC), Director of Navy Budget (N-82) and Graduates presently in their "Pay Back" tour. There is also an Air Force Cohort which covers about 40% of their course and addressing Air Force "Unique" processes and paralleling the framework of the Navy/Marine Cohort. Sixty percent of the Air Force course is jointly conducted with the Generic part of the Navy/Marine allowing for more Joint education. International Students are welcomed to participate as an elective. This course is graded pass/ fail. Prerequisite: GB3510.

GB4550 Advanced Financial Reporting (4-0) Winter/Summer
This course explores both underlying theory and practical applications of financial reporting and analysis. The course builds on financial reporting foundations presented in an introductory course and on basic concepts covered in auditing, economics, and finance courses. The course first develops an understanding of alternative accounting measurements, and then examines how alternative accounting policies are selected in a dynamic financial reporting environment that includes owners; creditors; employees; professional analysts; portfolio managers; and regulatory agencies. Finally, the course will determine how best to communicate financial performance and financial position to decision makers, users, and managers. Prerequisites: GB3051, GB4052, GB3510.

GB4560 Defense Financial Management (3-0) Fall/Spring
This course focuses on the competencies required of a Defense Financial Manager. It examines the diverse concepts, theories, and practices addressed in numerous specialty courses and ties them together in the framework of Defense Financial Management. The areas of coverage include: the Government Resource Management Environment, the Defense Resource Management Environment, Personnel Management, Manpower Management, Management and Internal Controls, Fiscal Law, the Planning, Programming, Budgeting Execution System (PPBES), Cost and Economic Analysis, Business Management Process Improvement, Accounting, Finance, and Auditing. Prerequisite: None.

GB4570 Advanced Finance (2-0) As Required
This course is designed to provide insights into advanced topics in financial decision making process encountered by commercial enterprises. Major topics covered include long-term financing, lease financing, optimal capital structure determination, dividend policy, security issues and refunding, risk analysis and real options, derivatives and risk management. Prerequisite: GB4052.

GB4580 Modeling for Planning and Control (3-0) Fall/Spring
Study of sophisticated analytical methods for various cost, policy and decision scenarios in DoD and other organizations. Emphasis is on developing analytical methods as decision support tools, with available computer software as computational aids. Major topics include regression, learning curve, Monte Carlo simulation, and time series models. Prerequisite: GB4043.

GB4999 Elective (4-0) Fall/Spring
Elective course to be selected by student with approval by academic associate.

GE Courses (EMBA Program)

GE3010 Organizations As Systems and Structures (3-0) Winter/Summer
GE3010 Organizations As Systems and Structures (3-0) Winter/Summer Open to EMBA DL students only. Defense organizations are purposive systems comprising tasks and technologies, vertical and lateral coordination structures and processes, reward systems, and individual motivation. This course prepares leaders to understand the organizational system components and their relationships: inputs (e.g., environment, history), design factors (i.e., people, task, structure, culture) and outputs/outcomes (e.g., productivity, satisfaction, growth). A primary focus is on the organizational level of analysis and includes such topics as environment, hierarchy and structural configuration, with special emphasis on the context and organization of DoD. Applications and cases address command and control, joint task forces and network centric operations with attention to organizational theory and design tradeoffs. Prerequisite: None.

GE3011 Management of Teams (2-0) Winter/Summer
Open to EMBA DL students only. Teams are a building block of today's organizations. Teams are evident throughout DoD in such forms as operational squads, integrated product teams (IPTs), R&D innovation teams, and Joint Task Forces. The course examines the differences between groups and teams, between leader-managed and self-managed teams, between virtual and face-to-face teams, and between effective and ineffective teams. Analysis of effective teams include such issues as team dynamics, decision making, rewards, commitment, and the management of conflict (inter-personal, intra-team, and inter-team) in which power, influence and negotiation play central parts. Prerequisite: None.

GE3031 Principles of Acquisition Management (3-0) As Required
Open to EMBA students only. This course introduces the fundamental principles of public and private sector acquisition management by examining current acquisition policy issues, strategies, contractual decisions, and program management concepts. The aspects of planning, organizing, staffing, directing and controlling efforts within a risk managed process will be examined. Acquisition functional areas addressed in this course include: logistics, test and evaluation, systems engineering, manufacturing management, quality assurance, funds management, budgeting, research and development, and contracting management. Prerequisite: None.

GE3042 Operations Management (4-0) As Required
Open to EMBA students only. An overview of operations in military and commercial systems. The course has three sections: (1) Creating processes, including a survey of process types, capacity

planning, and service system design; (2) Controlling processes, including MRP/ERP systems and the role of information; and (3) Coordinating processes, including inventory management, purchasing, and supply chain management. Prerequisite: GE3043.

GE3043 Analytical Tools for Decision Making (3-0) As Required

Open to EMBA students only. The objective of this course is to enhance students' ability to solve complex managerial problems and make decisions under conditions of uncertainty and competing objectives through the use of computer-based modeling techniques. The course incorporates probability material, decision models and decision analysis, decision trees, forecasting and simulation. The interactive environment of the electronic spreadsheet is used to provide an intuitive understanding of basic principles (e.g., understanding uncertainty and risk with Monte Carlo simulation rather than mathematical analysis). Prerequisite: None.

GE3050 Financial Reporting and Analysis (3-0) Winter/Summer

Open to EMBA DL students only. This course covers theory, concepts, and practices underlying Financial Accounting and Financial Reporting. The conceptual structure underlying the reporting of economic events in the form of the balance sheet, the income statement, and the statement of cash flows is first presented. Accounting recognition and measurement issues surrounding revenues, expenses, assets, liabilities and equity are introduced and analyzed. Finally, different forms of financial analysis based on financial report information are addressed. Throughout the course, emphasis is placed on the manager or user perspective. Attention is given to the federal government financial reporting model and standards. Prerequisite: None.

GE3051 Cost Management (3-0) Spring

Open to EMBA DL students only. This course introduces students to cost management concepts and theories which are used by managers to make decisions on the allocation of financial, physical, and human resources to achieve strategic as well as short-term organizational goals and objectives and evaluate performance using financial and non-financial measures. The course is designed for those having a prior course in financial reporting and analysis or financial accounting. Cost management includes traditional tools and techniques such as cost behavior for decision making, activity costing, cost allocation, and standard costing. Prerequisite: GE3050.

GE3070 Economics for Defense Managers (3-0) As Required

Open to EMBA DL students only. Develops the fundamental tools of microeconomics and macroeconomics, and applies them to defense management and resource allocation. Course centers on defense applications of economic theory. Topics covered include: defense and the macro economy; markets and their interactions with defense acquisition and contracting; national security implications of globalization; and efficiency in defense decision making. Prerequisite: MA2XXX, College algebra.

GE3109 Ethics and Moral Development (3-0) As Required

Offered to EMBA students in their first quarter: The objective of this course is to provide newly-enrolled Executive MBA students with an introduction to the ethical challenges of the global Defense business environment facing Navy corporate business leaders and resource managers. Through the use of case analyses and discussion, the course will explore the application of ethical thinking to contemporary issues in the private and public sectors. The course goals include: 1) introduce ethical concepts which are relevant to the moral and ethical dilemmas inherent in business decisions; 2) help students develop the critical thinking and analytical skills required to address complex issues; 3) identify the range of ethical problems facing senior leaders in business and government; and 4) encourage the students to develop a personal approach to achieve ethical outcomes in the corporate-level decision-making process. The students will use the managerial perspective and critical thinking skills developed in this course throughout the remainder of their studies to identify the ethical dimension in the process of formulating and implementing Navy policy and business strategies required to build and maintain the Fleet of the 21st Century. Prerequisite: None.

GE3221 Principles of Acquisition and Program Management I (3-0) As Required

Open to EMBA students only. This is the first of two courses which provides the student with an understanding of the underlying concepts, fundamentals and philosophies of the Department of Defense systems acquisition process and the practical application of program management methods within this process. The course examines management characteristics and competencies, control policies and techniques, systems analysis methods and functional area concerns. Techniques for interpersonal relationships will be examined in team exercise settings. Topics, from a program management perspective, include the evolution and current state of systems acquisition management, the system acquisition life cycle, requirements analysis, systems engineering, contract management, resource management, test and evaluation, user-producer acquisition management disciplines and activities; and program planning, organizing, staffing, directing and controlling. Case studies are used to analyze various acquisition issues. Defense Acquisition University (DAU) has granted MN 3221-MN3222, GE3221-GE3222 equivalency for ACQ 101, ACQ 201, PMT 251, PMT 257, BCF 102 and BCF 103. PREREQUISITE: None.

GE3222 Principles of Acquisition and Program Management II (3-0) As Required

Open to EMBA students only. This is the second of two courses which provides the student with an understanding of the underlying concepts, fundamentals and philosophies of the Department of Defense systems acquisition process and the practical application of program management methods within this process. The course examines management characteristics and competencies, control policies and techniques, systems analysis methods and functional area concerns. Techniques for interpersonal relationships will be examined in team exercise settings. Topics, from a program management perspective, include the evolution and current state of systems acquisition management, the system acquisition life cycle, requirements analysis, systems engineering, contract management, resource management, test and evaluation, user-producer acquisition management disciplines and activities; and program planning, organizing, staffing, directing and controlling. Case studies are used to analyze various acquisition issues. Defense Acquisition University (DAU) has granted MN 3221-MN3222, GE3221-GE3222 equivalency for ACQ 101, ACQ 201, PMT 251, PMT 257, BCF 102 and BCF 103. Prerequisite: GE3221 or consent of instructor.

GE3306 Strategic Purchasing (3-0) As Required

For EMBA students only. This course is a graduate-level seminar in strategic purchasing. The course will be taught through a combination of formal lecture, guided discussion, and case analysis. The primary goal of this course is to develop, structure, and execute

purchasing, not as a functional activity, but rather as a strategic component of total supply chain management. The course emphasizes the concept that companies with world-class purchasing practices derive a competitive advantage in their industries from their procurement and sourcing strategies. The course develops the concept of competitive advantage through strategic purchasing as it relates to efficient and effective structure and management within the Department of Defense. The emphasis on world-class purchasing practices entails observation and analysis of commercial organizations and their purchasing practices. The student will investigate whether select commercial organizations' purchasing practices are useful to the DoD, and determine practical implementation for use in the DoD acquisition environment. Prerequisite: None.

GE3510 Defense Financial Management Practice (3-0) As Required

For EMBA students. This course is designed for MBA students and presumes the student has a foundation including the PPBE system and Congressional Authorization and Appropriation processes. This course concentrates on financial management practices within DoD as distinct from policy and budgeting theory. The course covers the actors and activities and mechanics of building and defending budgets. It covers funding mechanisms for programs and activities, addressing the proper use and management of appropriated, reimbursable, and revolving funds. Basic principles of fiscal law are explored. It then addresses financial management and stewardship topics including budgetary accounting, management of cost drivers, the relationship between comptrollership and contracting, and internal controls. Contemporary financial management issues are discussed. Exercises and case studies are used to develop the students' ability to apply financial management concepts to real life situations. Prerequisite: None.

GE4015 Managing Complex Change in the DoD Environment (3-0) As Required

Open to EMBA students only. This course recognizes and describes the dilemmas inherent in any effort to change a human system. Emphasis is placed on strategies and technologies for planning, managing, and implementing change. The course emphasizes approaches to planning and managing change that reflect the complexity of organizations comprised of several interdependent systems--technology, structure, task, culture, and people. The course is application-oriented and intended to enhance skill development. Prerequisite: GE3010.

GE4016 Managing Strategic Change (4-0) Winter/Summer

The course focuses on senior-level decision-making processes under conditions of significant uncertainty. Part of the process includes assessment of the organization's external environment and its internal capacity to respond to decisions made to be responsive to that environment. The course takes into account the unique context of public organizations, particularly the context of DoD organizations. Furthermore, the course focuses on the challenges of implementing these decisions and evaluating the extent to which the decisions are reaching the desired outcomes, and determining what to do if they are not. The overall purpose of the course is to provide opportunities for students to grapple constructively with, and exercise good managerial judgment in, situations that are complex, rapidly changing, multidimensional, and potentially highly consequential in terms of their impact on the future. The course deals with the role of uncertainty in situations and issues that are critical for the long-term future health, survival and prosperity of the organization. Prerequisite: None.

GE4021 E-Business for Defense (3-0) As Required

Open to EMBA students only. The network era has revolutionized the manner in which business processes are conducted, and we have only just begun to understand the potential of how such processes can be conducted in the future. What we do understand is that electronic business (e-business) represents a combination of technologies, business models and managerial techniques that can enable fundamental process innovation with order-of-magnitude performance improvement, if conceived and implemented well. This applies in particular to military enterprises of the U.S. Defense Department, under tremendous pressure to modernize their forces and improve the quality of life for service men and women, because of the huge size, global reach, time-critical processes and hazardous missions associated with the "business" processes of military operations. This course addresses the application of e-business technologies, business models and management to defense. The course builds on students' knowledge of operations management, supply chain management, and strategy to address technologies, models and applications of business (e-business). The course has an explicit focus on e-business applications, opportunities and implications in defense organizations, even though many exemplars from private industry are discussed, and it integrates both theory and application to provide knowledge necessary to organize and manage in the networked, paperless enterprise of today and tomorrow. Course topics will include: IT and Strategy, IT and Organization, Extending the Enterprise (transformation), Making a Case for IT, Understanding Internetworking Infrastructure, Assuring Reliable and Secure IT Services, Managing Diverse IT Infrastructures and Managing IT Outsourcing. Prerequisite: None.

GE4043 Business Modeling and Analysis (3-0) As Required

Open to EMBA students only. This course introduces mathematical modeling for a sound conceptual understanding of the decision-making process. This course familiarizes the students with applications, assumptions, and limitations of the quantitative methods in modeling. It focuses on the development of mathematical and spreadsheet models, the verification of those models, sensitivity analysis of the solutions generated from a model, and the implementation of those solutions. Some of the topics covered include linear programming, non-linear and integer programming, simulation, and forecasting. The process of modeling and particular modeling tools are applied to business problems in finance, acquisition, logistics and manpower planning. Prerequisites: None.

GE4052 Managerial Finance (3-0) As Required

Study of capital budgeting techniques. This course provides an overview of the basic concepts and principles of financial management in the private sector and its implication on government contracting. It is designed to provide insights into the financial decision-making process encountered by commercial enterprises. The major emphasis is on financial environment, risk and return analysis, valuation models, cost of capital determination, optimal capital structure, and short-term and long-term financing. Prerequisite: GE3050.

GE4053 DoD Mission and Resource Determination 4-0) As Required

This course analyzes the resource requirements process within the Department of Defense (DoD) and in the executive and legislative branches of the U.S. federal government. It begins with a summary of the current threat situation and potential changes to it. Once the

threat is defined, the study of the resource allocation process to meet the threat begins. The course covers the resource planning and budgeting processes of the Department of the Navy, DoD and the federal government. It includes the politics of executive and congressional budgeting, and DoD budget and financial management processes and procedures including budget formulation and execution. It also includes analysis of the Planning, Programming, Budgeting Execution System (PPBES) used by DoD to plan, budget and implement national defense resource management policy and programs. Other areas included are budget process and fiscal policy reform and the dynamics of internal DoD competition for resources. Executive and congressional budget processes are assessed to indicate how national security policy is resourced and implemented through the budget process. Spending for national security policy is tracked from budget submission through resolution, authorization and appropriation. Budget formulation, negotiation, and execution strategies are evaluated to indicate the dynamics of executive-legislative competition over resource allocation priorities. Supplemental appropriation patterns and current year budget execution patterns and problems are also considered. Prerequisite: None.

GE4101 Collaborative Problem Solving I (3-3) Fall/Winter/Spring/Summer

GE4101 is the first part of the capstone project which uses a collaborative approach to integrate the knowledge and skills gained in the EMBA program. Participants are introduced to an applied research framework designed to enable them to work from theory to identify a business problem to be solved for a command; create a research design for data collection and analysis; and form conclusions and recommendations. Prerequisite: Completion of the previous seven quarters of the EMBA program.

GE4102 Collaborative Problem Solving II (3-3) Fall/Winter/Spring/Summer

GE4102 is the second part of the capstone project which uses a collaborative approach to integrate the knowledge and skills gained in the EMBA program. Participants work in small teams to prepare a project proposal, a final report, and a presentation containing recommendations to solve one of the command's business problems. Prerequisite: Completion of the previous seven quarters of the EMBA program.

GE4310 Strategic Acquisition Management (3-0) Spring

This course extends students' understanding of the complex and dynamic defense acquisition environment and ways in which various functional disciplines (e.g., contracting, test and evaluation, logistics) may be effectively integrated in successful acquisition programs. The effects and implications of current policy initiatives (e.g., acquisition reform, outsourcing) and contemporary industry trends on defense acquisition will be explored. Students will use relevant acquisition program cases to apply their knowledge by analyzing management challenges and developing strategies for success. Prerequisite: GE3222.

GE4480 Defense Supply Chain Management (3-0) Winter/Summer

This course is designed to provide an introduction to supply chain management (SCM). A supply chain is a network of organizations that supply and transform materials, and distribute final products to customers. Supply chain management is a broadly defined term for the analysis and improvement of flows of material, information, and money through this network of suppliers, manufacturers, distributors, and customers. SCM also plays a vital role in the military operations. The objective of SCM is to deliver the right product to the right customer at the right time. SCM emphasizes inventory-service level tradeoffs across the chain of players that, together, provide the product to a customer. Logistics has traditionally focused on materials issues within and downstream from the factory while SCM looks at the entire network of players, both up and down stream, and perhaps has more of an emphasis on information flows through the network. Logistics has traditionally been considered a more tactical topic while SCM has risen to prominence in recent years for addressing strategic aspects of product distribution. Ultimately, logistics and SCM activities are concerned with coordinating demand and supply. Common elements in that coordination are the management of materials (inventories), the location of materials (warehouses), and the movement of materials (transportation). As part of the coordination, an analyst must consider product and process designs as well as information flows between various players in the networks. These elements form the basis of this course. The two main objectives of this course are to help students understand: (1) the fundamental concepts and techniques necessary for attaining a world class performance in supply chain management, and (2) how these concepts and techniques can be applied to design, plan and operate supply chains supporting military operations. Prerequisites: GE3042 or permission from instructor.

GE4510 Strategic Resource Management (3-0) As Required

The objective of this course is to integrate business analysis, financial analysis, and strategic analysis in solving complex management problems involving the allocation of scarce resources to achieve overall organization objectives. Resources here are not limited to financial resources, but also include human and physical resources. The course will make use of a wide variety of management tools such as value chain analysis, competitive strategy, market positioning, supply chain management, activity analysis, target costing, cost of quality, and business process improvement techniques. Prerequisite: GE3051.

MN Courses

MN0163 Thesis Writing Workshop (0-1) Spring

Guidelines for scientific writing for the thesis are given with examples and opportunities for practice. Prerequisite: Consent of instructor.

MN0810 Thesis Research for Systems Management Students (0-8) Fall/Winter/Spring/Summer

Every student conducting thesis research in Systems Management resident programs will enroll in this course. Prerequisite: None.

MN0811 Thesis Research for Non-Resident Business & Public Policy Students (0-4) Fall/Winter/Spring/Summer

Every student conducting thesis research in the Distance Learning Contract Management (835) and Program Management (836) degree programs will enroll in this course.

MN2039 Basic Quantitative Methods In Management (4-0) Fall

This course introduces the mathematical basis required for advanced management and cost-benefit analysis. Math topics include algebra, graphs, differential calculus, including both single and multiple variable functions, and indefinite and definite integrals. Management concepts include cost-benefit and cost-effectiveness analysis, marginal analysis, unconstrained and constrained optimization, and welfare analysis. Prerequisite: College algebra or consent of instructor.

MN2111 Navy Manpower, Personnel, and Training Systems I (2-0) Fall

An introduction to the major issues, theory, and practice of the military MPT&E system. Graded on a Pass/Fail basis only. Prerequisite: Consent of instructor.

MN2112 Seminar In Manpower, Personnel, and Training Issues II (0-2) Summer

Continuation of MN2111. Graded on a Pass/Fail basis only. Prerequisite: Open to thesis students.

MN2155 Accounting for Management (4-0) Winter/Summer

Study of the fundamentals of financial and managerial accounting relevant to financial management. Introduction to financial accounting stressing accrual concepts and the content and analysis of financial statements. More in-depth focus on management accounting topics, including costing techniques for products and programs, use of cost information for decision making, capital budgeting, and financial performance measures. Applications of managerial accounting tools to DoD situations. Prerequisite: None.

MN2304 Seminar In Product Development (0-4) As Required

This course brings both government and industry product development leaders into the academic forum for interaction with students. Guest lecturers include government and industry product development executives, program managers, laboratory and field personnel, department officials, congressional members and staff personnel. Visits to government and industry facilities. Thesis and research presentations. Graded on a Pass/Fail basis. Prerequisite: Consent of instructor.

MN3001 Economics for Acquisition Managers (3-0) Fall/Winter/Spring/Summer

Develops the fundamental tools of microeconomics and macroeconomics and applies them to topics in the management and allocation of resources in defense acquisition management with particular emphasis on the applications of economic theory to defense decision making. Topics covered include defense and the macro economy; markets and their effects on defense acquisition and contracting practices; the economics of corporate strategy; and efficiency in defense decision making. Prerequisite: None.

MN3012 Communications Strategies for Effective Leadership (3-0) Fall/Winter/Spring/Summer

This course provides DoD military officers and civilians with the communication strategies and skills to manage and lead in the dynamic DoD environment. Instruction focuses on assessing various communication models, making strategic media choices, writing effective informative documents, developing associates' communication competencies through various feedback roles, and giving lucid briefings. Prerequisite: None.

MN3042 Operations Management (3-0) As Required

This course provides an overview of operations in military and commercial systems. The course has three sections: (1) creating processes, including a survey of process types, capacity planning, and service system design; (2) controlling processes, including MRP/ERP systems and the role of information; and (3) coordinating processes, including inventory management, purchasing, and supply chain management. This course is the Distance Learning version of GB3042. Prerequisite: None.

MN3108 Leadership In Product Development (3-2) As Required

This is a product development course providing a broad framework for the leadership of end-to-end product commercialization with a student hands-on design challenge, to give students perspective and appreciation for the critical success factors and inhibitors to successful commercialization of complex products and systems. The format includes lectures, guest speakers, case studies and a design challenge. Topics include product development strategy and leadership, the front-end process, product delivery, distribution and customer support. The Design Challenge is as a multi-disciplinary system design experience. Students work in teams to design, build, test and demonstrate a real product. The Design Challenge culminates with a prototype demonstration competition. Prerequisite: None.

MN3111 Analysis of Human Resource Management (4-0) Winter

A broad coverage of human behavior in the work situation, with key emphasis on the issues of work in the Navy Manpower Personnel and Training Environment. Topical areas covered include selection, placement, training development, and evaluation of personnel; motivation, remuneration, morale, supervision, and working conditions in military organizations; job design and organization development within complex military bureaucracies; equipment design and man-machine interface, and the impact of technological programs within the military. Prerequisite: GB3010.

MN3117 Organizational Processes (4-0) As Required

The purpose of this course is to provide the conceptual framework and skills needed to manage and lead organizations. The focus will be on three levels of skills needed to manage modern organizations: skills needed to manage individuals, skills needed to manage teams, and skills needed to manage the organization as a whole. It focuses on the organization of the future, identifies its characteristics, and explores the implications for living in, managing, and leading such an organization. The course also focuses on skills such as negotiating, cross-cultural communication, and teamwork. It examines the creation of the structures needed within the firm and the alliances, learning, and change practices needed to maintain global leadership. The course will use cases, experiential exercises, readings, discussions, and papers. Students have the opportunity to integrate conceptual material with their own experiences, beliefs, and actions. Prerequisite: None.

MN3118 Negotiation and Consensus Building (4-0) Spring

Security, Stability, Reconstruction and Transition (SSTR) environments bring together representatives from different nations and organizations. In order to accomplish the goals of interest, these varying representatives must develop awareness, appreciation, and ability to collaborate with each other. There is no formal organization that provides structures or standards to guide the collaboration of these individuals; they must rely on informal mechanisms for collaborative post-conflict efforts. Because the goals and interests of the participating parties frequently are not in alignment, negotiation and consensus-building capabilities contribute importantly to success. Negotiation and consensus building challenges students to develop their skills in interpersonal and group dynamics (e.g., conflict management, communication, perspective taking, decision making, team building) at both the dyadic level and the group team level. The pedagogy of the course uses simulations, cases, and experiential exercises that include high levels of cultural, ethnic, organizational, and ideological diversity.

Consensus building at both the dyadic and group levels is based on principles of self-organization and self-management, which are critical success factors in an environment such as SSTR where a hierarchic control system is not available as the mechanism of coordination among participants. Prerequisite: None.

MN3121 Organizational Design for Special Operations (4-0) As Required

Principles of organizational design are critically examined and applied to special operations' missions and organizations. Focus is on the organizational level of analysis and includes such topics as organizational environments, key success factors, technology and information systems, configuration and structure, organizational learning, reward systems, and decision making. Case method is used to develop diagnostic skills and a systemic perspective. Prerequisite: Enrollment in the SOLIC curriculum or consent of instructor.

MN3145 Marketing Management (4-0) Spring

This course takes a general management approach to marketing, examining (1) marketing as a process that creates and sustains customer value; and (2) the manager's role in assuring that the firm delivers products that are successful in the marketplace. The curriculum will emphasize approaches to market research (the "voice of the customer"), innovation, creating customer value in product development, product management, and general management of marketing activities. Topics include: market oriented strategic planning, the TQM marketing process, market research, segmentation, target markets, differentiation, product management, the marketing mix, customer satisfaction, and e-commerce. Case studies are used extensively. Prerequisite: None.

MN3154 Financial Management in the Armed forces (3-0) Winter/Summer

This course is designed for non-MBA students and focuses on financial management policies and practices in the DoD. It begins with a foundation including the origin of the Defense budget from national strategic planning through the PPBE system and the submission of the President's Budget to Congress. The Congressional Authorization and Appropriation processes and the flow of funds to the activity level complete the foundation. The course next explores the funding mechanisms for programs and activities, addressing the proper use and management of appropriated, reimbursable and revolving funds. Basic principles of fiscal law are explored. The course concludes with financial management and stewardship topics including budgetary accounting, management of cost drivers, and internal controls. Contemporary financial management issues are discussed. Exercises and case studies are used to develop the students' ability to apply financial management concepts to real life situations. Prerequisite: None.

MN3155 Financial Management for Acquisition Managers (2-0) Fall/Winter/Spring/Summer

This course is a study of financial management practices and issues associated with federal government acquisition programs. The course has emphasis on (1) the resource management process flow from initiation of a new acquisition program through execution of appropriated funds (procurement and research & development accounts) for that program, (2) the congressional approval and review process unique to procurement, and (3) cost estimation, analysis and evaluation as tools for sound acquisition management decision making, and long-term investment analysis. Prerequisites: MN2155; and MN3331 or MN3221 or consent of instructor.

MN3156 Financial and Managerial Accounting (4-0) As Required

This course is designed as a first course in Business Financial Management for graduate students. The course covers a range of topics in financial accounting, managerial accounting and business finance. All topics covered share a common theme in that they are related to the creation and use of financial models and information. The course requires critical thinking and the ability to analyze and apply financial models and reasoning in the context of case studies. The course is divided into two broad areas: Financial Information and Financial Management. Within these areas, specific topics include: financial accounting, financial reports, financial analysis, capital structure, costing systems, performance measurement and control, and investment analysis. Prerequisites: Admission to graduate standing, college algebra, MN3108 and MN3117.

MN3172 Resourcing National Security: Policy and Process (3-0) Winter/Summer

This course analyzes federal policy-making with emphasis on resource decision making for national defense. The roles of principal budget participants are examined in detail. Executive (especially DoD) and congressional budget processes are assessed to indicate how national security policy is implemented through resource allocation. Spending for national security policy is tracked from budget submission through resolution, authorization and appropriation. The politics of budgeting for national defense is evaluated to indicate the dynamics of executive-legislative competition over scarce federal resources. Graded Course. Prerequisite: None.

MN3221 Principles of Acquisition and Program Management I (3-0) Summer

This is the first of two courses which provides the student with an understanding of the underlying concepts, fundamentals and philosophies of the Department of Defense systems acquisition process and the practical application of program management methods within this process. The course examines management characteristics and competencies, control policies and techniques, systems analysis methods and functional area concerns. Techniques for interpersonal relationships will be examined in team exercise settings. Topics, from a program management perspective, include the evolution and current state of systems acquisition management, the system acquisition life cycle, requirements analysis, systems engineering, contract management, resource management, test and evaluation, user-producer acquisition management disciplines and activities; and program planning, organizing, staffing, directing and controlling. Case studies are used to analyze various acquisition issues. Defense Acquisition University (DAU) has granted MN 3221-MN3222, GE3221-GE3222 equivalency for ACQ 101, ACQ 201, PMT 251, PMT 257, BCF 102 and BCF 103. PREREQUISITE: None.

MN3222 Principles of Acquisition and Program Management II (3-0) As Required

This is the second of two courses which provides the student with an understanding of the underlying concepts, fundamentals and philosophies of the Department of Defense systems acquisition process and the practical application of program management methods within this process. The course examines management characteristics and competencies, control policies and techniques, systems analysis methods and functional area concerns. Techniques for interpersonal relationships will be examined in team exercise settings. Topics, from a program management perspective, include

the evolution and current state of systems acquisition management, the system acquisition life cycle, requirements analysis, systems engineering, contract management, resource management, test and evaluation, user-producer acquisition management disciplines and activities; and program planning, organizing, staffing, directing and controlling. Case studies are used to analyze various acquisition issues. Defense Acquisition University (DAU) has granted MN 3221-MN3222, GE3221-GE3222 equivalency for ACQ_101, ACQ_201, PMT 251, PMT 257, BCF 102 and BCF 103. Prerequisite: MN3221 or consent of instructor.

MN3301 Acquisition of Defense Systems (4-0) Fall/Spring

This course introduces the principles and concepts that underlie successful defense acquisition management. The course focuses on management of the acquisition process for defense systems from the development of an initial desired capability or need through design, development, production, fielding, sustainment, and disposal. Students gain an understanding of successful acquisition as an interdisciplinary activity through contributions and applications of principles from business, management, and technical disciplines. The course also emphasizes the statutory, regulatory, and policy environment of acquisition. Numerous case studies illustrate the application of concepts and principles in actual acquisition programs. Defense Acquisition University (DAU) has granted MN3301 equivalency for ACQ_101, ACQ_201, BCF 102 and BCF 103. Prerequisite: None.

MN3302 Advanced Program Management (2-0) As Required

Course builds on the student's experience in the acquisition workforce. Cases are used to examine each of the major disciplines in the acquisition process and bring each student to a current and common understanding of the acquisition environment, process, requirements and management approaches. Prerequisite: DAWIA Level II Certification.

MN3303 Principles of Acquisition and Contract Management (4-0) Winter/Summer

This course is an introduction to the principles of government acquisition and contracting. It presents the fundamentals of the Federal Acquisition Regulation (FAR) and the DoD FAR Supplement; the federal acquisition and contracting processes, including requirements determination, acquisition strategies, government contract law, ethics, contract types, contracting methods, and acquisition/contract management techniques. Prerequisite: None.

MN3304 Contract Pricing and Negotiations (5-2) Winter/Summer

This course involves the study and application of pricing theory and strategies, cost methods, cost and price analysis, cost principles, Cost Accounting Standards, and contract negotiations as used in the Federal Government. Students develop and sharpen negotiating skills by participating in practical negotiation exercises with corporations. Prerequisites: MN3303.

MN3306 Strategic Purchasing (3-0) Fall/Spring

This course is a graduate-level seminar in strategic purchasing. The course will be taught through a combination of formal lecture, guided discussion, and case analysis. The primary goal of this course is to develop, structure, and execute purchasing, not as a functional activity, but rather as a strategic component of total supply chain management. The course emphasizes the concept that companies with world-class purchasing practices derive a competitive advantage in their industries from their procurement

and sourcing strategies. The course develops the concept of competitive advantage through strategic purchasing as it relates to efficient and effective structure and management within the Department of Defense. The emphasis on world-class purchasing practices entails observation and analysis of commercial organizations and their purchasing practices. The student will investigate whether select commercial organizations' purchasing practices are useful to the DoD and determine practical implementation for use in the DoD acquisition environment. Prerequisite: None.

MN3307 Entrepreneurship in Strategic Purchasing (3-0) Winter/Summer

MN3307 is a graduate level seminar on the entrepreneurial concept and management and its application to strategic purchasing. Entrepreneurial thinking is designed to exploit opportunities in uncertain environments. The primary goal for MN3307 is to explore and develop strategic and critical thinking in entrepreneurial concepts and management along with specific methods for utilizing these concepts and tools within world-class purchasing organizations. Students will critically examine how the entrepreneurial mindset is applied in progressive business ventures and how DoD and the government can effectively apply these concepts and management tools for effective and efficient purchasing operations. The foundation of MN3307 is an analysis of the process by which the entrepreneurial mindset generates new ideas, researches the likelihood of success, and successfully implements the idea. The course will also investigate the critical role of entrepreneurial leadership and scanning the environment for opportunity, and capitalizing on opportunities to benefit DoD purchasing operations. The course will be taught through a combination of informal lecture, guided discussion, case study, and student presentations. Prerequisite: None.

MN3309 Acquisition of Embedded Weapon Systems Software (4-0) Winter/Summer

This course examines the fundamentals of major Congressional statutes, agency policies and regulations, and legal precedents which govern the Federal procurement process. The course contrasts the legal regimes of private and government contracting with strong emphasis on unique aspects of government contracts law, including: appropriations limitations; the power to contract; competitive and non-competitive methods of contract formation; contract administration issues such as changes and terminations; transparency and oversight; and bid protests, size protests and disputes. The course prepares students to identify and choose among legal tools, strategies, and processes which should control their decision-making as contracting professionals. Prerequisites: MN3331 or MN3222 or MN3302.

MN3312 Government Contracts Law (4-0) Fall/Spring

This course examines the legal structure within which federal government contracts with private industry are formulated and executed. The course addresses the unique aspects of government contract law including such topics as agency authority, contract interpretation, disputes and remedies, Alternative Dispute Resolution (ADR), socio-economic laws, labor law, property, patent and data rights, conflicts of interest, protests, and ethics. Comparisons are made with the Uniform Commercial Code (UCC). Emphasis is on the use of Court and Board of Contract Appeals (BCA) cases. Prerequisites: MN3303 or MN3341.

MN3313 Contracting for Modeling and Simulation (M&S) (4-0) As Required

This course serves M&S certificates and degree programs offered by the Department of systems Engineering. This course familiarizes program managers, systems engineers, and other DoD managers with the major contracting issues involved in the acquisition and use of M&S products and services. Principal course topics include intellectual property (IP) issues, delivery terms, maintenance responsibility, standards for documentation, open architecture, interoperability, and reuse. Prerequisites: MV/SE3313 or permission of the instructor.

MN3315 Acquisition Management and Contract Administration (4-0) Fall/Spring

This course focuses on the management functions and decision-making techniques involved in the award and administration of Best Value competitively negotiated contracts. The first phase of the course concentrates on the source selection phase of the acquisition process; specific topics include acquisition planning, market research, source selection planning, proposal development, solicitation management, source selection evaluation, contract award, and contractor debriefings. The second phase of the course emphasizes the performance phase of the acquisition process; specific topic areas include organizing for contract administration, transitioning to performance, quality management, subcontract management, financial management, performance monitoring, change management, and contract closeout. Emphasis is on the use of legal case studies and practical exercises. Prerequisites: MN3304 and MN3312.

MN3318 Contingency Contracting (2-0) Winter/Summer

This course is a study of the principles of contingency contracting and the fundamental skills required to provide direct contracting support to joint tactical and operational forces participating in the full spectrum of armed conflict and military operations other than war, both domestic and overseas. Topics include: Types of Contingencies, Cross-Cultural Awareness, Contingency Contracting Officer Authority, Roles and Responsibilities, Anti-terrorism and Security, Planning, Contractual Methodologies and Instruments, Contract Administration, and Ethics/Standards of Conduct. Prerequisite: None.

MN3320 Contract Cost and Price Analysis (3-0) Fall/Winter/Spring/Summer

This course involves the study and application of pricing theory and strategies, costing methods, cost and price analysis, cost principles, Cost Accounting Standards, and related genres in examining proposed and incurred costs in Federal contracts in both pre-award and post-award contexts. Prerequisite: MN3303 or similar introductory contracting principles course. May not require this for MSCM students with extensive field experience and existing CON Level I DAU certification or higher.

MN3321 Federal Contract Negotiations (3-0) Fall/Winter/Spring/Summer

This course involves the study and application of the art and science of developing and conducting comprehensive government contract negotiations. Emphasis is placed on cost and price analytical techniques in the formulation and presentation of a pre-negotiation business clearance, strategy and actual conduct of negotiations in a simulated business environment. Prerequisite: MN3320.

MN3331 Principles of Acquisition and Program Management (5-1) Fall/Winter/Spring/Summer

This course provides the student with an understanding of the underlying concepts, fundamentals and philosophies of the Department of Defense systems acquisition process and the practical application of program management methods within this process. The course examines management characteristics and competencies, control policies and techniques, systems analysis methods and functional area concerns. Techniques for interpersonal relationships will be examined in team exercise settings. Topics, from a program management perspective, include the evolution and current state of systems acquisition management, the system acquisition life cycle, requirements analysis, systems engineering, contract management, resource management, test and evaluation, user-producer acquisition management disciplines and activities; and program planning, organizing, staffing, directing and controlling. Case studies are used to analyze various acquisition issues. Defense Acquisition University (DAU) has granted MN3331 equivalency for ACQ_101, ACQ_201, PMT 251, PMT 257, BCF 102 and BCF 103. Prerequisite: None.

MN3341 Advanced Contracting Principles (4-2) As Required

This course builds on the student's knowledge and experience in contracting to address the more complex pre-award contracting issues in the acquisition environment, including contracting methods, contract types, negotiation, source selection, contingency contracting, environmental contracting, contracting for services, R&D contracting and international procurement. Major issues regarding acquisition reform are addressed. Ethical issues throughout the contracting process are examined. Cases are used to illustrate methods for attacking contracting problems and challenges. Prerequisite: Enrolled in 835 curriculum or consent of instructor.

MN3342 Advanced Contract Management (4-1) As Required

This course builds on the student's knowledge and experience in contracting to address the more complex post-award contracting issues in the acquisition environment including disputes and appeals, claims, intellectual and technical data rights, post-award pricing and negotiations, terminations, contract modifications, traffic and transportation, value engineering, environmental contracting, contractor systems reviews, property administration, quality assurance, contract financing, alternative dispute resolution (ADR), labor relations, contractor performance monitoring and surveillance, contractor performance evaluation. Prerequisites: MN3341, MN3312.

MN3361 Software Acquisition Management (2-0) Fall/Winter/Spring/Summer

Advanced Acquisition Program. This course concentrates on the management of software products and software intensive systems. It is intended to focus essential program management techniques on the software element to ensure successful and timely system development. The course provides the student with knowledge of software acquisition management control processes and tools. Current software acquisition articles and caselets are analyzed for application of program leadership, software development techniques, and management tools applied. Topic areas include: DoD software environment; software acquisition strategies; impediments to successful software intensive system development; software oriented requirements development; contracting for software, software discriminate proposals; software test and

evaluation management; Post Deployment Software Support; risk management; and software costing and budgeting. Integrative exercises involving software managerial problem solving and decision making in the program management environment are used. Prerequisite: MN3331 or consent of instructor.

MN3362 Acquisition Design Verification and System Assessment (2-0) Fall/Winter/Spring/Summer

Advanced Acquisition Program. This course examines Developmental, Operational, and Joint Test & Evaluation as viewed from the Program Manager's perspective. The student will be able to distinguish the difference between the various testing types and the impact testing results will have on the decision makers thought process. Actual military and civilian test cases are used as examples for discussion purposes. Topics include the role of T&E in the Systems Engineering Process, T&E policy Structure and Oversight Mechanism, Requirements Generation, Modeling and Simulation, Alternative Acquisition Program T&E, Human systems Integration and Live Fire T&E. Integrative case studies involving managerial problem solving and decision making in the PMO environment are also used to provide application of concepts in both IPT teaming and multiple-role individual settings. Teamwork exercises are conducted to reinforce concepts and add real-world human dynamics. Upon completion, all exercises are evaluated with after-action reviews and assessments. Prerequisite: MN3331 or consent of instructor.

MN3363 Acquisition Manufacturing and Quality Management (2-0) Fall/Winter/Spring/Summer

For AAAP program students. This course provides the student with knowledge and application of integrated management control processes with regard to performance, cost, and schedule, while examining higher-level and real world defense systems. Issue-oriented topic areas likely to affect Program Management Office personnel include: acquisition reform; acquisition strategy; industrial base; production and manufacturing; quality management; and risk management. Integrative case studies involving managerial problem solving and decision making in the PMO environment are also used to provide application of concepts in both IPT teaming and multiple-role individual settings. Teamwork exercises are conducted to reinforce concepts and add real-world human dynamics. Upon completion, all exercises are evaluated. Prerequisite: MN3331 or consent of instructor.

MN3364 Business Financial and Contract Management (2-0) Fall/Winter/Spring/Summer

Advanced Acquisition Program. The course builds on the student's knowledge and experience in contracting, and contracting related fields, to address the more complex pre-award, award and post-award issues in the acquisition and contracting, and business and financial management arenas. Prerequisite: MN3331 or consent of instructor.

MN3365 Acquisition Logistics & Program Sustainment (2-0) Fall/Winter/Spring/Summer

Advanced Acquisition Program. This course focuses on the logistics and sustainability planning for new major weapon systems in each phase of the DoD acquisition process. It links logistics and sustainability planning, in the early stages of system development, to the effects on the system's total ownership cost. The course describes sustainability planning and management through the Systems Engineering Process and supportability analyses techniques. The course addresses the following specific subject areas: Designing for Life Cycle Cost and Cost As an Independent Variable (CAIV); Logistics Supportability Elements; Supportability analyses; Logistics Open Systems; Software Support Planning; Supply Chain Management; and Post-Production Support Planning. Prerequisite: MN3331 or consent of instructor.

MN3370 Seminar on Leadership in Supply Chain Management (0-2) Fall/Winter/Spring/Summer

Graduate-level seminar emphasizing current and emerging issues from a broad range of logistics and supply chain management subjects. Speakers from the Department of Defense, other government agencies, and industry. Graded on Pass/Fail basis. Prerequisite: Consent of instructor.

MN3384 Principles of Acquisition Production and Quality Management (4-1) Fall/Spring

This course provides the student with an understanding of the principles and concepts of production and quality management in the DoD acquisition environment. Topics include production planning and control, "lean" production, and bottleneck analysis; quality management systems, statistical process control, and six sigma; cost estimating methods, activity based costing, and progress payments in support of production; producibility; environmental, safety and occupational health; warranties; specs and standards reform; and the Defense industrial base. Prerequisite: MN3331 or MN3221 / MN3222 or MN3302 or consent of instructor.

MN3392 Systems and Project Management (4-0) Summer

Management ensures progress toward objectives, proper deployment and conservation of human and financial resources, and achievement of cost and schedule targets. Topics include strategic project management, project and organizational learning, lean thinking, cost, schedule planning and control, structuring of performance measures and metrics, technical teaming and project management, information technology support, risk management, and process control. Course delivery consists of lectures, speakers, case studies, and experience sharing, and reinforces collaborative project-based learning and continuous improvement. Prerequisite: MN3108.

MN3402 Seminar in Installation Management I (0-2) As Required

Introduces students to a variety of topics associated with the management of a complex military base installation. Graded on a Pass/Fail basis. Prerequisite: Consent of instructor.

MN3411 System of Systems Program Definition and Concept Development (3-2) Fall

Same as SE3411. Managing the integration of Large System of Systems (SoS) through a Lead Systems Integrator brings together all developers through a single, central point of communication and control to direct work activities, plan for SoS integration, organize for effective scheduling, and build the team's commitment to successful integration and interoperability. SoS integration often poses confounding problems due to the myriad of interactions between systems and the overall meta-system. This course discusses the special problems of managing the integration of system of systems. Topics include the characteristics of the large scale SoS, program management of SoS integration, uses of SoS design and architecture for decision analysis, feasibility analysis and approaches for SoS integration, SoS contract management, and execution for SoS acquisitions. Prerequisite: A strong background in systems engineering or approval by instructor.

MN3412 System of Systems Design and Development (3-2) Winter

Same as SE3412. This course discusses the special problems of managing and engineering system of systems from the LSI

perspective. Topics include characteristics of SoS in the LSI management environment, engineering implications of SoS issues, management and engineering methodology of SoS, SoS architecture, analysis of SoS, and tools for engineering and monitoring SoS. Managing the integration of SoS through an LSI requires attention to the meta-systems implications of changes at the systems level. This course discusses the special problems of managing the integration of system of systems from the LSI perspective. Topics from the LSI perspective include the characteristics of the large scale SoS, program management of SoS integration, uses of SoS design and architecture for decision analysis, feasibility analysis and approaches for SoS integration, SoS contract management, and execution for SoS acquisitions. Prerequisite: MN3411.

MN3413 System of Systems Integration, Qualification and Lifecycle (3-2) Spring

Same as SE3413. This course discusses these special problems of managing and engineering system of systems from the LSI perspective. Topics include complexity theory in program management (PM), integrated risk management, SoS program assessment strategy, SoS governance, SoS integration design & considerations, SoS performance analysis, SoS leading indicators and reference model strategy. Prerequisite: MN3411 and MN3412.

MN3420 Supply Chain Management (3-0) As Required

This course is designed to provide an introduction to supply chain management (SCM). A supply chain is a network of organizations that supply and transform materials, and distribute final products to customers. Supply chain management is a broadly defined term for the analysis and improvement of flows of material, information, and money through this network of suppliers, manufacturers, distributors, and customers. The objective of SCM is to deliver the right product to the right customer at the right time. SCM emphasizes inventory-service level tradeoffs across the chain of players that, together, provide the product to a customer. Logistics has traditionally focused on materials issues within and downstream from the factory while SCM looks at the entire network of players, both up and down stream, and perhaps has more of an emphasis on information flows through the network. Logistics has traditionally been considered a more tactical topic while SCM has risen to prominence in recent years, attracting high-level attention. Ultimately, logistics and SCM activities are concerned with coordinating demand and supply. Common elements in that coordination are the management of materials (inventories), the location of materials (warehouses), and the movement of materials (transportation). As part of the coordination, an analyst must consider product and process designs as well as information flows between various players in the networks. These elements will form the basis of this course. This course is the Distance Learning version of GB4480. Prerequisites: MN3042, MN4043.

MN3510 Defense Financial Management Practice (3-0) Fall/Spring

This distance learning course is designed for MBA students and presumes the student has a foundation including the PPBE system and Congressional Authorization and Appropriation processes. This course concentrates on financial management practices within DoD as distinct from policy and budgeting theory. The course covers the actors and activities and mechanics of building and defending budgets. It covers funding mechanisms for programs and activities, addressing the proper use and management of appropriated, reimbursable, and revolving funds. Basic principles of fiscal law are explored. It then addresses financial management and

stewardship topics including budgetary accounting, management of cost drivers, the relationship between comptrollership and contracting, and internal controls. Contemporary financial management issues are discussed. Exercises and case studies are used to develop the students' ability to apply financial management concepts to real life situations. Prerequisite: None.

MN3760 Manpower Economics I (4-0) As Required

An introduction to the theoretical aspects of labor economics. Concepts covered include the supply of labor, the demand for labor, wage determination, internal labor markets, human capital, earnings functions, turnover, compensation systems, and compensating wage differentials. Special readings are used that apply the principles to military manpower. Prerequisites: GB3040, GB4071.

MN3810 Fundamental Issues in Energy Technology Adoption (4-0) Winter

This course is designed to cater to all NPS energy curric students who need to know something about how the great new technologies, ideas and practices they research and talk about in other classes might actually get adopted by some DoD entity, and how to get them adopted. It is also appropriate for any other NPS students who would like to learn about some of the basic issues in technology adoption, and don't mind learning it mainly through energy related examples.

MN3900 Readings In System Management (V-0) Fall/Winter/Spring/Summer

An individualized program of readings and study in some area of the systems management, designed to meet the student's special educational needs. Prerequisites: A background in the area of study and departmental approval; graded on a Pass/Fail basis only.

MN4043 Business Modeling and Analysis (3-0) As Required

This course introduces mathematical modeling for a sound conceptual understanding of the decision-making process. This course familiarizes the students with applications, assumptions, and limitations of the quantitative methods in modeling. It focuses on the development of mathematical and spreadsheet models, the verification of those models, sensitivity analysis of the solutions generated from a model, and the implementation of those solutions. Some of the topics covered include linear programming, non-linear and integer programming, simulation, and forecasting. The process of modeling and particular modeling tools are applied to business problems in finance, acquisition, logistics and manpower planning. This course is the Distance Learning version of GB4043. Prerequisites: None.

MN4053 Defense Budget and Financial Management Policy (4-0) Winter/Summer

This distance learning course analyzes the resource requirements process within the Department of Defense (DoD) and in the executive and legislative branches of the federal government. It begins with a summary of the current threat situation and potential changes to it. Once the threat is defined, the study of the resource allocation process to meet the threat begins. The course covers the resource planning and budgeting processes of the Department of the Navy, DoD and the federal government. It includes the politics of executive and congressional budgeting, and DoD budget and financial management processes and procedures including budget formulation and execution. It also includes analysis of the Planning, Programming, Budgeting Execution System (PPBES) used by

DoD to plan, budget and implement national defense resource management policy and programs. Other areas included are budget process and fiscal policy reform and the dynamics of internal DoD competition for resources. Executive and congressional budget processes are assessed to indicate how national security policy is resourced and implemented through the budget process. Spending for national security policy is tracked from budget submission through resolution, authorization and appropriation. Budget formulation, negotiation, and execution strategies are evaluated to indicate the dynamics of executive-legislative competition over resource allocation priorities. Supplemental appropriation patterns and current year budget execution patterns and problems are also considered. Prerequisite: None.

MN4090 Joint Applied Project I (2-0) Fall/Winter/Spring/Summer
Course reflects laboratory hours dedicated to presenting research techniques and independent/team efforts needed to conduct Joint Applied Project research and analysis and to produce the Professional Report. These laboratory hours will be used by students and student teams for interactions with their Joint Applied Project advisors, Academic Associate(s), editors, and thesis processors in producing high quality, disciplined research products for publication as appropriate. Prerequisite: None.

MN4091 Joint Applied Project II (2-0) Fall/Winter/Spring/Summer
Intended to help students attack unstructured managerial problems. Student teams must determine the organizational objective and identify what the underlying issues are; and determine the most appropriate tools from the curriculum to apply in order to provide insight into these issues; and recommend appropriate courses of action. Graded course. Prerequisite: None.

MN4104 Strategic Management Issues In Military Organizations (3-0) As Required
Examination of strategic management from the perspective of leadership in military education and training organizations. This course explores strategic planning, policy formulation, and organizational adaptation with a dual emphasis on understanding the concepts as well as acquiring the ability to isolate and communicate concepts relevant to developing subordinates. Prerequisites: consent of instructor.

MN4105 Strategic Management (3-0) As Required
Strategic Management entails the establishment of an organization's direction and the implementation and evaluation of that direction given the organization's external environment and its internal capabilities. The principal aim of this course is the transfer and adaptation of the principles of business strategic management to the Department of Defense and other federal agencies. In previous courses, students concentrate on the functional elements of management (e.g., accounting, finance, acquisition, logistics, contracting, etc.). This course addresses the challenges of setting direction and implementing strategies for the total system or whole organization. Cases and approaches from the public and private sectors enable students to develop the knowledge, skills, and abilities to strategically think, plan, and manage. Prerequisites: MN3012.

MN4106 Manpower / Personnel Policy Analysis (4-0) Summer
Study and analysis of military manpower / personnel policy alternatives with emphasis on identifying the trade-offs involved, the dynamic impact of major policy decisions and the short-term and long-term consequences of decisions. Review, use and evaluation of tools to aid in selecting policy alternatives. Analysis of issues in the DoD and military services. Prerequisites: MN3760, MN4111.

MN4107 Systems Thinking and Modeling for a Complex World (4-0) Fall/Winter/Spring/Summer
This course introduces you to System Dynamics modeling for the analysis of organizational policy and strategy. You will learn to visualize an organization in terms of the structures and policies that create dynamics and regulate performance. The goal is to use the analysis and modeling techniques of System Dynamics to improve understanding of how complex organizational structures drive organizational performance, and then to use that understanding to design high leverage interventions to achieve organizational goals. We use role-playing games and computer-based simulations called "microworlds," where space and time can be compressed, slowed, and stopped so we can experience the long-term side effects of decisions, systematically explore new strategies, and develop our understanding of complex systems (analogous to the "flight simulators" that pilots use to learn about the dynamics of flying an aircraft). The course presents system dynamics with a minimum of mathematical formalism. The goal is to develop the students' intuition and conceptual understanding, without sacrificing the rigor of the scientific method. (No prior computer modeling experience is needed.) Prerequisite: None.

MN4110 Multivariate Manpower Data Analysis I (4-1) Winter
An introduction to multivariate data analysis. This section will focus on the tools necessary to perform data analysis. The primary goal of this course is to introduce multiple linear regression models. The second goal involves making correct inferences and interpretations of the findings. Special topics include hypothesis testing, model specification issues, multicollinearity, dummy variables, and research methodology. Prerequisite: GB3040 or consent of instructor.

MN4111 Multivariate Manpower Data Analysis II (4-1) Spring
An introduction to the specialized multivariate techniques used for analysis of military manpower data. Topics include advanced linear estimation techniques, such as panel data analysis and two-stage models. In addition, nonlinear methods are introduced, such as binary choice models and survival analysis. The course also covers special techniques for policy evaluation and reduction of estimation bias due to omitted variables or sample selection. Students apply techniques to manpower databases. Prerequisite: MN4110, or consent of instructor.

MN4114 Sociological and Psychological Perspectives on Military Service (4-0) Winter
Exploration of the concepts, theories, and methods of military sociology and military psychology as applied historically and in the current setting. Study of the military as a social institution, focusing on the internal organization and practices of the armed forces as well as the relationship between the military and society. Review and evaluation of the psychological principles employed in a variety of military areas such as health care, selection and job classification, human factors, organizational systems, personnel security, and performance appraisal. Emphasis on representative cases in DoD and the armed forces. Prerequisite: GB3010.

MN4115 Foundations of Education and Learning in DoD Organizations (4-0) Fall

Analysis of issues in DoD education, learning and training (ELT). Major course themes focus on understanding adult military ELT from a strategic systems perspective; analyzing instructional program design, implementation, and technologies and applying methods of needs analysis and program evaluation. Examination of how DoD can become a learning organization to respond to the dynamic demands of both the organization and its military members. Guest speakers, military publications, student cases, and discussion based on the experience of the instructor and the students are utilized to maintain the necessary focus on current military applications. Prerequisite: GB3010.

MN4116 Society of Human Resource Management (0-3) Fall/Spring

This course prepares students for taking the Human Resource Certification Institute (HRCI) certification examination. Prerequisite: Enrollment in the MSA curriculum and consent of instructor.

MN4118 Modeling for Decision Support in Manpower Systems (3-2) Fall/Spring

An introduction to applied manpower models and modeling techniques. Students will gain insight into how models are used by policy makers in the decision process and into the complexity of the military manpower system. Several models that are currently used by the Bureau of Naval Personnel and Headquarters USMC will be analyzed, including accession planning, sea-shore rotation policy, promotion planning and inventory projection models. Other topics covered include the manpower planning process, types of models, model evaluation and good modeling practices. Prerequisites: GB3040, GB4043, OS4701 (may be taken concurrently).

MN4119 Navy Manpower Requirements Process (3-0) Summer

An in-depth analysis of fleet and shore unit Manpower requirements and personnel documents. The course will cover the determination and validation of fleet requirements as they pertain to an operational unit's Required Operational Capabilities and Projected Operational Environment and the resulting Ship Manpower Document (SMD), Squadron Manpower Document (SQMD), and Fleet Manpower Document (FMD); and how the Shore Manpower Requirements Determination Process (SMRDP) links the Mission, Function and Task statement to the resulting Statement of Manpower Requirements (SMR). The course covers how fleet and shore manpower documents link with the Activity Manpower Document (AMD). The Personnel sub-process will be studied as it relates to the Enlisted Distribution and Verification Report (EDVR) in support of fleet readiness. Prerequisites: Enrollment in the MSA curriculum and consent of instructor.

MN4123 Organizing and Planning In Complex Networks (4-0) Summer

In 21st century operational and policy settings, people are expected to work in networks to get things done. Operating beyond the boundaries of any one organization in an inter-organizational domain, network members are called upon to join forces and work collaboratively with others. Network collaborations are difficult, however, because they challenge traditional management assumptions. Members must coordinate without hierarchy, lead without formal authority, and solve problems and make decisions without someone being "in control:" or "in charge." This course provides the basic knowledge, skills, and abilities to enable students to work collectively in networks, especially those with members who come from different cultural, ethnic and national organizations. With the use of cases, experiential exercises, and simulations, students learn how to craft and execute collaborative strategies to improve network performance. Prerequisite: Consent of instructor.

MN4125 Managing Planned Change in Complex Organizations (4-0) Spring

Examination of the approaches to planning and managing change efforts in complex social systems made up of the interdependent components of technology, structure, task, and people; and of the role of the manager or staff specialist; and the process of helping. Emphasis is placed on strategies and technologies for diagnosis and planning aimed at effective implementation. Course provides opportunities for practice using both simulations and actual organizational cases. Particular emphasis is placed on the DoD/DoN organizations and the special problems they have in bringing about change.

MN4130 Marine Manpower Management (3-0) Summer

Upon completion of this course, the student will have an in-depth understanding of USMC Manpower Management and implementation of management policy techniques through analysis, procedures, organizational and administrative actions to better staff Headquarters Marine Corp management policy issues. USMC officers will gain insight into management actions that support budget requirement requests and the resource allocation efforts subsequent to budget approval. Each officer will develop an understanding of the relationship between the Table of Organization (T/O), Troop List (TL) and the Authorized Strength Report (ASR). Each officer will complete an UNS report. Graded (3-0). Prerequisite: MN2111 or consent of instructor.

MN4145 Policy Analysis (4-0) Fall/Spring

Develops the tools and techniques of economic efficiency to assist public sector decision makers in analyzing resource allocation in government activities. Focuses on developing the principles of cost-benefit analysis (CBA) and cost-effectiveness analysis (CEA). Stresses the application of CBA and CEA to specific investment projects, programs, and policies in the federal government, especially in the Department of Defense. Prerequisites: MN3161 and OS3101 or equivalent.

MN4157 Seminar in Management Accounting I (3-0) Fall/Spring

This course complements the financial management program by covering significant topics not otherwise included in the program to prepare students to obtain the Certified Management Accountant (CMA) and/or Certified in Financial Management (CFM) designation. This course covers topics in business analysis, corporate financial management, management accounting and reporting, and strategic management. This course reviews, in more depth, topics covered in the introductory financial and cost management course. Specific topics addressed in the course may vary. Prerequisite: GB3050 and GB3051.

MN4304 Defense Systems Contracting (2-0) Winter/Summer

This course is the study of the DoD's major systems contracting policies, processes, procedures, and practices. A review of major systems acquisition and program management is provided but the primary focus is on the contracting process used to acquire defense

systems for the various services. The topics covered include: acquisition environment, acquisition strategy, source selection, incentive contracting, alpha contracting, multi-year procurement, and requirement/capability specifications. Prerequisites: MN3331 or MN3222.

MN4307 Program Management Policy and Control (4-0) Fall/Winter/Spring/Summer

This course provides the student with knowledge and understanding of major systems management control processes and tools, application of program management control systems and the use of computer-based management information systems with strategic media choices so as to develop effective media campaigns, interact effectively with the print and broadcast news media, and handle press conferences and similar media events. Particular attention is focused on anticipating and handling crisis communication. Specifically, students will learn to organize crisis management teams, develop crisis management plans, and create communication plans to manage information and public perception. Case studies involving program management problem solving and decision making in the acquisition environment are used. Prerequisite: MN3331 or MN3392, MN3303, MN3155 (or GB4053 or MN3364), MN4470 (or GB4450 or MN3365), MN3384 (or MN3363), MN3309 (or MN3361), and MN4602 (or MN3362).

MN4308 Field Contract Management (2-0) As Required

Examines procurement at the installation and center level. Emphasis is on (1) simplified acquisition procedures, (2) contracts for other than major systems, (3) services contracting, and (4) contracting for information technology resources. Prerequisite: MN4473 or consent of instructor.

MN4310 Logistics Engineering (4-0) Fall/Spring

The concept of integrated logistics support in the design and maintenance of weapon systems. Operational requirements, system maintenance concept, functional analysis, life cycle costs, logistics support analysis, systems design, test and evaluation, production, spare/repair parts management are discussed. This course also covers topics in logistics information technology, inventory management culture and commercial-sector best practices for military. Case studies include logistics life cycle cost, reliability and readiness analysis for major weapon systems Prerequisite: GB4043, OS3006, (both may be taken concurrently).

MN4311 Contracting for Services (3-0) Fall/Spring

This course studies the DoD's major services contracting policies, processes, procedures, and practices. Detailed and critical examination of current policies, issues, and practices in services contracting, to include performance based services contracting (PBSC), is accomplished through extensive case, policy, and report analysis requiring synthesis of concepts, processes and best practices. A review of major services acquisition and program management is provided but the primary focus is on the contracting process used to acquire major services for the DoD. Topics include: information technology services, base operating support services, environmental services, construction services, and contractor logistics support. Prerequisites: MN3331 and MN3303 or by permission of the instructor.

MN4366 Program Management and Leadership (4-0) Summer

This course provides the student with knowledge and understanding of major systems management control processes and tools, application of program management control systems and the use of computer-based management information systems with strategic media choices so as to develop effective media campaigns, interact effectively with the print and broadcast news media, and handle press conferences and similar media events. Particular attention is focused on anticipating and handling crisis communication. Specifically, students will learn to organize crisis management teams, develop crisis management plans, and create communication plans to manage information and public perception. Case studies involving program management problem solving and decision making in the acquisition environment are used. Prerequisites: MN3331 or MN3109/MN3392, MN3303 (or MN3371), MN3155 (or GB4053 or MN3364), MN4470 (or GB4450 or MN3365), MN3384 (or MN3363), MN3309 (or MN3361), and MN4602 (or MN3362).

MN4371 Acquisition and Contracting Policy (4-0) Fall/Spring

This course uses case studies and current acquisition issues to analyze government and business acquisition/contracting policies. Emphasis is on acquisition decision making and policy formulation/execution. Prerequisites: MN3304, MN3320 and MN3312 (or equivalent)

MN4374 Seminar In Acquisition Management: Strategic Purchasing (3-0) Fall/Spring

This course is a graduate-level seminar in strategic purchasing. The primary purpose and objective of MN4374 is to provide the student with an opportunity to review and analyze the concepts and disciplines of strategic purchasing, to demonstrate critical analysis and thinking skills in applying strategic purchasing management and execution to make DoD and other agencies "world-class" buying organizations. A second purpose is to investigate the specific topics, concepts and theories that are projected to be of high interest to DoD acquisition activities of the future. The course is divided into three components. The MN4374 course includes 15 blocks of instruction, focusing on those areas of the world-recognized Institute for Supply Management as world-class business practices for progressive purchasing. Specific cases and in-class "exams" are designed to reinforce class readings and discussions. The course is designed to capitalize on the foundations provided by MN3303, MN3306, and MN3307. Critical thinking and analytical skills are developed in designing and executing the most efficient and effective purchasing organizations and associated business processes. Prerequisite: None

MN4379 Operations Management (4-0) Winter

This course introduces students to problems and analysis related to the design, planning, control, and improvement of manufacturing and service operations. It will extensively utilize case studies and analytical problem sets. Topics include operations strategy, process analysis, project analysis, materials management, production planning and scheduling, quality management, computer-aided manufacturing, capacity and facilities planning, and theory of constraints applied to product development. The course will equip students with the basic tools and techniques used in analyzing operations, as well as the strategic context for making operational decisions. Prerequisites: MN3108, MN3117, and OS3211, or consent of instructor.

MN4414 LSI - Leadership in System Integration (4-0) Summer

Same as SE4414. Most major DoD acquisition activities are not the development of new systems but the improvement and

integration of existing legacy systems. Furthermore, this acquisition activity is made exceptionally complex because the systems need to be integrated with a "Systems-of-Systems" (SoS) approach. SoS acquisition, development, and integration require skills in system integration that exceed those required with standalone system acquisition. These skills are embodied in the role of the "Lead System Integrator" (LSI), previously a contractor, but increasingly a DoD employee. In this course we examine the roles of the LSI, where DoD acquisition skills may need to be strengthened to perform as the LSI, and discuss methods and tools to do so. This course is a capstone to MN3411, MN3412, and MN3413.

MN4450 Logistics Strategy (3-0) As Required
DAU Equiv: LOG 304. This is the logistics capstone course. The course explores and analyzes the concepts, processes and methods of strategic planning and execution, emphasizing aggressive proactive techniques to ensure maximum logistics influence on major weapon systems acquisition as well as optimum life cycle management of fielded systems. Cultural constraints of the current logistics environment and how to succeed in it is a significant focus of the course. The course examines and analyzes key opportunities for maximum logistics influence in requirements, development, contracting, test and evaluation, reliability, and maintainability as well as financial management and communications. The course features logistics management relevance to service roles and missions. It employs lectures, guided discussions, case studies, role-playing, panel discussions, and lessons learned in the DoD acquisition environment. For the final examination project, the class is divided into teams and produces a comprehensive strategic plan for logistics for a fictitious major program. This course is the Distance Learning version of GB4450. Prerequisite: MN4410.

MN4470 Strategic Planning and Policy for The Logistic Manager (4-0) Winter/Summer
The course explores and analyzes the concepts, processes and methods of strategic logistics planning and execution, emphasizing proactive techniques to ensure maximum logistics influence on major weapon systems acquisition as well as optimum life cycle management of fielded systems. The course will examine and analyze key opportunities for maximum logistics influence in requirements development, contracting, test and evaluation, reliability and maintainability, as well as financial management and communications. The course will feature logistics management relevance to service roles and missions. The course will employ lectures, guided discussions, case studies, role-playing, panel discussions and lessons learned in the DoD acquisition environment. Upon successful completion of the course, the student will be awarded a DAWIA (Defense Acquisition Workforce Improvement Act) Level III certificate for Acquisition Logistics. Prerequisite: GB4410 or consent of instructor.

MN4473 Strategic Acquisition and Contract Management (4-1) As Required
Tailored toward the students in the class, the course examines the unique contracting issues/problems encountered in a variety of organizational situations. Analysis, discussion and potential resolution of actual working problems are undertaken. A comprehensive written case study is the capstone effort in the course for each student. Students will be grouped into teams simulating integrated product team (IPT) organization to address various issues germane to the students' organizations. Prerequisite: MN3342.

MN4474 Organizational Analysis (2-0) As Required
This course concentrates on analysis of acquisition organizations from an open systems perspective. Focus is on tools and techniques for diagnosing managerial problems by analyzing structure, task requirements, technology, culture, and various organizational subsystems. The course emphasizes application in that students complete a course project requiring integrated application of the systems model in an analysis of their own acquisition organization. Prerequisite: none.

MN4602 Test and Evaluation Management (2-2) Fall/Winter/Spring/Summer
Designed to cover Developmental, Operational and Joint Test and Evaluation, including planning concepts and procedures frequently used in test and evaluation programs. Taught from the perspective of the Program Manager, Test Project Officer and Test Engineer. Actual military cases are used for examples. Topics include the role of Test and Evaluation in Systems Engineering and Acquisition Management, DT and OT test planning, introduction to test design, conduct of tests, live fire testing, modeling and simulation, human systems integration (HIS), reporting of test results, range and resource issues, and lessons learned. Student teams will write a detailed test plan. Prerequisite: MN3302.

MN4760 Manpower Economics I (4-0) Spring
An introduction to the theoretical aspects of labor economics. Concepts covered include the supply of labor, the demand for labor, wage determination, internal labor markets, human capital, earnings functions, turnover, compensation systems, and compensating wage differentials. Special readings are used that apply the principles to military manpower. Prerequisite: None.

MN4761 Applied Manpower Analysis (4-0) Summer
Application of theoretical models and quantitative techniques to Navy and DoD manpower, personnel, and training issues. Topics include application of cost-benefit and cost-effectiveness analysis techniques to manpower policies, manpower supply models, attrition and reenlistment models, force structure analysis, manpower productivity, and compensation systems. Course uses specialized readings in DoD and Navy manpower. Prerequisites: MN3760 and MN4111.

MN4790 Managing Diversity (4-0) Spring
This is an experiential course developing awareness, understanding, and leadership action for managing diversity and inclusion in the uniform and civilian military. The course explores social constructs of gender, race, class, and culture; builds personal, leadership, and organizational skills for addressing diversity and inclusion issues; and develops the competency of leaders to respond effectively to the opportunities and the challenges posed by the increasing presence of diversity in the military. The objective of managing inclusion is to maximize the organization's performance through understanding, valuing, and leveraging diversity both in the workplace and in the customer base. Managing diversity competency is developed through personal and organizational introspection and change. Graded on a Pass/Fail basis only. Prerequisite: None.

MN4900 Readings in Management (V-0) Fall/Winter/Spring/Summer
An individualized program of advanced readings and study in some area of Systems Management. Prerequisites: A background of advanced work in the area of study and departmental approval. Graded on a Pass/Fail basis only.

**MN4970 Seminar in Systems Management (V-0)
Fall/Winter/Spring/Summer**
Study of a variety of topics of general interest in the systems management, to be determined by the instructor. Prerequisites: A background in systems management and consent of instructor.

MN4999 Elective (4-0) As Required
Course elective.

PD Courses

PD0810 Thesis Research (0-8) Fall/Winter/Spring/Summer
Thesis research for PD21 students.

Global Public Policy Academic Group

Chairman (Interim)

Robert McNab
Associate Professor
Halligan Hall Room 233

831-656-3132
DSN 756-2306
rmmcnab@nps.edu

Associate Chair

Frank Barrett
Professor
Ingersoll Hall Room 240

831-656-2328
DSN 756-2328
fbarrett@nps.edu

Dr. Margalynne Armstrong, Visiting Associate Professor (Santa Clara Law).

Mie Augier, Associate Professor, Ph.D., Copenhagen Business School, 2001.

Frank J. Barrett, Professor, Ph.D., Case Western, 1990.

Walter Christman, Associate Professor, Ph.D., University of Geneva, 2007.

Karen Guttieri, Assistant Professor, Ph.D., University of British Columbia, 1999.

Robert Looney, Professor, Ph.D., University of California, Davis.

George Lucas, Professor, Ph.D., Northwestern University, 1978.

Robert M. McNab, Associate Professor, Ph.D., Georgia State University, 2001.

Paula Philbin, Senior Lecturer.

Maria Pineda, Visiting Professor (UCLA).

Anke Richter, Academic Associate, Ph.D., Stanford University, 1996.

Marc Ventresca, Associate Professor.

Brief Overview

The Global Public Policy Academic Group was established by the Naval Postgraduate School (NPS), 1 January 2009, as an inter-disciplinary group to study the national security implications of globalization. The group conducts research and develops research-led educational programs. By broadening the understanding of the forces of globalization and their potential impact on U.S. national security policy, NPS endeavors to not only inform, but to also shape, national policy. On 1 October 2012, GPPAG moved to become an academic group within the Graduate School of Business and Public Policy.

A core competency of NPS is the linking of traditional disciplines to national security and defense applications. NPS faculty provide a wide-range of relevant expertise on leadership, program management, economic development, strategy and planning, cross-cultural communications, conflict resolution, metrics, organizational learning and other relevant subjects. A core mission of the Naval Postgraduate School is to prepare security practitioners for the emerging security environment.

Program Development

In support of the National Security Strategy of the United States, the National Defense Strategy, the National Strategy for Homeland Defense, and the Navy's Maritime Strategy, the GPPAG develops a broad-based, interdisciplinary research program to investigate the interaction of globalization and national security. GPPAG faculty conduct research on global governance and development, new security economics, rule of law, and fiscal decentralization. These research efforts directly influence the development of graduate curricula in GPPAG in support of the Department of Defense. The GPPAG continues to deliver graduate certificates on Security, Stability, and Development in Complex Operations and the Rule of Law, with the objective of providing non-traditional students a path towards a Masters in Global Public Policy.

Certificate in Stability, Security and Development in Complex Operations - Curriculum 210

Program Director
Karen Guttieri, Ph.D.
Quarters E Building 279

guttieri@nps.edu

Brief Overview

The purpose of the program is to provide a professional education program to the civil affairs community focusing on the relevant, requisite skills identified by the Department of Defense, as necessary for implementing Irregular Warfare, on a global scale. NPS faculty have studied post-9/11 shifts in operational environments and adaptations in the various CA doctrines, force structure, training and deployments. This program develops a conceptual framework for analyzing key civil affairs and psychological operations and provides graduate level education to participants in order to enhance their effectiveness as they plan and execute complex operations. The program aims to capture civil affairs and psychological operations operational and tactical innovations, and resulting lessons.

Requirements for Entry

A baccalaureate degree with above-average grades is desired. An academic profile code of 365 is required.

Program Length

Fall SSDCO
DL: 15 Oct–24 Nov
IR: 27 Nov–21 Dec

Winter SSDCO
DL: 14 Jan–23 Feb
IR: 25 Feb–22 Mar

Spring ROL
DL: 1 Apr–11 May
IR: 13 May–31 May

Summer SSDCO
DL: 24 Jun–3 Aug
IR: 5 Aug–30 Aug

Graduate Certificate Requirements

Requirements for the Certificate in Stability, Security, and Development in Complex Operations are met by successful completion of all three courses.

Program Phases

The Security, Stability and Development in Complex Operations (SSDCO) Certificate Program consists of three courses delivered in hybrid residence status.

Phase one of the certificate involves distance learning over a three to four week period.

Phase two entail four weeks of intensive in-residence coursework.

Phase three of the certificate includes three to four weeks of distance learning to complete required coursework for course grade (as opposed to a pass/fail).

The program content and projects challenges the student academically and addresses problems of interest to the DoD with specific emphasis on the challenges of civil-military relations and human dynamics.

Required Courses

GP3100 (4-0) Global Change and International Governance
GP3200 (4-0) Security and Development
GP3300 (4-0) Introduction to Analytic Methods

Certificate in Civil Military Operations and the Rule of Law (Res & DL) - Curriculum 215

Program Director

Karen Guttieri, Ph.D.
Quarters E Building 279
guttieri@nps.edu

Brief Overview

Well-functioning justice institutions and government bound by the rule of law are vital to security and development. America's interest in the rule of law abroad is expressed in the 2010 US National Security Strategy, calling for the US to "improve its capability to strengthen the security of states at risk of conflict and violence," including internal, external, and regional security, "respect for human rights and the rule of law" and "administrative and oversight capability of civilian security sector institutions, and the effectiveness of criminal justice." The 2010 Quadrennial Defense Review calls Civil Affairs "the vanguard" of Defense Department support to US government agency assistance to partner nations in the rule of law.

The goal of this certificate program is to provide Civil Affairs, Psychological Operations, and related rule of law practitioners with the knowledge and skills needed in order to provide effective support to rule of law missions in a variety of operational environments, from conflict prevention to post-conflict stabilization. The three courses comprising the program are integrated in order to educate students on the rule of law at all levels, including international conventions, national and regional rule of law systems, and local governance and traditional rule of law mechanisms.

Civil Military Operations and the Rule of Law is a graduate certificate that complements the NPS program Stability, Security and Development in Complex Operations (SSDCO). These hybrid distributed/in-

residence program are particularly tailored to the needs of Reserve personnel.

Requirements for Entry

Applicants for the CMO and Rule of Law program must have an earned bachelor's degree from a regionally accredited academic institution, and in the absence of a waiver, the NPS certificate in Stability, Security and Development in Complex Operations (SSDCO). While GPPAG will accept applications from virtually all undergraduate major fields, admissions decisions will primarily be based on adequate performance in social science and humanities classes. The program is sponsored by the United States Army Civil Affairs and Psychological Operations Command. We welcome related rule of law practitioners on a space-available basis.

Program Length

One Quarter

Graduate Certificate Requirements

Requirements for the Certificate in Civil Military Operations and the Rule of Law are met by successful completion of all three courses.

Program Phases

Distributed learning: Ap. 1 - May 11

In-residence: May 13-31

Required Courses

GP3110	(4-0)	Legitimacy, Law and Society
GP3210	(4-0)	Comparative Legal Systems
GP3310	(4-0)	Public Order and Accountability

Note: Courses are taken concurrently.

GP3100 Global Change and International Governance (4-0) Winter/Summer

This course addresses principles that drive globalization and how and where the military and civilians address the civil dimension in pre-conflict, conflict, and post-conflict environments. Theories of regional economic development, location and trade are applied to the contemporary process known as "globalization" and used to decipher its effects on regional and national patterns of development, employment, income distribution, political institutions, and policymaking. Specific topics of discussion are: globalization and the production of risks, climate and environmental change, division of labor, power and governance, regional and international development, risks as drivers of change, financial and information flows, and capitalism and globalization.

GP3110 Legitimacy, Law, and Society (4-0) Fall/Winter/Spring/Summer

This course investigates the role of legitimacy in governance systems, including the rules, norms and social processes that shape and legitimate political order. We address the legality of war (jus ad bellum) in so far as it affects the legitimacy of political orders that follow it. The focus in this course is upon the rules that apply in the midst of war or occupation (jus in bello)and the processes of transition through interim to more durable regimes after conflict. We will consider the institutional and social context for governance, including the role of social movements and media in the development of legitimate political order under rule of law. The class will draw upon case studies of real-world scenarios. The discussion of legal issues in this course is part of a broader conversation on reconciliation and the rule of law. Significant actors in this space include the United Nations and other international regimes, civil society, national-level public officials, and the military. Students will learn about legal definitions, frameworks, and international assistance efforts. Prerequisites: none.

GP3200 Security and Development (4-0) Winter/Summer

Complex security challenges including state failure, transnational terrorism, energy crisis and pandemics compel us to think about prevention and stability operations in new ways. The course seeks to develop analytic skills and empirical knowledge needed to assess requirements and capacities for stability, security and development, and to develop strategies for peace building. Students will gain expertise relevant to preventive engagement and counterinsurgency, and especially to civil-military operations such as humanitarian relief, peace and stability operations abroad and homeland security efforts at home. Specific areas of concentration are: stability in the global context, theories and strategies, implementation challenges, and practical applications.

GP3210 Comparative Legal Systems (4-0) Fall/Winter/Spring/Summer

Comparative law is the study of alternative legal systems. In the context of Civil Military Operations knowledge of the legal traditions of the host country is necessary to the process of helping to reestablish or support a culture of lawfulness. An understanding of host country legal traditions and resources contributes to the cultural competence of successful graduates and an ability to support rule of law systems that are perceived as fair and acceptable to the host country population. Today, the issues of how systems and institutions interact with legitimacy and perceptions are critical for Civil Affairs policy and work in the field. The Rule of Law certificate underscores this with the substantive contents in the two other courses. The Comparative Legal Systems course engages your knowledge and learning from those courses through the focused look at legal traditions on the books and in practice in different countries. To reinforce the link between theory and application, this course also introduces principles and precepts of dispute resolution and organizational design, to provide context for the analysis of comparative legal systems and recognition of challenges and opportunities Civil Affairs practitioners will face. This further content addresses the cultural competence of graduates and leverages their prior knowledge of organizational and institutional design – emphasizing the importance of institutional and well as individual 'capacity' to work within different legal system contexts.

GP3300 Introduction to Analytic Methods (4-0) Winter/Summer

GP3300 focuses on the use of analytical decision making techniques in the support of stability operations. The first part of the course focuses on the framework for analytical decision-making and accurate costing of projects. The second part of the course discusses multi-objective decision-making. In the final part of the course, we will discuss risk and the economics of stability operations.

GP3310 Public Order and Accountability (4-0)
Fall/Winter/Spring/Summer
This course surveys the role of and need for legal institutions to provide the physical security necessary for reconstructing society as well as rebuilding/creating state legitimacy. The concept of justice is central to this process, as is creating a robust and fair justice sector. Most practitioners have come to realize that it is impossible to address the problems arising from conflict without addressing the interrelationships between security, development and politics. We examine these with an eye to the practical applications for the Civil Affairs community. We will discuss the challenge of operationalizing legal concepts and norms, and introducing Rule of Law into countries that have no prior concept of the role of legal and security institutions as protectors of and servants to the people, and courts as neutral arbitrators of the law. The class will tackle the subjects of torture, truth and reconciliations structures, the Geneva Protocols, and war crimes, as well as the role of civilian policing in conflict zones. We will also tackle the issue of privatizing roles and functions in conflict areas, and the problems of corruption and organized crime. The class will draw upon case studies of real-world scenarios from Nuremberg, Abu Gharaf, Guantanamo, and South Africa. We will discuss the key actors involved in the Rule of law process: NGOs, the United Nations, the State Department, NATO, and regional organizations.

GP4800 Directed Studies in Global Public Policy (V-V)
Fall/Winter/Spring/Summer
Format and content vary. Normally involves extensive assigned readings, individual discussions with the instructor, papers and/or examinations. Prerequisite: consent of instructor.

Defense Resources Management Institute (DRMI)

Website
www.nps.edu/drmi

Executive Director

Francois Melese, Ph.D.
Code DRMI, Halligan Hall, Room M4

(831) 229-3179
FAX (831) 656-2139
fmelese@nps.edu

Overview

DRMI conducts professional education programs in analytical decision making and resources management for military officers of all services, and senior civilian officials of the United States and over 165 other countries. Established in 1965 by the Secretary of Defense as an educational institution, DRMI is located at the Naval Postgraduate School in Monterey, California.

Our Approach

DRMI faculty conduct programs that develop an understanding and appreciation of the concepts, techniques, and analytical decision making skills related to defense resources management. We draw upon evidence-based research and practice from the fields of management, economics and decision analysis. Our goal is to enhance the effective allocation and use of resources in defense organizations

The mission, objectives and responsibilities of DRMI are set forth in Department of Defense Directive 5010.35.

Programs Offered

Defense Resources Management Course - Four weeks in length; presented five times a year.

International Defense Management Course - Eleven weeks in length; presented twice a year.

Senior International Defense Management Course - Four weeks in length; presented once each year; normally starting the last week of June.

Multiple-Criteria Decision Making Course – Two weeks in length; presented as scheduled.

Budget Preparation, Execution and Accountability Course - Eight days in length; presented as scheduled.

Performance Management and Budgeting- Five days in length; presented as scheduled.

Risk Management - Two weeks in length; presented as scheduled.

Human Capital Resources Management Course - Two weeks in length; presented as scheduled.

Business Case Analysis - One week in length; presented as scheduled.

Mobile Education Courses - Normally one to two weeks in length, for U.S. military services and defense agencies, and for foreign governments upon specific request and approval.

Courses for Other Agencies - Programs are from one to two weeks duration, resident or on-site, for non-defense federal governments upon specific request and approval.

DRMI Curricula

DRMI faculty prepare integrated curricula from many disciplines including management, economics and decision analysis. Each course requires course participants to understand and use the basic language and analytic tools that support some aspect of defense resources management.

All courses are E-IMET certified.

Course Descriptions

In-Resident Courses

Defense Resources Management Course (DRMC)

Participants: U.S. and international military officers and civilians.

(U.S.): Military officers from all services (grades O-3 and above); DoD civilians GS-9 and above.

(International): Equivalent military and civilians as above. English language capability required.

This course is presented in English.

Integrates analytical concepts, principles, methods, and techniques drawn from the disciplines of management, economics, and quantitative methods, and applies them to decisions involving the allocation of financial, logistic and human resources. A variety of analytical frameworks are presented that will enhance the participants' competence at recognizing and evaluating the risk assessments and tradeoffs that must be made among competing alternatives at both the strategic and operational levels of defense organizations.

DRMI faculty teach this course using a mix of lectures, small group discussions and real world case studies. This approach provides a dynamic learning environment designed to develop the analytical decision making skills necessary in today's challenging environment. Contemporary issues such as the global war on terror, regional and international instability, infrastructure protection and multinational defense cooperation are used to illustrate the environment in which current defense resource allocation decisions must be made.

CPE: 116 points. Graduate Education Credit: 4 units (requires passing a test at the end of weeks 2 and 4)

International Defense Management Course (IDMC)

Participants: International students only. Military grades of O-3 and above and defense-related civilians of equivalent rank.

This course is presented in English.

The course provides a series of lectures in three major areas: the defense management environment, quantitative and economic analysis, and management systems in the context of strategy, implementation, and operations. A major curricular concept of this course is comparative resources management, i.e. the examination of how different countries allocate resources. In order to enhance the comparative aspects of the curriculum, DRMI leadership encourages broad national representation with a diversity of both military services/agencies and civilian government officials. In addition to the small-group discussions that are a key part of the learning environment, each country's participants are required to give a presentation on national security issues faced by their country. These presentations allow for class-wide discussion of key security issues around the world.

During the course, DRMI conducts a field trip to selected military and government agencies in the Washington D.C. area. This trip provides an opportunity for the participants to receive special briefings on management techniques and

problems, and to observe actual practices at the operating level.

Senior International Defense Management Course (SIDMC)

Participants: Senior international students only. Enrollment is restricted to military flag and general officers (grades O-7 and above) and defense-related civilians of equivalent rank, except for countries where the O-6 grade is comparable to flag/general rank, in which case officials may be enrolled on a waiver basis.

Participation in this course is normally 50-54 senior officials from as many as 45 countries.

This course is presented in English.

The lecture, small discussion group, case study, and problem format and content described above for the International Defense Management Course also apply, but are compressed in time. Two or three senior U.S. guest speakers are invited to address the class and a short field trip is conducted.

Multiple Criteria Decision Making Course (MCDM)

Participants:

U.S. and international military officers and civilians.

Military grades of O-3 and above and defense-related civilians of equivalent rank.

This course is presented in English.

This course develops a method of approach to support decision making by managers in defense organizations. The focus is on practical application to management decisions involving many organizational objectives. Emphasis is placed on formulating the problem, understanding the analytical process involved in evaluating potential solution alternatives, and interpreting the results of the analysis in support of choosing a solution. We will provide practical examples from defense resource allocation problems. Each participant will be required to apply the multi-criteria decision approach taught during this course to a decision problem of current interest to their own MoD. The problem can be one that is already being analyzed, or a new problem. Participants will have the opportunity to work in depth on this problem with a faculty member during the course. A final presentation will be delivered on the last day of the course. This exercise will link the theoretical environment with the real world through a practical and relevant application of course concepts. It is also hoped that this will serve as a foundation for further work on this problem once the participants return to their own organizations

Budget Preparation, Execution and Accountability Course

Participants:

U.S. and international military officers and civilians.

Military grades of O-3 and above, and defense-related civilians of equivalent rank.

This course is presented in English.

This course examines the preparation, execution and accountability of defense budgets. We provide the foundation for preparing and executing the budget by discussing the overall budget process beginning with planning and programming. Planning and programming are the stages where policy formulation and allocation of resources support national priorities, goals and objectives. This course reviews these concepts, and then illustrates how to take the programming decisions from the Ministry of Defense (MOD) through the budget cycle. We begin with a section on budget preparation using MOD programming guidance, integrating programs with budget guidance to create a budget. We then provide information, tools and techniques, and exercises on estimating budget submissions, funds control, performance management and feedback, all components of preparing, executing, and providing accountability for defense budgets.

Risk Management

Participants:

U.S. and international military officers and civilians.

Military grades of O-3 and above, and defense-related civilians of equivalent rank.

This course is presented in English.

This course focuses on the question of risk and how to incorporate risk analysis into public sector policymaking. The course examines the question of uncertainty and how to quantify uncertainty. The course then moves into the question of how to quantify risk. Questions of acceptable and unacceptable risk are examined and participants are challenged with a series of case studies to manage risk in a public sector decision making environment.

Performance Management and Budgeting

Participants:

US Officers (Active or Reserve) and International Military Officers, of Grades 0-3 and above, or equivalent; individuals participating in accelerated career development programs; and foreign officials of similar rank or grade.

This course is presented in English.

This course examines performance management and budgeting beginning with planning-to-budgeting and government accounting systems, and different types of and uses for budgets. We provide a foundation for performance management and budgeting by developing top-level goals and objectives, examining indicators of performance and performance hierarchies, and showing how indicators can be used in budgeting systems. Faculty present real world and teaching examples of measures of

efficiency and effectiveness, and how those measures impact budget decisions and implementation. Participants then create performance measures for a defense organization and discuss how they can be used in a defense budget. Participants should bring examples of performance measurements for their own organizations and how that information is implemented in their own budget systems.

In-Resident Course Dates. Current courses dates are available on our website at www.nps.edu/drmi http://www.nps.edu/drmi.

Mobile Education Courses

Mobile International Defense Management Course (MIDMC)

MASL P319016

The Mobile International Defense Management Course (MIDMC) is suitable for professionals concerned with the economic, efficient and effective allocation and use of scarce defense resources in today's complex and uncertain security environment. Participants normally come from a broad spectrum of fields, to include logistics, operations, personnel, acquisition, financial management, program management, planning, engineering, and program evaluation. This course is designed for military officers rank O-3 and above and equivalent civilian officials.

Analytical Decision Making Course (ADMC)

The ADMC is suitable for professionals concerned with the economic, efficient and effective allocation and use of scarce defense resources in today's complex and uncertain security environment. Participants usually come from a broad spectrum of fields, to include logistics, operations, personnel, acquisition, financial management, program management, planning, engineering, and program evaluation. This course is designed for military officers rank O-3 and above and equivalent civilian officials.

GRADUATE SCHOOL OF ENGINEERING AND APPLIED SCIENCES (GSEAS)

Website

www.nps.edu/Academics/GSEAS

Dean

Philip A. Durkee, Ph.D.

Naval Postgraduate School
Code 07, Spanagel Hall, Room 537
833 Dyer Road
Monterey, CA 93943-5117

(831) 656-2727, DSN 756-2727, FAX (831) 656-7861
durkee@nps.edu

Associate Dean

Christopher Smithtro, Col, USAF

Code 07B, Spanagel Hall, Room 537
833 Dyer Road
Monterey, CA 93943

(831) 656-3939, DSN 756-3939
cgsmitht@nps.edu

The Graduate School of Engineering and Applied Sciences consist of seven Departments, two Committees, and two Academic Group:

Department of Applied Mathematics	MA
Department of Electrical and Computer Engineering	ECE
Engineering Acoustics Academic Committee	EAAC
Department of Mechanical and Aerospace Engineering	MAE
Department of Meteorology	MR
Department of Oceanography	OC
Department of Physics	PH
Space Systems Academic Group	SP
Department of Systems Engineering	SE
Undersea Warfare Academic Group	USWAG

Overview

The Graduate School of Engineering and Applied Sciences (GSEAS) supports the Navy and the Department of Defense by educating future leaders to lead, innovate and manage in a changing, highly technological world, and by conducting research recognized internationally for its relevance to national defense and academic quality. More specifically, GSEAS provides advanced technical and scientific knowledge and understanding so graduates:

· understand the capabilities and limitations of current and future technologies in battle space environments

· understand and apply emerging and advanced technologies to enhanced war fighting capabilities
· are able to grow, anticipate, respond and lead in future complex, rapidly changing technological environments
· are able to represent their organization's technical needs and interests with and within myriad constituencies, to include DoD, the Joint Staff, and industry

GSEAS accomplishes the above by offering high quality, traditional academic degrees that include:
· Science and engineering curricula tailored to the needs of naval communities and other DoD constituents
· Research programs funded by the defense community, aligned to future capabilities--integrated into curricula and courses
· Hands-on education--classroom theory linked to real-world experiences in laboratories, experiments, testing--often classified
· Blending current operational experience of students, emerging technologies, and cutting-edge faculty in a joint, international culture
· Life changing education--transforming officers into technical generalists, sub-specialists and war fighters

Curricula

Traditional degree granting programs are offered by departments, normally at both the master's and Ph.D. levels. Most of these degree programs are an integral part of one or more unique interdisciplinary curricula designed for relevance to national security needs. Each of these curricula infuses cutting edge knowledge into academic courses taught by a dedicated, world-class faculty:

Applied Mathematics (380)
Combat Systems Sciences and Engineering (533)
Electronic Systems Engineering (590)
Electrical Systems Engineering (593)
Reactors/Mechanical Engineering via Distance Learning (571)
Mechanical & Naval Engineering (570)
Mechanical & Naval Engineering - Energy Focus (563)
Mechanical Engineering for Nuclear Trained Officers via Distance Learning (572)
Meteorology (372)
Meteorology and Oceanography (373)
Oceanography (440)
Operational Oceanography (374)
Space Systems Engineering (591)
Space Systems Operations (366) *
Space Systems Operations (Distance Learning) (316)*
Space Systems Operations (International) (364)

Systems Engineering (580)
Systems Engineering PhD (581)
Systems Engineering Analysis (308) *
Systems Engineering Certificate (282)
Systems Engineering (Distance Learning) (311)
Systems Engineering Management (MSSEM)/ Product
Development (Distance Learning) (721)
Underwater Acoustic Systems (Distance Learning) (535)
Undersea Warfare (525) *
Undersea Warfare (International) (526) *
U.S. Naval Test Pilot School/Mechanical & Aerospace
Engineering (613)

*Indicates an interdisciplinary curriculum offered with the
Graduate School of Operational and Information Sciences

Degrees

Within each of these curricula, students have the
opportunity to earn a high quality academic degree while
focusing on an area relevant to national defense and war
fighting capabilities. For example, students enrolled the in
Space Systems Engineering (Curriculum 591) have an
opportunity to study and do research related to space
systems while earning an academic degree from either the
Department of ECE, PH, MAE, ME or CS and while
students enrolled in the Undersea Warfare (Curriculum
525/526) have the opportunity to study and do research
related to undersea warfare while earning a degree from
either the Departments of ECE, MA, MAE, PH, OC, or
OR.   Student research is under the tutelage of faculty with
research experience related to national security and is an
integral part of the educational experience of each student.

GSEAS offers the following degree programs, each
designed and evolved to meet the changing needs of the
Navy and defense communities while maintaining high
academic standards:

Master of Science in Applied Mathematics, Ph.D. in
Applied Mathematics

Master of Science in Applied Physics, Ph.D. in Applied
Physics

Master of Science in Applied Science (Physical
Oceanography), (Acoustics), or (Signal Processing)

Master of Science in Astronautical Engineering,
Astronautical Engineer, Ph.D. in Astronautical
Engineering

Master of Science in Combat Systems Technology

Master of Science in Electrical Engineering, Electrical
Engineer, Ph.D. in Electrical & Computer Engineering

Master of Science in Engineering Acoustics, Master of
Engineering Acoustics, Ph.D. in Engineering Acoustics

Master of Science in Engineering Science

Master of Science in Engineering Systems

Master of Science in Mechanical Engineering, Mechanical
Engineer, Ph.D. in Mechanical Engineering

Master of Science in Meteorology, Ph.D. in Meteorology

Master of Science in Meteorology and Physical
Oceanography

Master of Science in Physical Oceanography, Ph.D. in
Physical Oceanography

Master of Science in Physics, Ph.D. in Physics

Master of Science in Product Development

Master of Science in Systems Engineering, Ph.D. in
Systems Engineering

Master of Science in Systems Engineering Analysis

Master of Science in Systems Engineering Management

Department of Applied Mathematics

Chairman

Carlos F. Borges
Spanagel Room 254
(831) 656-2207, DSN 756-2207
borges@nps.edu

Associate Chairman for Labs and Computing

David R. Canright
Spanagel Room 246
(831) 656-2782, DSN 756-2782
dcanright@nps.edu

Associate Chairman for Instruction
Craig Rasmussen
Spanagel Room 238B
(831) 656-2763, DSN 756-2763
ras@nps.edu

Associate Chairman for Research

Pante Stanica

Spanagel Room 268
(831)656-2714, DSN 756-2714
pstanica@nps.edu

Carlos F. Borges, Professor and Chair (1991)*; Ph.D.,
University of California, Davis, 1990.

David Canright, Associate Professor and Associate Chair
for Labs and Computing (1988); Ph.D., University of
California, Berkeley, 1987.

Lester E. Carr, III, Lecturer (2005); Ph.D., Naval
Postgraduate School, 1989.

Doyle Daughtry, Lecturer (2004); MA, East Carolina University, 1973.

Fariba Fahroo, Professor (1992); Ph.D., Brown University, 1991.

Christopher Frenzen, Professor (1989); Ph.D., University of Washington, 1982.

Ralucca Gera, Associate Professor (2005); Ph.D., Western Michigan University, 2005.

Frank Giraldo, Professor (2006); Ph.D., University of Virginia, 1995.

Wei Kang, Professor (1994); Ph.D., University of California, Davis, 1991.

Jeremy Kozdon, Assistant Professor (2012); Ph.D., Stanford University, 2009.

Arthur Krener, Distinguished Visiting Professor (2006); Ph.D., University of California, Berkeley, 1971

Bard Mansager, Senior Lecturer, (1991); M.A., University of California, San Diego, 1979.

Beny Neta, Professor, (1985); Ph.D., Carnegie-Mellon University, 1977.

Guillermo Owen, Distinguished Professor (1983); Ph.D., Princeton University, 1962.

Craig Rasmussen, Professor and Associate Chair for Instruction(1991); Ph.D., University of Colorado at Denver, 1990.

Clyde Scandrett, Professor (1987); Ph.D., Northwestern University, 1985.

Gabriela Stanica, Lecturer (2012); MA SUNY Buffalo, 1999.

Pantelimon Stanica, Professor and Associate Chair for Research (2006); Ph.D., State University of New York at Buffalo, 1998.

Lucas Wilcox, Assistant Professor (2012); Ph.D., Brown University, 2006.

Hong Zhou, Associate Professor (2004); Ph.D., University of California, Berkeley, 1996.

Professors Emeriti:

Donald A. Danielson, Professor Emeritus (1985); Ph.D., Harvard University, 1968.

Richard Franke, Professor Emeritus (1970); Ph.D., University of Utah, 1970.

Harold M. Fredricksen, Professor Emeritus (1980); Ph.D., University of Southern California, 1968.

William Gragg, Professor Emeritus (1987); Ph.D., University of California, Los Angeles, 1964.

Toke Jayachandran, Professor Emeritus (1967); Ph.D., Case Institute of Technology, 1967.

Gordon E. Latta, Professor Emeritus (1979); Ph.D., California Institute of Technology, 1951.

Arthur L. Schoenstadt, Professor Emeritus (1970); Ph.D., Rensselaer Polytechnic Institute, 1968.

Maurice Dean Weir, Professor Emeritus (1969); D.A., Carnegie-Mellon University, 1970.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

Brief Overview

As well as the Master of Science and Ph.D. programs in Applied Mathematics, the Applied Mathematics Department offers individually tailored minor programs for many of the school's doctoral students. The majority of the department instructional—effort is devoted to the service courses offered.

Degrees

Master of Science in Applied Mathematics

In order to enter a program leading to the degree Master of Science in Applied Mathematics, the prospective student is strongly advised to possess either a Bachelor degree with a major in mathematics or a strong mathematical orientation in a Bachelor degree in another discipline.

Any program that leads to the degree Master of Science in Applied Mathematics for a student who has met the entrance criteria must contain a minimum of 32 quarter-hours of graduate-level (3000-4000 numbered) courses with a minimum QPR of 3.0. The program specifications must be approved by the Chairman of the Department of Applied Mathematics and the Academic Associate. The program is subject to the general conditions specified in the Academic Council Policy Manual as well as the following:

1. A student must complete or validate the four 1000 level calculus sequence and the introductory courses in linear algebra and discrete mathematics.

2. The program must include at least 16 hours in 3000 level mathematics courses and 16 hours of approved 4000 level mathematics courses.

3. Courses in Ordinary Differential Equations, Real Analysis, and upper division Discrete Mathematics are specifically required, and those at the 3000 level or above may be applied toward requirement (2)

4. An acceptable thesis is required. The Department of Applied Mathematics permits any student pursuing a

dual degree to write a single thesis meeting the requirements of both departments, subject to the approval of the Chairmen and Academic Associates of both departments.

In addition to the core courses required in item (3), the program allows the student to select an applied subspecialty option from the following list: applied mathematics, numerical analysis and computation, discrete mathematics, operations research, theoretical mathematics, and intelligence.

Doctor of Philosophy

The Department of Applied Mathematics offers the Doctor of Philosophy in Applied Mathematics degree. Areas of specialization will be determined by the department on a case by case basis. Requirements for the degree include course work followed by an examination in both major and minor fields of study, and research culminating in an approved dissertation. It may be possible for the dissertation research to be conducted off-campus in the candidate's sponsoring organization.

Entrance into the program will ordinarily require a master's degree, although exceptionally well-prepared students with a bachelor's degree in mathematics may be admitted. A preliminary examination may be required to show evidence of acceptability as a doctoral student. Prospective students should contact the Chairman of the Applied Mathematics Department or the Academic Associate for further guidance.

Minor in Applied Mathematics

Ph.D. students from another department can qualify for a minor in mathematics by taking at least four mathematics courses at the 3000 or 4000 level; at least three of these must be at the 4000 level. The QPR for courses taken toward the minor requirement must be at least 3.5. The courses taken should constitute a coherent minor program, and must be approved by the Academic Associate for the Department of Applied Mathematics. The use of reading courses to satisfy the requirement is strongly discouraged.

Prerequisites

Prerequisites are as described in the course descriptions. If a student has not taken the prescribed prerequisites at NPS, then a validation examination by the Applied Mathematics Department may be substituted.

Applied Mathematics Course Descriptions

MA Courses

MA0134 Problem Solving Session for MA1113/4 (No Credit) (0-3) Spring/Summer/Fall/Winter

Offered for no credit, pass/fail. Students must be concurrently enrolled in either MA1113 or MA1114, but the course is not mandatory for either course. Prerequisites: None.

MA0156 Problem Solving Session for MA1115/6 (No Credit) (0-3) Spring/Summer/Fall/Winter

Offered for no credit, pass/fail. Students must be concurrently enrolled in either MA1115 or MA1116, but the course is not mandatory for either course. Prerequisites: None.

MA0810 Thesis Research (0-8) As Required

Every student conducting thesis research will enroll in this course. Prerequisites: None.

MA1010 Algebra and Trigonometry (4-0) As Required

Real number system, complex numbers, exponents and radicals, algebraic expressions and operations, linear and quadratic equations, inequalities, functions and graphs, polynomials and their zeros, rational functions, exponential and logarithmic functions, systems of equations, matrices, trigonometry and unit circles, trigonometric identities and functions. Prerequisites: None.

MA1025 Introduction to Mathematical Reasoning (4-0) As Required

An introductory course in logic and elementary discrete mathematics to be taken by students in the Operations Research curriculum. Considerable emphasis is placed on propositional and predicate logic, and on techniques of proof in mathematics. Mathematical topics include sets, functions, and relations. Coverage of combinatorics includes an introduction to permutations, combinations, the pigeon-hole principle, and the principle of inclusion/exclusion. No previous experience with this material is assumed. Prerequisites: None.

MA1113 Single Variable Calculus (4-0) Spring/Summer/Fall/Winter

Review of analytic geometry and trigonometry, functions of one variable, limits, derivatives, continuity and differentiability; differentiation of algebraic, trigonometric, logarithmic and exponential functions with applications to maxima and minima, rates, differentials; product rule, quotient rule, chain rule; antiderivatives, integrals and the fundamental theorem of calculus; definite integrals, areas. Taught at the rate of nine hours per week for five weeks. Prerequisites: Pre-Calculus mathematics.

MA1114 Single Variable Calculus II with Matrix Algebra (4-0) Spring/Summer/Fall/Winter

Topics in calculus include applications of integration, special techniques of integration, infinite series, convergence tests, and Taylor series. Matrix algebra topics covered are: the fundamental algebra of matrices including addition, multiplication of matrices, multiplication of a matrix by a constant and a column (vector) by a matrix; elementary matrices and inverses, together with the properties of these operations; solutions to mxn systems of linear algebraic equations using Gaussian elimination and the LU decomposition (without pivoting); determinants, properties of determinants; and a brief introduction to the arithmetic of complex numbers and DeMoivre's theorem. Taught at the rate of nine hours per week for five weeks. Prerequisites: MA1113.

MA1115 Multi-variable Calculus (4-0) Spring/Summer/Fall/Winter

Vector algebra and calculus, directional derivative, gradient, polar coordinates and parametric equations, functions of several independent variables, limits, continuity, partial derivatives, chain rule, maxima and minima, double and triple integrals, cylindrical and spherical coordinate systems. Taught at the rate of nine hours per week for five weeks. Prerequisites: MA1114.

MA1116 Vector Calculus (3-0) Spring/Summer/Fall/Winter

The calculus of vector fields; directional derivative, gradient, divergence, curl; potential fields; Green's, Stokes', and the divergence integral theorems. Applications in engineering and physics. Taught at the rate of seven hours per week for five weeks. Prerequisites: MA1115.

MA1118 Multivariable Calculus for Operations Research (4-0) Fall/Spring

First-order linear differential equations, curves and surfaces, polar coordinates, vector algebra and calculus, functions of several independent variables, partial derivatives, Taylor series, chain rule, maxima and minima, directional derivatives and gradient, Lagrange multipliers, double integrals. Prerequisite: MA1114.

MA2025 Logic and Discrete Mathematics I (4-1) Summer/Winter

MA2025 is a first course in discrete mathematics for students of mathematics and computer science. Topics include propositional and predicate logic up to the deduction theorem, methods of mathematical proof, naive set theory, properties of functions, sequences and sums, mathematical induction, an introduction to divisibility and congruences, and an introduction to enumerative combinatorics. Prerequisites: None, although a review of algebra skills is recommended.

MA2043 Introduction to Matrix and Linear Algebra (4-0) As Required

The fundamental algebra of vectors and matrices including addition, scaling, and multiplication. Block operations with vectors and matrices. Algorithms for computing the LU (Gauss) factorization of an MxN matrix, with pivoting. Matrix representation of systems of linear equations and their solution via the LU factorization. Basic properties of determinants. Matrix inverses. Linear transformations and change of basis. The four fundamental subspaces and the fundamental theorem of linear algebra. Introduction to eigenvalues and eigenvectors. Prerequisites: Students should have mathematical background at the level generally expected of someone with a B.S. in Engineering, i.e., familiarity with Calculus and solid algebra skills. EC1010 (May be taken concurrently.)

MA2121 Differential Equations (4-0) Spring/Summer/Fall/Winter

Ordinary differential equations: linear and nonlinear (first order) equations, homogeneous and non-homogeneous equations, linear independence of solutions, power series solutions, systems of differential equations, Laplace transforms. Applications include radioactive decay, elementary mechanics, mechanical and electrical oscillators, forced oscillations and resonance. Prerequisites: MA1114.

MA2300 Mathematics for Management (5-0) Winter/Spring/Summer

Mathematical basis for modern managerial tools and techniques. Elements of functions and algebra; differential calculus of single- and multi-variable functions; integration (antidifferentiation) of single-variable functions. Applications of the derivative to rates of change, curve sketching, and optimization, including the method of Lagrange multipliers. Prerequisite: College algebra.

MA3001 Incremented Directed Study (Variable 1-0 or 2-0) (V-0) As Required

Provides the opportunity for a student who is enrolled in a 3000 level mathematics course to pursue the course material and its applications in greater depth by directed study to the extent of one additional hour beyond the normal course credit. Prerequisites: Enrollment in a 3000 level mathematics course and consent of instructor.

MA3025* Logic and Discrete Mathematics II (4-1) As Required

Provides a rigorous foundation in logic and elementary discrete mathematics to students of mathematics and computer science. Topics from logic include modeling English propositions, propositional calculus, quantification, and elementary predicate calculus. Additional mathematical topics include elements of set theory, mathematical induction, relations and functions, and elements of number theory. Prerequisites: MA2025 (preferable) or MA1025.

MA3030 Introduction to Combinatorics and Its Applications (4-1) As Required

Provides a thorough grounding in elementary combinatorics and its applications to computer science and discrete probability theory to students of computer science who concurrently take MA3025, Logic and Discrete Mathematics. Topics from combinatorics include fundamental counting rules, binomial and multinomial theorems, the pigeonhole and inclusion/exclusion principles, and homogeneous recurrence relations. Elementary discrete probability is covered, up to the expectation of a discrete random variable. Corequisite: MA3025.

MA3042 Linear Algebra (4-0) As Required

Finite-dimensional vector spaces, linear dependence, basis and dimension, change of basis. Linear transformations and similarity. Scalar product, inner product spaces. Orthogonal subspaces and least squares. LU (with pivoting), Cholesky, and QR factorizations. Eigenvalues/eigenvectors, diagonalization. Hermitian matrices, quadratic forms, definite matrices. Vector and matrix norms, orthogonal transformations, condition numbers. Prerequisite: MA1114.

MA3046 Matrix Analysis (4-1) As Required

This course provides students in the engineering and physical sciences curricula with an applications-oriented coverage of major topics of matrix and linear algebra. Matrix factorizations (LU, QR, Cholesky), the Singular Value Decomposition, eigenvalues and eigenvectors, the Schur form, subspace computations, structured matrices. Understanding of practical computational issues such as stability, conditioning, complexity, and the development of practical algorithms. Prerequisites: MA2043 and EC1010.

MA3110 Intermediate Analysis (4-0) Summer/Winter

Multi-variable calculus integrated with linear algebra. Functions of several variables, continuous transformations, Jacobians, chain rule, implicit function theorem, inverse function theorem, extreme, optimization and Lagrange multiplier technique. Applications in Operations Research. Prerequisites: MA1115 and MA3042.

MA3132 Partial Differential Equations and Integral Transforms (4-0) Spring/Summer/Fall/Winter

Solution of boundary value problems by separation of variables; Sturm-Liouville problems; Fourier and Bessel series solutions, Fourier transforms; classification of second-order equations;

applications, method of characteristics. Applications to engineering and physical science. Satisfies the ESR in differential equations for the Applied Mathematics program. Prerequisites: MA2121 and MA1116.

MA3139 Fourier Analysis and Partial Differential Equations (4-0) Summer/Winter

Fourier series; solution of the one and two-dimensional wave equations, D'Alembert's solution, frequency and time domain interpretations; Fourier integral transforms and applications to ordinary and partial differential equations and linear systems; Convolution theorems. Course covers basic material essential for signal processing, filtering, transmission, waveguides, and other related problems. Applications include spectral analysis of electronic signals, e.g., radar or sonar. Designed for UW and EW/IW students. Prerequisites: MA1115 and MA2121.

MA3185 Tensor Analysis (3-0) Fall

Definition and algebra of tensors. Dyadic representation in Cartesian and general components. Calculus of tensor fields in curvilinear coordinates. Derivation and application of the basic equations of heat conduction, rigid body mechanics, elasticity, fluid mechanics, electromagnetism, Newtonian and Einsteinian orbital mechanics. Prerequisites: MA1116.

MA3232 Numerical Analysis (4-0) Spring/Summer/Fall/Winter

Provides the basic numerical tools for understanding more advanced numerical methods. Topics for the course include: Sources and Analysis of Computational Error, Solution of Nonlinear Equations, Interpolation and Other Techniques for Approximating Functions, Numerical Integration and Differentiation, Numerical Solution of Initial and Boundary Value Problems in Ordinary Differential Equations, and Influences of Hardware and Software. Prerequisites: MA1115, MA2121 and ability to program in MATLAB and MAPLE.

MA3243 Numerical Methods for Partial Differential Equations (4-1) Winter

Course designed to familiarize the student with analytical techniques as well as classical finite difference techniques in the numerical solution of partial differential equations. In addition to learning applicable algorithms, the student will be required to do programming. Topics covered include: Implicit, Explicit, and Semi-Implicit methods in the solution of Elliptic and Parabolic PDE's, iterative methods for solving Elliptic PDEs (SOR, Gauss-Seidel, Jacobi), the Lax-Wendroff and Explicit methods in the solution of 1st and 2nd order Hyperbolic PDEs. Prerequisites: MA3132 and the ability to program in a high level language such as Fortran, C, or MATLAB.

MA3261 Basic Parallel Computation (3-0) As Required

The course has two goals: First, to introduce fundamental issues such as shared vs. distributed memory, connection topologies, communication algorithms, speedup, efficiency, storage requirements, granularity, pipelining, problem scaling, and useful paradigms for algorithm development. Second, to develop working proficiency by designing, implementing, and evaluating the performance of several parallel algorithms. These include, but are not limited to, numerical quadrature, matrix computations, sorting, network analysis, and dynamic programming. Prerequisites: MA1115 or MA3025 and ability to program in a high-level language.

MA3301 Linear Programming (Same as OA3201) (4-0) As Required

See OA3201 for course description.

MA3393 Topics in Applied Mathematics (V-0) As Required

A selection of topics in applied mathematics. The course content varies and the credit varies. This course is intended to reflect study for the beginning graduate student in an area for which no formal course is taught. Credit for this course may be granted more than one time to an individual student. Prerequisites: Consent of instructor.

MA3560* Applied Modern Algebra and Number Theory (4-0) As Required

This course is devoted to aspects of modern algebra and number theory that directly support applications, principally in communication. The algebraic emphasis is on ring and field theory, with special emphasis on the theory of finite fields, as well as those aspects of group theory that are important in the development of coding theory. Elements of number theory include congruences and factorization. Applications are drawn from topics of interest to DoN/DoD. These include error correcting codes and cryptography. Prerequisites: MA3025.

MA3607 Introduction to Real Analysis (4-0) Summer

The objective of this course is for students to achieve a solid understanding of the basic concepts, theorems, and proofs in introductory real analysis, including: limits, sequences, series, continuity, uniform convergence and uniform continuity, differentiation, and Riemann integration. This is a mathematics course in the pure sense. Proofs will be emphasized, and the student will learn how to reproduce, understand, create and enjoy mathematical proofs. Prerequisites: MA1114.

MA3610 Topology, Fractals, and Chaotic Dynamics (3-0) As Required

An introductory course on chaotic dynamics systems and fractals. Topics covered include: flows on the line, bifurcations, linear systems, phase plane, limit cycles, the Lorenz equations, fractals, and one-dimensional maps. Applications include population growth, laser threshold, the pendulum, relaxation oscillations, and synchronized chaos. Prerequisites: MA1115 and MA2121.

MA3677 Theory of Functions of a Complex Variable I (4-0) As Required

Selected topics from the theory of functions of a complex variable; analytic functions, power series, Laurent series. Singularities of analytic functions; contour integration and residues; applications of residues to real integrals and Laplace transforms, zeros of analytic functions, infinite product representation for analytic functions; maximum modulus theorems for analytic and harmonic functions; conformal mapping. Applications include interference effects in optics and problems from heat flow and fluid flow. Prerequisites: MA1115.

MA3730 Theory of Numerical Computation (3-0) As Required

Analysis of computational methods used for the solution of problems from the areas of algebraic equations, polynomial approximation, numerical differentiation and integration, and numerical solutions of ordinary differential equations. Prerequisites: MA2121.

MA4026 Combinatorial Mathematics (4-0) As Required

Advanced techniques in enumerative combinatorics and an introduction to combinatorial structures. Topics include generating

functions, recurrence relations, elements of Ramsey theory, theorems of Burnside and Polya, and balanced incomplete block designs. Application areas with DoD/DoN relevance range from mathematics to computer science and operations research, including applications in probability, game theory, network design, coding theory, and experimental design. Prerequisites: MA3025.

MA4027 Graph Theory and Applications (4-0) Fall

Advanced topics in the theory of graphs and digraphs. Topics include graph coloring, Eulerian and Hamiltonian graphs, perfect graphs, matching and covering, tournaments, and networks. Application areas with DoD/DoN relevance range from mathematics to computer science and operations research, including applications to coding theory, searching and sorting, resource allocation, and network design. Prerequisites: MA3025.

MA4103 Thesis Topics Seminar (3-0) As Required

Explores in depth discrete dynamical systems and the thesis topics of students enrolled in the Applied Mathematics degree program. Fulfills the ESR to provide students with the experience of organizing and presenting applied mathematical ideas to students and faculty, including a classroom environment. Prerequisites: Consent of instructor. Graded on a Pass/Fail basis only.

MA4237 Advanced Topics in Numerical Analysis (V-V) Fall

The subject matter will vary according to the abilities and interest of those enrolled. Applications of the subject matter to DoD/DoN are discussed. Prerequisites: Consent of instructor.

MA4242 Numerical Solution of Ordinary Differential Equations (4-0) As Required

Adams formulas, Runge-Kutta formulas, extrapolation methods, implicit formulas for stiff equations; convergence and stability, error estimation and control, order and stepsize selection, applications. Prerequisites: MA3232.

MA4243 Numerical Solution of Partial Differential Equations (3-1) As Required

Finite difference methods for parabolic, elliptic, and hyperbolic equations, multi-grid methods; convergence and stability, error estimation and control, numerical solution of finite difference equations, applications. Prerequisites: MA3132, MA3232 suggested.

MA4245 Mathematical Foundations of Galerkin Methods (4-0) As Required

Variational formulation of boundary value problems, finite element and boundary element approximations, types of elements, stability, eigenvalue problems. Prerequisites: MA3132, MA3232 or equivalent.

MA4248 Computational Linear Algebra (4-1) As Required

Development of algorithms for matrix computations. Rounding errors and introduction to stability analysis. Stable algorithms for solving systems of linear equations, linear least squares problems and eigen problems. Iterative methods for linear systems. Structured problems from applications in various disciplines. Prerequisites: MA3046, or consent of instructor, advanced MATLAB programming.

MA4261 Distributed Scientific Computing (4-0) As Required

General principles of parallel computing, parallel techniques and algorithms, solution of systems of linear equations, eigenvalues and singular value decomposition, domain decomposition and application (e.g., satellite orbit determination and shallow water fluid flow). Prerequisites: MA3042 or MA3046, MA3132, and MA3232.

MA4301 Nonlinear Programming (Course Taught by or Staff, Same as OA4201) (4-0) As Required

See OA4201 for course description.

MA4302 Design of Experiments (Course Taught by or Staff, Same as OA4101) (3-1) As Required

See OA4101 for course description.

MA4303 Regression Analysis (Course Taught by or Staff, Same as OA4102) (4-0) As Required

See OA4102 for course description.

MA4304 Time Series Analysis (Course Taught by or Staff, Same as OA4308) (4-0) As Required

See OA4308 for course description.

MA4305 Stochastic Models II (Course Taught by or Staff, Same as OA4301) (4-0) As Required

See OA4301 for course description.

MA4311 Calculus of Variations (4-0) As Required

First and second order tests, Lagrange multipliers, Euler-Lagrange equation, nonsmooth solutions, optimization with constraints, Weierstrass condition, optimal control of ODE systems, Pontryagin maximum principle. Applications may include: control and dynamical systems, estimation, weak formulations, Hamilton's variational principle, or others depending on the interests of the students. Prerequisites: MA2121.

MA4321 Stability, Bifurcation and Chaos (3-0) As Required

Differential equations and dynamical systems, equilibrium of autonomous systems, stability, Liapunov's method, examples of chaos, local bifurcations of vector fields and maps, chaotic dynamical systems. Prerequisites: MA3610.

MA4322 Principles and Techniques of Applied Mathematics I (4-0) Fall

Selected topics from applied mathematics to include: Dimensional Analysis, Scaling, Stability and Bifurcation, Perturbation Methods— regular and singular with boundary layer analysis, as well as, asymptotic expansions of integral, integrals equations, Green's functions of boundary value problems, and distribution theory. Prerequisites: MA3042 and MA3132; MA3232 strongly recommended.

MA4323 Principles and Techniques of Applied Mathematics II (4-0) Winter

Continuation of MA4322. Selected topics include: calculus of variations, Hamiltonian Mechanics, distribution theory and Green's Functions in two and three dimensions, and discrete models. Prerequisites: MA4322

MA4332 Partial Differential Equations (4-0) As Required

This course provides an introduction to the theory of partial differential equations. It includes the following topics: classification of second order equations; initial value and boundary value problems for hyperbolic, parabolic, and elliptic partial differential equations; existence and uniqueness of linear elliptic and parabolic PDEs; nonlinearparabolic and elliptic PDEs; Hamilton-Jacobi equations; systems of conservation laws and nonlinear wave equations; transform methods and Green's functions. Prerequisites: MA3132, and MA3232 strongly recommended.

MA4335 Linear and Nonlinear Waves (3-0) As Required
Analysis of the two main classes of wave motion, hyperbolic waves and linear dispersive waves. Topics covered include: kinematic waves, shock waves, shock structure and shock fitting, Burger's equation, the wave equation, linear dispersive waves, wave patterns and water waves. Prerequisite: MA3132.

MA4362 Astrodynamics (3-0) As Required
Review of the two-body problem. The effects of a third point mass and a distributed mass. Expansion of the disturbing potential in series of Legendre functions. Variation of parameter equations for osculating orbital elements. Perturbation and numerical solution techniques. Statistical orbit determination. Codes used by the military to maintain the catalog of artificial satellites and space debris. Prerequisites: SS3500 or equivalent.

MA4372 Integral Transforms (3-0) As Required
The Laplace, Fourier and Hankel transforms and their inversions; Asymptotic behavior. Applications to problems in engineering and physics. Prerequisites: MA3132.

MA4377 Asymptotic and Perturbation Methods I (4-0) As Required
Advanced course in the application of approximate methods to the study of integrals and differential equations arising in physical problems. Topics covered include: asymptotic sequences and expansions, integrals of a real variable, contour integrals, limit process expansions applied to ordinary differential equations, multiple variable expansion procedures and applications to partial differential equations. Prerequisites: MA3132.

MA4378 Asymptotic and Perturbation Methods II (3-0) As Required
Continuation of MA4377. Prerequisites: MA4377.

MA4391 Analytical Methods for Fluid Dynamics (4-0) As Required
The basic fluid dynamic equations will be derived, and a variety of analytical methods will be applied to problems in viscous flow, potential flow, boundary layers, and turbulence. Applications in aeronautics will be discussed. Prerequisites: MA3132 or MA3139.

MA4392 Numerical Methods for Fluid Dynamics (4-0) As Required
Numerical methods exclusively will be applied to fluid dynamics problems in viscous flow, potential flow, boundary layers, and turbulence. Applications in aeronautics will be discussed. Prerequisites: MA3232 and MA4391.

MA4393 Topics in Applied Mathematics (V-0) Fall
The course content varies but applications of interest to the DoN/DoD will be discussed. Credit may be granted for taking this course more than once. Prerequisites: Consent of instructor.

MA4400 Cooperation and Competition (4-0) Spring
The course will develop game theoretic concepts in evaluations of the importance of players in bargaining situations and of elements in networks. Topics covered include cooperative and noncooperative games, bargaining, the Shapley Value, and coalitions. The course will study applications to military problems and applications to economics, political science, and biology. There will be extensive reading from the literature. Prerequisites: MA3042, OA3201, and an introductory course in probability.

MA4550 Combinatorial and Cryptographic Properties of Boolean Functions (4-0) As Required
The course will discuss the Fourier analysis of Boolean functions and the relevant combinatorics with an eye toward cryptography and coding theory. Particular topics will include avalanche features of Boolean functions, correlation immunity and resiliency, bentness, trade-offs among cryptographic criteria and real-life applications in the designs of stream and block ciphers. Prerequisite: MA3025 or a similar combinatorial/discrete mathematics course (and recommended, but not required, an introductory course in probability).

MA4560* Coding and Information Theory (4-0) Summer
Mathematical analysis of the codes used over communication channels is made. Techniques developed for efficient, reliable and secure communication are stressed. Effects of noise on information transmission are analyzed and techniques to combat their effects are developed. Linear codes, finite fields, single and multiple error-correcting codes are discussed. Codes have numerous applications for communication in the military, and these will be addressed. Prerequisites: MA3560.

MA4565 Advanced Modern Algebra (3-0) As Required
A continuation of MA3560. Rings, ring homomorphism, integral domains and Euclidean domains. Unique factorization rings, polynomial rings. Modules and ideals. Noetherian rings, Field extension and Galois theory. Prerequisites: MA3560.

MA4570 Cryptography (4-0) Spring
The methods of secret communication are addressed. Simple cryptosystems are described and classical techniques of substitution and transposition are considered. The public-key cryptosystems, RSA, Discrete Logarithm and other schemes are introduced. Applications of cryptography and cryptanalysis. Prerequisites: MA3560.

MA4593 Topics in Algebra (3-0) Fall
A selection of topics in algebra. Content of the course varies. Credit for taking the course more than once is allowed. Students may select a topic of interest to the DoN/DoD, so the course can support the MERs in a variety of curricula. Prerequisite: MA3560.

MA4620 Theory of Dynamical Systems (4-0) As Required
This course provides an introduction to the theory of dynamical systems providing a basis for the analysis and design of systems in engineering and applied science. It includes the following topics: Second order linear systems; contraction mapping, existence and uniqueness of solutions; continuous dependence on initial conditions; comparison principle; Lyapunov stability theorems; LaSalle's theorem; linearization methods; nonautonomous systems; converse theorems; center manifold theorems; and stationary bifurcations of nonlinear systems. Prerequisites: MA2121.

MA4635 Functions of Real Variables I (3-0) As Required
Semi-continuous functions, absolutely continuous functions, functions of bounded variation; classical Lebesgue measure and integration theory, convergence theorems and Lp spaces. Abstract measure and integration theory, signed measures, Radon-Nikodym theorem; Lebesgue decomposition and product measure; Daniell integrals and integral representation of linear functionals. Prerequisites: MA3606.

MA4636 Functions of Real Variables II (3-0) As Required
Continuation of MA4635. Prerequisites: MA4635.

MA4675 Complex Analysis (4-0) As Required
A continuation of MA3677. Differential equations in the complex plane, transform methods, the Wiener-Hopf method, integral equations, discrete Fourier analysis. Prerequisite: MA3677.

MA4693 Topics in Analysis (3-0) Spring
Content of the course varies. Students will be allowed credit for taking the course more than once. Prerequisites: Consent of instructor.

MA5810 Dissertation Research (0-8) As Required
Dissertation research for doctoral studies. Required in the quarter following advancement to candidacy and then continuously each quarter until dissertation is approved by the Academic Council.

MO Courses
MO designated courses are intended for students in operational curricula only. They do not satisfy the mathematics course requirements for accredited engineering curricula, nor do they satisfy the prerequisites for any of the MA designated courses.

MO1180 Topics in Mathematics for Systems Analysis (3-2) Spring/Fall
A one quarter course in logic, elementary mathematics, combinatorics, and matrix algebra, plus a review of selected topics from single variable calculus with extensions to two variables. This course is intended for first-quarter students in the distance learning Master of Systems Analysis curriculum. Logic places emphasis on the Propositional and Predicate Calculus. Elementary mathematical topics include sets, functions, and relations. Coverage of combinatorics includes an introduction to basic principles of counting (sum and product rules), permutations, and combinations. The fundamental algebra of matrices includes addition, multiplication of matrices, and multiplication of a matrix by a constant, and a column (vector) by a matrix; elementary matrices and inverses, together with the properties of these operations; solutions to m x n systems of linear algebraic equations using Gaussian elimination. Selected topics from single-variable calculus are extended to functions of two-variables, including double integrals over rectangles and general regions. (This course may not be taken for credit by students in an engineering or science degree program, nor may it be used as a prerequisite for any other mathematics course). Prerequisite: Single-variable calculus.

MO1901 Mathematics for ISSO (3-0) As Required
A brief survey of selected calculus and post-calculus topics--single variable derivatives and integrals, infinite series and sequences, complex numbers, and Fourier series and transforms. (This course may not be taken for credit by students in an engineering or science degree program, nor may it be used as a prerequisite for any other mathematics course.) Prerequisites: None.

MO1903 Mathematics for ISSO Space Systems Operations Specialization (3-0) Fall
To be taken concurrently with MA1114. The course consists of a brief survey of the following topics: Complex numbers, Fourier series and transforms, and Ordinary Linear Differential Equations. (This course may not be taken for credit by students in an engineering or science degree program, nor may it be used as a prerequisite for any other mathematics course.) Taught at the rate of seven hours per week for five weeks. Prerequisites: MA1113.

*Required courses for the certificate program *Mathematics of Secure Communication*.

Mathematics of Secure Communication Certificate - Curriculum 280

Program Manager

Pante Stanica
Spanagel Hall, Room 268
(831) 656-2714, DSN 756-2714, FAX (831) 656-2355
pstanica@nps.edu

Brief Overview

The Mathematics of Secure Communication certificate program comprises four upper division and graduate level courses. Upon successful completion of the coursework, students will be awarded a certificate of accomplishment, in keeping with standard practices of the Naval Postgraduate School. The purpose of this program is to provide mathematics education to naval officers and DoD civilians in the broad areas of Cryptography, Coding and Information Theory, and Secure Communications.

Requirements for Entry

Requirements for entry include completion of an introductory course in Discrete Mathematics equivalent to MA2025. Also required is a baccalaureate degree with an academic profile code (APC) of 324.

Entry Dates

At the beginning of the spring and fall quarters, with start dates in late March/ early April and late September/ early October, respectively.

Program Length

Four quarters.

Graduate Certificate Requirements

To earn the academic certificate students must pass all four courses with a C+ (2.3 Quality Point Rating (QPR)) or better in each course and an overall QPR of 3.0 or better. Students earning grades below these standards will need to retake the courses to bring their grades within standards or they will be withdrawn from the program.

Required Courses

Quarter 1
MA3025   (4-1)   Logic and Discrete Mathematics II

Quarter 2
MA3560   (4-0)   Applied Modern Algebra and Number Theory

Quarter 3
MA4560   (4-0)   Coding and Information Theory

Quarter 4
MA4570   (4-0)   Cryptography

Certificate in Scientific Computation - Curriculum 283

Program Manager

Beny Neta
Spanagel Hall, Room 270
(831) 656-2235, DSN 756-2235
FAX (831) 656-2355
bneta@nps.edu

Brief Overview

The Scientific Computation academic certificate provides education in the use of mathematical analysis and numerical solution techniques to model science and engineering problems on computers. Scientific Computation has become the third pillar of scientific research, a peer with traditional methods of physical experimentation and theoretical investigation, and as such has emerged as an area critical to the success of the mission of the Navy and the Department of Defense. High performance computers are already widely used in weather prediction, modeling ocean dynamics, design and testing of advanced weapons systems, development of new smart materials, etc. And it has become very clear that even more broad application of scientific computation will be essential to accelerate scientific discovery for national competitiveness and global security.

A thorough understanding of the mathematics underlying the algorithms is essential for the correct interpretation and further development of computational approaches in science. The Scientific Computation certificate program is designed to provide that very background. It is comprised of four courses – the first two of these are fundamental and the other two are selected from a group of nine courses that allows the certificate to be tailored to a specific area of interest. Upon successful completion of the coursework, students will be awarded a certificate of accomplishment in keeping with standard practices of the Naval Postgraduate School.

Requirements for Entry

Prospective students must meet the necessary prerequisites for the courses in the program.

Entry Date

Program entry dates are flexible and students who wish to pursue this certificate should coordinate with the program manager.

Program Length

Variable.

Graduate Certificate Requirements

To earn the academic certificate students must pass all four courses with a C+ (2.3 Quality Point Rating (QPR)) or better in each course and an overall QPR of 3.0 or better. Students earning grades below these standards will need to retake the courses to bring their grades within standards or they will be withdrawn from the program.

Required Courses

| MA3046 | Matrix Analysis |
| MA3232 | Numerical Analysis |

And any two from

MA4237	Advanced Topics in Numerical Analysis
MA4242	Numerical Solution of Ordinary Differential Equations
MA4243	Numerical Solution of Partial Differential Equations
MA4245	Mathematical Foundations of Galerkin Methods
MA4248	Computational Linear Algebra
MA4261	Distributed Scientific Computing
MA4311	Calculus of Variations
MA4377	Asymptotic and Perturbation Methods
MA4620	Theory of Dynamical Systems

Applied Mathematics - Curriculum 380

Program Officer

LCDR Thor Martinsen
Code EC/MA, Spanagel Hall, Room 401A

(831)656-2678, DSN 756-2859
Fax (831)656-2760 (ECE) and (831)656-2355 (MA)
tmartins@nps.edu

Academic Associate

Don Danielson
Code MA, Spanagel Hall, Room 238B

(831) 656-2622, DSN 756-2622, FAX (831) 656-2355
dad@nps.edu

Brief Overview

This program is designed to meet the needs of the Department of Defense for graduates who are skilled in applying concepts of higher mathematics. The objective of the program is to equip an officer with the skill to analyze a military problem, formulate it in mathematical terms, solve or approximate a solution, and interpret and present the results.

Completion of this curriculum also qualifies an officer as an Applied Mathematics Subspecialty with a code of 4100P. A typical job in this subspecialty is an instructor in

mathematics at the U.S. Naval Academy or the U.S. Military Academy at West Point.

Requirements for Entry

Preparatory to graduate work in applied mathematics, the officer shall have completed a strong program of study at the undergraduate level or the first three quarters of the mathematics core sequence, which includes linear algebra, advanced calculus in one and several variables, ordinary differential equations, probability and statistics. Officers not having the required qualifications for direct input enter the program indirectly through the Engineering Science (460) curriculum. An APC of 324 is required.

Entry Date

Advanced Science (Applied Mathematics) is an eight-quarter course of study with preferred entry date in June. If further information is needed, contact the Academic Associate or Program Officer for this curriculum.

Typical Course of Study

Quarter 1

MA1113	(4-0)	Single Variable Calculus I
MA1114	(4-0)	Single Variable Calculus II w/ Matrix Algebra
MA2025	(4-0)	Logic & Discrete Mathematics I
NW3230	(4-2)	Strategy & Policy

Quarter 2

MA1115	(4-0)	Multi-variable Calculus
MA1116	(3-0)	Vector Calculus
MA3025	(4-1)	Logic & Discrete Mathematics II
MA3042	(4-0)	Linear Algebra

Quarter 3

MA3046	(4-0)	Linear Algebra
MA3110	(4-0)	Intermediate Analysis
MA2121	(4-0)	Differential Equations
MA3560	(3-0)	Modern Appl Algebra $ Num Theory

Quarter 4

NW3275	(4-0)	Joint Maritime Ops I
MA3301	(4-0)	Linear Programming
MA3132	(4-0)	PDEs
OA3101	(4-1)	Probability

Quarter 5

NW3276	(2-2)	Joint Maritime Ops II
MA3607	(4-0)	Real Analysis
MA3232	(4-0)	Num Analysis
OA3102	(4-1)	Statistics

Quarter 6

MA4322	(4-0)	Principles and Techniques of Applied Mathematics I
MA3677	(4-0)	Complex Analysis
MA3xxx	(3-0)	Elective

OA3103	(4-1)	Data Analysis

Quarter 7

MA4323	(4-0)	Principles and Techniques of Applied Mathematics II
MA0810	(4-0)	Thesis Research
MA4xxx	(3-0)	Elective
MA4xxx	(4-0)	Elective

Quarter 8

MA0810	(4-0)	Thesis Research
MA0810	(4-0)	Thesis Research
MA4xxx	(3-0)	Elective
NW3285	(4-0)	National Security Decision

Educational Skill Requirements (ESR) Applied Mathematics - Curriculum 380

The value of graduate education in mathematics lies in the vast breadth of its applicability. The officer with advanced education in mathematics possesses skills in problem solving, modeling, abstraction, optimization, and analysis that are sufficiently general that they apply in many arenas and never lose their currency in the face of changing technology and yet-to-be-identified needs. Graduate education in mathematics is a career-long enabler. Students in the Applied Mathematics curriculum will receive a solid mathematical foundation as they transition into graduate curricula emphasizing relevant and modern advanced mathematical techniques. Students will be encouraged to develop and utilize skills in analysis, reasoning, creativity, and exposition as they acquire knowledge of mathematics and its applications.

1. **Fundamental Areas:** The officer will complete courses in the following fundamental areas of Mathematics, developing sufficient mastery to qualify for teaching Mathematics at the undergraduate level.
   a. Single, Multivariate, and Vector Calculus
   b. Linear Algebra and Algebraic Structures
   c. Logic and Discrete Mathematics
   d. Real and Complex Analysis
   e. Modern Applied Algebra and Number Theory
   f. Numerical Analysis
   g. Mathematical Modeling in Applied Mathematics
   h. Ordinary and Partial Differential Equations

2. **Applications:** The officer will become well-versed in the applications of mathematics to real world problems of interest to the military, enhancing performance in post-graduate operational billets and policy making positions.

3. **Computer Skills**: The officer will acquire the ability to use higher-level structured computer languages on current workstations

4. **Communication and Research Skills:** The officer will perform independent research in an area of Mathematics, develop written and oral presentation skills, and gain instructional experience.

5.   **Joint Professional Military Education:** Graduates will complete the Navy Joint Professional Military Education Phase I requirements.

Department of Electrical and Computer Engineering

Chairman

Clark Robertson, Ph.D.
Code EC, Spanagel Hall, Room 437A

(831) 656-2081, DSN 756-2081, FAX (831) 656-2760
crobertson@nps.edu

Associate Chairman, Instruction

Frank Kragh, Ph.D.
Code EC/Kh, Spanagel Hall, Room 448B

(831) 656-7502, DSN 756-7502
fekragh@nps.edu

Associate Chairman, Student Programs

Monique P. Fargues, Ph.D.
Code EC/Fa, Spanagel Hall, Room 456

(831) 656-2859, DSN 756-2859
fargues@nps.edu

Associate Chairman, Research

Phil Pace, Ph.D.
Code EC/Pc, Spanagel Hall, Room 543B

(831) 656-2645, DSN 756-2645
pepace@nps.edu

Associate Chairman, Operations

Michael Hsu, CDR, USN
Code EC/Hs, Spanagel Hall, Room 422

dsneely@nps.edu

Ronald G. Aikins, Research Associate (2006), BSCS, Western Kentucky University, 1979

Robert W. Ashton, Associate Professor (1992); Ph.D., Worcester Polytechnic Institute, 1991.

Nathan Brown, Research Associate (2012); M.S., Case Western Reserve University, 2010.

Jon T. Butler, Distinguished Professor (1987); Ph.D., Ohio State University, 1973.

Roberto Cristi, Professor (1985); Ph.D., University of Massachusetts, 1983.

Monique P. Fargues, Professor and Associate Chair for Student Programs (1989); Ph.D., Virginia Polytechnic Institute and State University, 1988.

Douglas J. Fouts, Professor (1990); Ph.D., University of California at Santa Barbara, 1990.

David Garren, Associate Professor (2012); Ph.D., College of William and Mary, 1991.

Deborah Goshorn, Research Assistant Professor (2008); Ph.D., University of California at San Diego, 2010.

Rachel Goshorn, Assistant Professor (2006); Ph.D. University of California at San Diego, 2005.

Tri T. Ha, Professor (1987); Ph.D., University of Maryland, 1977.

Phil Hopfner, Research Associate (2005); B.S., University of Washington, 1984

Robert (Gary) Hutchins, Associate Professor (1993); Ph.D., University of California at San Diego, 1988.

David C. Jenn, Professor (1990); Ph.D., University of Southern California, 1989.

Alex Julian, Assistant Professor (2004); Ph.D., University of Wisconsin, Madison, 1997.

Jeffrey B. Knorr, Professor Emeritus (1970); Ph.D., Cornell University, 1970.

Frank Kragh, Associate Professor and Associate Chair for Instruction (2003); Ph.D., Naval Postgraduate School, 1997.

Herschel H. Loomis, Jr., Distinguished Professor (1981); Ph.D., Massachusetts Institute of Technology, 1963.

John McEachen, Professor (1996); Ph.D., Yale University, 1995.

James Bret Michael, Professor (2004); Ph.D. George Mason University, 1993.

Sherif Michael, Professor (1983); Ph.D., University of West Virginia, 1983.

Donna Miller, Research Associate (2007); MSSE (Software Engineering), Naval Postgraduate School, 2000.

Michael A. Morgan, Distinguished Professor (1979); Ph.D., University of California at Berkeley, 1976.

Giovanna Oriti, Associate Professor (2008); Ph.D. University of Catania, Italy, 1997.

Phillip E. Pace, Professor and Associate Chair for Researcher (1992); Ph.D., University of Cincinnati, 1990.

Andrew Parker, Research Associate (1996); M.S., University of Maryland, 1994; MSES, Naval Postgraduate School, 1992.

Matthew Porter, Research Associate (2012); M.S., Naval Postgraduate School, 2011.

John P. Powers, Distinguished Professor Emeritus (1970); Ph.D., University of California at Santa Barbara, 1970.

R. Clark Robertson, Professor and Chair (1989); Ph.D., University of Texas at Austin, 1983.

Ric Romero, Assistant Professor (2010); Ph.D. University of Arizona, 2010.

Alan Ross, Professor of the Practice of Computer Engineering (2008); Ph.D., University of California, Davis, 1978.

Deborah Shifflett, Research Associate (2001); MPA, Golden Gate University, 1996.

Weilian Su, Associate Professor (2004); Ph.D., Georgia Institute of Technology, 2004.

Frederick Terman, Senior Lecturer (1983); MSEE, Stanford University, 1964.

Charles W. Therrien, Professor Emeritus (1984); Ph.D., Massachusetts Institute of Technology, 1969.

Preetha Thulasiraman, Assistant Professor (2012); Ph.D. University of Waterloo, Ontario, Canada, 2010.

Murali Tummala, Professor (1986); Ph.D., India Institute of Technology, 1984.

Todd Weatherford, Associate Professor (1995); Ph.D., North Carolina State University, 1993.

Xiaoping Yun, Distinguished Professor (1994); Sc.D., Washington University, 1987.

Lawrence J. Ziomek, Professor (1982); Ph.D., Pennsylvania State University, 1981.

Dan Zulaica, Research Associate (2010); B.S., University of Texas at Arlington, 1981.

*The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

Brief Overview

The Department of Electrical and Computer Engineering is the major contributor to programs for the education of officers in the Electronic Systems Engineering curriculum, the Combat Systems curriculum, the Space Systems Engineering curriculum, the Electronic Warfare curriculum and the Information Warfare curriculum. Additionally, the department offers courses in support of other curricula such as Information Technology

Management; Command, Control, Communications, Computers and Intelligence (C4I); Space Systems Operations; Underwater Acoustics and Engineering Acoustics.

If needed, an MSEE student will usually spend six to twelve months learning or reviewing material at a junior or senior level before entering into graduate studies. The graduate study portion of a typical program is about one year in duration with a combination of course study and thesis work being performed. The thesis portion of the program is the equivalent of four courses (one quarter) with an acceptable written thesis being a requirement for graduation.

The curriculum is organized to provide the students with coursework spanning the breadth of Electrical and Computer Engineering. In addition, students concentrate in one major area of specialization within Electrical and Computer Engineering by taking a planned sequence of advanced courses. Currently there are formal concentrations in:

Communications Systems
Computer Systems
Cyber Systems
Guidance, Navigation and Control Systems
Power Systems and Microelectronics
Signal Processing Systems
Network Engineering
Sensor Systems Engineering

The department has about forty faculty members, including tenure track, non-tenure track, and military faculty, contributing to the instructional and research programs.

Mission

The ECE department mission is to provide NPS students with the highest quality and most defense-relevant graduate education available in electrical and computer engineering.

Degrees

The ECE department offers programs leading to the Master of Science degree in Electrical Engineering (MSEE), the Master of Science in Engineering Science with a major in Electrical Engineering [MSES(EE)] or the Master of Science in Engineering Science with a major in Computer Engineering [MSES(CE)], the Master of Engineering with major in Electrical Engineering[MEng(EE)] or the Master of Engineering with a major in Computer Engineering [MEng(CE)], the degree of Electrical Engineer (EE) and Doctor of Philosophy (Ph.D.). A student is able to earn one of the academic degrees listed above while enrolled in Electronic Systems Engineering (Curriculum 590 resident or 592 non-resident distance learning), Space Systems

Engineering (Curriculum 591), Combat Systems Science & Engineering (Curriculum 533), and Undersea Warfare (Curriculum 525). The department typically graduates over forty graduate degree candidates per year in resident programs and additional candidates in distant learning programs.

MSEE Degree Program

The MSEE Degree Program is accredited by the Engineering Accreditation Commission (EAC) of ABET, http://www.abet.org. A Bachelor of Science in Electrical Engineering or its equivalent is required for the MSEE degree. Credits earned at the Naval Postgraduate School and credits from the validation of appropriate courses at other institutions are combined to achieve the degree equivalence.

To complete the course requirements for the MSEE degree, a student needs a minimum of 52 credit hours of graduate level work. There must be a minimum of 36 credits in the course sequence 3000-4999, of which at least 30 credits must be in Electrical and Computer Engineering. The remainder of these 36 credits must be in engineering, mathematics, physical science, and/or computer science. Specific courses may be required by the department and at least four courses that total a minimum of 12 credits, must be in the course sequence 4000-4999.

An acceptable thesis for a minimum of 16 credits must be presented to, and approved by, the department.

MSEE Program Educational Objectives: The MSEE Degree program has the following objectives (i.e., skills and abilities that graduates are expected to attain 3-5 more years after graduation):

· **Technical Leadership:** Graduates in the several years following graduation will be known and respected for their technical leadership along diverse career paths in government service and/or the private sector.

· **Technical Program Management:** Graduates in the several years following graduation will possess the ability to handle assignments related to research, design, development, procurement, maintenance, and life cycle management of electronic systems for Naval and other military platforms.

· **Operational Utilization:** Graduates in the several years following graduation will possess the ability to understand the capabilities and limitations of military electronic systems and to effectively employ electronic systems in military operations.

MSEE Student Outcomes: In order to achieve the above objectives, the Program curriculum is designed to produce the following outcomes (skills and abilities students will have at the time they complete the Program):

· **Independent Investigation:** Students will possess the ability to conduct and report the results of a technically challenging, defense-relevant independent investigation.

· **EAC of ABET Criterion 3. Student Outcomes:** Students will satisfy Engineering Criteria (a) – (k) of the Engineering Accreditation Commission of ABET's Engineering Criteria for General Baccalaureate Level Programs in Criterion 3 applied to the demonstration of the mastery of the advanced-level material of the curriculum.

Students with acceptable academic backgrounds may enter a program leading to the degree Master of Science in Engineering Science with an emphasis in Electrical Engineering [MSES{EE} degree]. The program of each student seeking this degree must contain at least 52 credit hours of graduate level work including 36 credit hours in the course sequence 3000-4000. Of these 36 course credits, at least 20 must be in Electrical and Computer Engineering, and an additional 12 must be in engineering, mathematics, physical science and/or computer science. At least 12 of the 36 must be in the course sequence 4000-4999. All students must register for a minimum of 16 hours of thesis research and submit an acceptable thesis. This program provides depth and diversity through specially arranged course sequences to meet the needs of the Navy and the interests of the individual. The department chairman's approval is required for all programs leading to this degree.

MSES(EE) Degree Program

Students who do not have BSEE degrees and are unable to achieve BSEE equivalency can pursue the MSES(EE) degree. Such students must by virtue of their education and on-the-job experience be capable of successfully completing one of the MSEE Degree Program specialization tracks. Except for BSEE degree equivalency, the requirements for the MSES(EE) degree are the same as those for the MSEE degree.

MEng(EE) Program

The Master of Engineering (Electrical Engineering) is a course-based degree program for non-resident students enrolled in distance learning programs. Students must complete a minimum of 32 credit hours of graduate level course work which includes a minimum of three courses and 10 credit hours of 4000 level course work. MEng(EE) degree programs must contain a minimum of 5 courses in electrical and computer engineering. This degree program is quite flexible and can be designed with a focus tailored to meet distance learning customer requirements for workforce development.

EE Degree Program

Students with strong academic backgrounds may enter a program leading to the degree of Electrical Engineer. The EE degree program requires more course work and a more comprehensive thesis than a master's degree program but

does not require the seminal research demanded in a Ph.D. program.

A minimum of 96 total graduate credits is required for the award of the engineer's degree, of which at least 24 must be in accepted thesis research, and at least 54 credits must be in Electrical and Computer Engineering courses.

At least 36 of the total hours are to be in courses in the sequence 4000-4999. Approval of all programs must be obtained from the Chairman, Department of Electrical and Computer Engineering.

TSSE Program

The Total Ship Systems Engineering Program is an interdisciplinary, systems engineering and design-oriented program available to students enrolled in Mechanical Engineering, Electrical and Computer Engineering or Combat Systems programs. The program objective is to provide a broad-based, design-oriented education focusing on the warship as a total engineering system. The eight-course sequence of electives introduces the student to the integration procedures and tools used to develop highly complex systems such as Navy ships. The program culminates in a team-performed design of a Navy ship, with students from all three curricula as team members. Students enrolled in programs leading to the Electrical Engineer Degree are also eligible for participation. Entry requirements are a baccalaureate degree in an engineering discipline with a demonstrated capability to perform satisfactorily at the graduate level. The appropriate degree thesis requirements must be met, but theses that address system design issues are welcome.

Ph.D. Degree Program

The Department of Electrical and Computer Engineering has an active program leading to the Doctor of Philosophy degree. Joint programs with other departments are possible. A noteworthy feature of these programs is that the student's research may be conducted away from the Naval Postgraduate School in a cooperating laboratory or other installation of the federal government. The degree requirements are as outlined under the general school requirements for the doctor's degree.

ECE Department Laboratories

The laboratories of the department serve the dual role of supporting the instructional and research activities of the department. The department has well-developed laboratories in each specialty area.

Nano-electronics Lab

This laboratory supports design and analysis of semiconductor devices, design and development of VLSI integrated circuits, and design, implementation and testing of microprocessor and VLSI systems. Major equipment of the lab includes: Semiconductor Parameterization Equipment, Capacitance-Voltage measurement

equipment, Semi-automatic Probing stations, High Speed Sampling Scopes, Logic Analyzers, Printed Circuit Assembly tools, Unix and PC workstations, Silvaco(TM) TCAD simulation tools, Tanner and Cadence Design tools and Semiconductor Parameterization Equipment (high power capability), Manual Probing stations (2+), Wire-bonding equipment, and PC workstations. The lab supports courses and thesis research projects in the MSEE degree Computer/Nanotechnology track and Power/Solid state track. This lab will be a major player in the nanoelectronics of the NPS Nano/MEMs initiative.

Digital Electronics/Microprocessor Lab

This laboratory is an instructional lab that supports courses in digital logic design and microprocessor-based system design. Students acquire practical knowledge through hard-wired and programmable logic design. Programmable design includes CPLDs (complex programmable logic devices) and FPGAs (field-programmable gate arrays). Students learn how to develop combinational and sequential circuits using hardware description languages, VHDL and/or Verilog. They learn the design, verification, and simulation process used in contemporary digital computer design using tools like ModelSim, Precision, and Synplify Pro. This lab supports instruction in microprocessor programming and interfacing, as well as system design involving high-speed pipeline processors and architectures. Specifically, ARM is used as a representative RISC (reduced instruction set computer) processor. Students gain an understanding of embedded computing through assignments that create systems which acquire inputs (data, keyboard entry, A/D etc.) and produce outputs (processed data, displayed data, D/A, etc.). For example, students program an NXT robot that accepts human-supplied controller input and produces signals that drive actuator motors.

Circuits and Signals Lab

This laboratory provides support for instruction and research in the areas of basic analog design, discrete component testing, fundamental circuit design, and communication theory. The laboratory is equipped with CAD facilities capable of schematic capture, circuit simulation, and fault detection. The lab utilizes various test equipment to include, but not limited to, oscilloscopes, signal generators, spectrum analyzers, multi-meters, and high-speed data acquisition equipment.

Academic Computing Lab

This laboratory is the largest PC-equipped learning resource center in Spanagel Hall and the primary PC computational facility for the Department of Electrical and Computer Engineering. It is primarily a teaching laboratory for accomplishing computer assignments that are assigned as part of ECE courses. It is also used for research-related computing but only when such computing does not interfere with course work. The laboratory serves

approximately 350 students annually and supports over 25 courses and over 12 curricula. It is also heavily used for student thesis preparation. The computers in this lab are, by necessity, high-end systems because the vast majority of software used in the lab are scientific and engineering applications that are extremely computationally intensive. The NPS Information Technology Assistance Center (ITAC) organization supplies labor for maintenance and upgrading of this facility.

Optical Electronics Lab

This laboratory provides educational and research support in the areas of fiber optics, lasers (including a fiber sigma laser), integrated optics and electro-optics. The laboratory has a variety of fiber optics instrumentation (including two OTDRs, a fusion splicer, optical spectrum analyzer, connector application equipment, a 1.5 Gb/s digital pattern generator and BER tester, an optical fiber amplifier, optical autocorrelator for pulsewidth measurement, various diode laser controllers), RF and microwave instrumentation (signal synthesizer, microwave spectrum analyzer), and general purpose test instrumentation. A variety of detectors, integrated optical modulators and imaging equipment are also available. The lab supports EC3210, EC3550, EO3911, EC4210, thesis students, and research in fiber optic communications and optical signal processing.

Electromagnetics Lab

This laboratory supports instruction and research in the area of microwave systems and technology. This is accomplished with a mix of hardware, instruments, test systems, and software. Included in the lab inventory are scalar and vector microwave network analyzers, electromagnetic software for simulating antennas, ships and aircraft, and a software design system for simulation of microwave circuits and systems. There is also a fully automated anechoic chamber for antenna pattern measurements.

Radar and Electronic Warfare Systems Lab

The objective of the Radar and Electronic Warfare (EW) Systems Laboratory is to educate military officers and civilians in the technology and operational characteristics of electronic warfare. The Radar and Electronic Warfare Systems Laboratory supports both research and teaching. The hardware laboratory contains instrumented radar and electronic warfare equipment and has been in operation for over 35 years. Each radar system is well instrumented to operate as a teaching tool. The equipment allows the student to experience hands-on knowledge of performance characteristics, conduct experimental research, and reinforces concepts that are taught in the classroom.

Controls and Robotics Lab

This laboratory is mainly an instructional lab that supports experiments for all courses in Guidance, Navigation, Controls, and Robotics. Lab facilities include servo control stations and associated computers (equipped with A/D and D/A data acquisition cards, LabView, and Matlab/SIMULINK software) that are used to conduct simulations and physical experiments, modeling, analysis, and design of control systems. The lab is also equipped with advanced robots to support robotics laboratory assignments and thesis projects in robotics.

Power Systems Lab

The Power Systems Laboratory supports postgraduate education and thesis research related to the design, analysis, simulation and implementation of power converter and electric drive technology. Thesis research projects are closely coupled to current Department of Defense priorities including more-survivable power system architectures such as DC Zonal Electric Distribution, Integrated Power Systems, and electric propulsion. In coursework and projects, students employ modern device technologies, hardware-in-the-loop synthesis tools, simulation packages, measurement devices, and power converter and electric machine modules to assess component operation, develop feedback controls, and study evolving power system challenges. An emphasis is placed on prototyping and validating against detailed simulation models.

Digital Signal Processing Lab

This laboratory supports instruction and research in the area of Digital Signal Processing. Research and student thesis include work in the areas of detection and classification of signals, face recognition, acoustic communications, multirate signal processing and other areas. Lab facilities include several Windows based workstations and the capability of programming Field Programmable Gate Arrays (FPGA) for real time applications.

Computer Communications and Networking Lab

This laboratory supports instruction and research in computer network design, engineering, and infrastructure development. The lab is currently divided between guided media (wire and fiber optic) networks and wireless networks. The lab also has facilities within the NPS High Performance Computing lab for network simulation and experimentation. Thesis work and research undertaken include modeling and simulation of high-speed and wireless networks and related protocols, video transmission and voice transmission over digital networks, traffic modeling, simulation and analysis, design and simulation of wide area networks, and related areas. Guided media lab facilities include routers, LAN switches, Voice-over-IP servers, Telcom fiber optic switches, ATM switches, video processing equipment, a channel simulator, protocol analyzers, network simulation packages, and computer workstations. The wireless lab facilities include WiFi,

WiMax, VoIP, and sensor mote equipment, as well as a variety of signal generation and analysis equipment.

Secure Computing Lab

This lab contains computing facilities for classified projects (up to the SECRET level). It contains a variety of computing platforms from Windows-based PCs to a Linux cluster. The lab is also heavily used by students preparing classified documents including class presentations and theses.

Cryptologic Research Lab (CRL)

This laboratory is the NPS's center for research in communications engineering, focusing on physical layer design issues for wireless communications devices. Research areas emphasized are non-binary modulation, forward error correction coding, software defined radio, spread spectrum systems, cellular systems, wireless local and wide area networks, and interference mitigation. The CRL's facilities include many tools for modern communications engineering, such as eight software defined radio design stations; a state-of-the-art wireless fading channel simulator; arbitrary waveform generators; microprocessor-, digital signal processor (DSP)-, and field programmable gate array (FPGA)-based signal possessing development systems; and various signal generation, capture, and analysis tools.

Flash X-ray Lab

The NPS Flash X-ray Laboratory provides DoD support, testing and research capability to study weapons effects on electronics. It provides a Gamma radiation source to verify operation of electronic circuit and systems in a nuclear weapons environment. The machine can additionally be used to study Electro Magnetic Pulse for nuclear or microwave weapons. This is one of two Flash X-ray systems in the Navy (NRL).

Signal Enhancement Lab

The ECE department does a significant amount of research in wireless communications functions, both transmitting and receiving, in-the-clear and encrypted, solving interference, electromagnetic compatibility and radio spectrum utilization issues. Applications include Direction Finding, Improvised Explosive Device detection and jamming, and low-profile and Ultra-Wide-Band antenna development. This laboratory provides hardware and software support of these projects and is entirely research-supported.

Other support facilities within the department include the Calibration and Instrument Repair Laboratory. Classified instruction and research are supported by appropriately certified facilities.

Calibration and Repair Lab

The Calibration Lab and Electronics Repair Lab is a dual function facility that provides Electronics Calibration capabilities and Electronics General Repair functions.

The Electronics Test Equipment Repair Lab is a full-time, stand-alone repair facility. It provides a wide repair support for all NPS Electronics Test Equipment that are listed in the Property Book Inventories, maintained by each department. Repair parts, test equipment and library of repair and service manuals are also maintained on site.

The Calibration Lab is a Type 4 Electronics Field Repair Facility (FCA) assigned to region METCALPAC, Tech HQ, NAVSEASYSCOM. All test equipment that falls within the assigned Phase Packages (4 Phases) are all supported.

Electrical and Computer Engineering Course Descriptions

EC Courses

EC0810 Thesis Research (0-8) Spring/Summer/Fall/Winter
Every student conducting thesis research will enroll in this course. Prerequisites: None.

EC0820 Integrated project (0-12) As Required
This course is available to students in the Electrical and Computer Engineering Department who are participating in an integrated project. Prerequisites: Consent of instructor.

EC0950 Seminar (No Credit) (0-1) As Required
Lectures on subjects of current interest will be presented by invited guests from other universities, government laboratories, and from industry, as well as by faculty members of the Naval Postgraduate School. Prerequisites: None.

EC1010 Introduction to Matlab (1-1) Spring/Summer/Fall/Winter
An introductory course for students with little or no programming background using MATLAB. Basic concepts of the MATLAB environment are considered, such as matrix operations, vector and matrix manipulations, equation solving, simulation, programming, and graphing. This course prepares students for using MATLAB in future course work in the ECE department. Graded on a Pass/Fail basis only. Prerequisites: None.

EC2010 Probabilistic Analysis of Signals and Systems (3-1) Summer/Winter
The foundations of signals and systems are developed from probabilistic and statistical approaches. Emphasis is on signal processing, communication systems, and computer networks relevant to military applications. Topics include probability, random variables, and random sequences; density and distribution functions; deterministic versus nondeterministic signals; expectation, the dc and the r.m.s. values of nondeterministic signals, correlation and covariance; radar and sonar signal detection; LTI systems, transformation of random variables and the central limit theorem; basic queuing theory and computer communication networks. Prerequisites: EC2410 (may be taken concurrently).

EC2100 Circuit Analysis (3-2) Summer/Winter
The fundamental circuit analysis course for Electrical Engineering majors. The course considers circuit principles, circuit topology, direct current circuits, natural response, forced response, total response, impedance concepts, the application of the Laplace transformation to solve circuit problems and device transfer functions. The laboratories will utilize both computer software and hands-on exercises. Prerequisites: PH1322, MA1043, and MA2121 (may be concurrent).

EC2110 Circuit Analysis II (3-2) Fall
A continuation of EC2100. The course considers circuit principles, impedance concepts and steady-state ac circuits, ac power, frequency response and selectivity, basics of operational amplifiers and an introduction to machines and power converters. Prerequisites: EC2100.

EC2200 Introduction to Electronics Engineering (3-3) Summer/Winter
An introduction to electronic devices and circuits. Solid state physics and semiconductor fundamentals. Properties of p-n junctions in diodes; Bipolar Junction Transistors (BJT) and Field Effect Transistors (FET); static and dynamic models for these devices, and their linear and nonlinear applications. Applications of transistors in the design of amplifiers and digital systems. Ideal operational amplifiers characteristics and applications. Fabrication and the design of integrated circuits. Prerequisites: EC2100.

EC2220 Electrical Engineering Design (3-4) Spring
A team-based capstone engineering design course emphasizing the application of electrical engineering principles, devices, and circuits to the design, analysis, implementation, and testing of electronic systems. The intensive laboratory component initially reviews various electronic circuits useful in the design of the final project. Final projects require the design, analysis, implementation, testing and demonstration of an electronic system that also incorporates realistic parameters impacting the design process, such as economics, ergonomics, ethics, environmental impact, safety, etc. Prerequisites: EC2200.

EC2300 Introduction to Control Systems (3-2) Summer/Winter
This course presents classical analysis of feedback control systems using basic principles in the frequency domain (Bode plots) and in the s-domain (root locus). Performance criteria in the time domain such as steady-state accuracy,
transient response specifications, and in the frequency domain such as bandwidth and disturbance rejection are introduced. Simple design applications using root locus and Bode plot techniques will be addressed in the course. Laboratory experiments are designed to expose the students to testing and evaluating mathematical models of physical systems, using computer simulations and hardware implementations.ME2801 and EC2300 are equivalent courses. PREREQUISITES: AE2440/EC2440 and MA2121. This course can be offered as an online course. Familiarity with the MATLAB development environment is assumed.

EC2320 Linear Systems (3-1) Fall
Formulation of system models including state equations, transfer functions, and system diagrams for continuous and sampled-data systems. Computer and analytical solution of system equations. Stability, controllability, and observability are defined. Introduction to design by pole placement using measured and estimated state feedback. Application to military systems is introduced via example. Prerequisites: EC2100 and ability to program in MATLAB.

EC2400 Discrete Systems (3-1) Spring/Fall
Principles of discrete systems, including modeling, analysis and design. Topics include difference equations, convolution, stability, bilateral z-transforms and application to right-sided and left-sided sequences, system diagrams and realizations, and frequency response. Simple digital filters are designed and analyzed. Prerequisites: MA1113 and ability to program in MATLAB.

EC2410 Analysis of Signals and Systems (3-1) Summer/Winter
Analysis of digital and analog signals in the frequency domain; properties and applications of the discrete Fourier transform, the Fourier series, and the continuous Fourier transform; analysis of continuous systems using convolution and frequency domain methods; applications to sampling, windowing, and amplitude modulation and demodulation systems. Prerequisites: MA1113 & ability to program in MATLAB or consent of instructor.

EC2440 Introduction to Scientific Programming (Same as AE2440) (3-2) Winter/Summer
This course offers an introduction to computer system operations and program development using NPS computer facilities. The main goal of this course is to provide an overview of different structured programming techniques, along with introduction to MATLAB/Simulink/GUIDE and to use modeling as a tool for scientific and engineering applications. The course discusses the accuracy of digital computations, ways to incorporate symbolic computations, and presents numerical methods in MATLAB functions. PREREQUISITES: Knowledge of single variable calculus and matrix algebra. This course can be offered as an online course.

EC2450 Accelerated Review of Signals and Systems (4-0) As Required
An advanced review of continuous and discrete system theory intended for students who have previous education in these areas. Topics covered by each student will depend upon background and competence in the subject matter of EC2400, EC2410, and EC2320. Prerequisites: Sufficient background in linear systems theory. Graded on Pass/Fail basis only.

EC2500 Communications Systems (3-2) Spring/Fall
In this first course on the electrical transmission of signals, the theory, design, and operation of analog and digital communication systems are investigated. Included are A/D conversion, modulation, demodulation, frequency-division multiplexing, and time-division multiplexing. Prerequisites: EC2200 and EC2410.

EC2650 Fundamentals of Electromagnetic Fields (4-1) Spring/Fall
This course covers electromagnetic field theory and engineering applications. Both static and dynamic electric and magnetic field theory is covered. The complete theory is presented in terms of Maxwell's equations and boundary conditions. Applications include induction, plane wave propagation in lossless and lossy media, analysis of finite transmission lines, and plane wave reflection. Labs provide practical experience with microwave instruments, components, and measurement techniques. Prerequisites: MA1116 or equivalent.

EC2820 Digital Logic Circuits (3-2) Spring/Fall
An introductory course in the analysis and design of digital logic circuits that are the basis for military and civilian computers and digital systems. No previous background in digital concepts or electrical engineering is assumed. Topics include: data representation, Boolean algebra, logic function minimization, the

design and application of combinatorial and sequential SSI, MSI, and LSI logic functions including PLAs and ROMs, and the fundamentals of finite state machine design and applications. Laboratories are devoted to the analysis, design, implementation, construction, and debugging of combinatorial and sequential logic circuits using SSI, MSI, LSI, and programmable logic devices. Prerequisites: None.

EC2840 Introduction to Microprocessors (3-2) Summer/Winter

An introduction to the organization and operation of micro processing and microcomputers, both key embedded elements of military systems. Topics include: the instruction set, addressing methods, data types and number systems, stack and register organization, exception processing, assembly language programming techniques including macros, assembly language implementation of typical control structures, data structures, and subroutine linkage methods. Laboratory sessions teach a systematic method for program design and implementation. The laboratory assignments consist of a series of programs which collectively implement a major software project. Prerequisites: A high level language.

EC2990 Design Projects in Electrical Engineering (0-8) Spring/Summer/Fall/Winter

Design projects under the supervision of faculty members. Individual or team projects involving the design of devices or systems. Projects will typically be in support of faculty members. Prerequisites: Consent of instructor. Graded on Pass/Fail basis only.

EC3000 Introduction to Graduate Research (1-0) Spring/Summer/Fall/Winter

This course is designed to prepare students to undertake graduate research and to write a thesis or dissertation. The first part of the course provides an overview of (1) the NPS Department of Electrical and Computer Engineering, the department's research program and its faculty, (2) the NPS Research Program and the organization and functions of the NPS Research Office, (3) NPS library electronic resources, (4) an overview of S&T planning in the DoD, and (5) guidance on the thesis process. In the second part of the course, research opportunities are presented by the faculty. A broader view of the field of electrical and computer engineering is gained through student attendance at ECE Department seminars delivered by outside speakers. In the third part of the course, students are exposed to thesis research currently being carried out in the ECE Department by attending thesis presentations delivered by graduating students. Prerequisites: Consent of instructor. Graded on Pass/Fail basis only.

EC3110 Electrical Energy: Present and Emerging Technologies (3-2) Spring

This course presents electrical energy topics for on shore facilities, expeditionary and ship applications divided into three categories; generation, distribution and consumption. For these three categories the current state of the art is presented first and then expounded with emerging technologies including renewable energy sources, energy harvesting, smart grid, micro-grids, smart metering, energy management systems, flexible AC transmission systems (FACTS), battery management systems, all electric and hybrid transportation systems, more efficient loads such as lighting, motors and power converters. PREREQUISITE: EC2100 or EO2102 (may be taken concurrently) or consent of instructor.

EC3130 Electrical Machinery Theory (4-2) Winter

An introduction to the analysis of magnetically-coupled circuits, dc machines, induction machines, and synchronous machines. The course will include explicit derivations of torque, voltage, and flux linkage equations, formulation of steady-state circuits, development of reference frame theory, and the basics of machine simulation as required in shipboard electric drive analysis. Prerequisites: EC2100.

EC3150 Solid State Power Conversion (3-2) Summer

A detailed analytical approach is presented for the operation, performance, and control of the important types of solid state power converters found in naval shipboard power systems. The course reviews the characteristics of power semiconductor switching devices. A systems approach is used to analyze high power converters: phase controlled rectifiers, line commutated inverters, self-commutated inverters, transistor converters, and switching regulators. Prerequisites: EC2100 or consent of instructor.

EC3200 Advanced Electronics Engineering (3-2) Spring

Characteristics of differential and multistage amplifiers. Transistors frequency response, including Bipolar Junction Transistors (BJT), Junction Field Effect Transistors (JFET), and Metal Oxide Semiconductor Field Effect Transistors (MOSFET); characteristics and design consideration. Integrated circuit OPAMP applications; analysis and design of non-ideal OPAMPs. Applications of BJTs and Complementary Metal Oxide Semiconductors (CMOS) in integrated circuits, and different biasing techniques. Analysis and design of digital circuits, including Transistor Logic (TTL), Emitter Coupled Logic (ECL), and CMOS logic families. Applications and design feedback amplifiers and operational amplifiers applications in analog filters and oscillators. Prerequisites: EC2200.

EC3210 Introduction to Electro-Optical Engineering (4-1) Fall

An overview of the elements that comprise current military electro-optical and infrared (EO/IR) systems. Topics include properties of light, optical elements, quantum theory of light emission, operating principles of laser sources, propagation of Gaussian beams, laser sources, laser modulators, thermal sources of radiation, laser and IR detectors (photomultipliers, photoconductors, photodiodes, avalanche photodiodes), signal-to-noise analysis of direct- and heterodyne-receiver systems. Includes military applications of electro-optic and infrared technology such as missile seekers, laser designators, laser weapons, and Bragg-cell signal processors. Prerequisites: EC2200 and EC2650.

EC3220 Semiconductor Device Technologies (3-2) Fall

This course is intended to familiarize the student with solid state device operation and fabrication of present day semiconductors and transistor technologies. Topics include: fundamental theory of charge transport, semiconductor materials (Si, GaAs, SiGe, InP), bandgap engineering, epitaxy crystal growth, and semiconductor device manufacturing technology. A virtual wager lab is accomplished in the software labs to visualize parameters as impurity implants to electron flow. Measurement labs will utilize hands-on wafter probe measurements of digital and analog devices. Prerequisites: EC2200 or equivalent.

EC3230 Space Power and Radiation Effects (Formerly EO3205) (3-1) Spring

Fundamentals of different power systems utilized in spacecraft; photovoltaic power technology; solid-state physics, silicon solar cells, solar cell measurement and modeling, gallium arsenide cells and II-V compounds in general, array designs and solar dynamics.

Radiation effects on solid state devices and materials. Survivability of solar cells and integrated circuits in space environment and annealing method. Other space power systems including chemical and nuclear (radioisotope thermoelectric generators and nuclear reactors). Energy storage devices and power conversion. Spacecraft power supply design. Note: EC3230 is taught with compressed scheduling (first six weeks of quarter). Prerequisites: EC2200.

EC3240 Renewable Energy at Military Bases and for the Warfighter (3-2) Summer

The course will introduce participants to current energy use at military bases as well as mobile platforms power sources. Participants will be introduced to state-of-the-art renewable energy systems that would be utilized at military installations. This will include; detailed study of Photovoltaic & Solar Energy use, overview of wind energy & other renewable energy sources, as well as energy storage systems. Cost saving comparisons and environmental impact will be conducted. The course will also investigate the use of some of the above renewable systems in mobile platforms for the warfighters and expeditionary forces personal use. PREREQUISITE: EC2100 or EO2102 (or equivalent basic course in Electrical Engineering.)

EC3280 Introduction to MEMS Design (3-3) As Required

This is a 4.5 credit hour class introducing the students to Micro Electro Mechanical Systems (MEMS). Topics include material considerations for MEMS and microfabrication fundamentals. Surface, bulk and non-silicon micromachining. Forces and transduction; forces in micro-nano-domains and actuation techniques. Case studies of MEMS based microsensor, microactuator and microfluidic devices. The laboratory work includes computer aided design (CAD) of MEMS devices and small group design project. Prerequisites: basic understanding of electrical and mechanical structures: EC2200 or MS2201 or PH1322 or consent of instructor.

EC3310 Optimal Estimation: Sensor and Data Association (3-2) Winter

The subject of this course is optimal estimation and Kalman filtering with extensions to sensor fusion and data association. Main topics include the theory of optimal and recursive estimation in linear (Kalman filter) and nonlinear (extended Kalman filter) systems, with applications to target tracking. Topics directly related to applications, such as basic properties of sensors, target tracking models, multihypothesis data association algorithms, reduced order probabilistic models and heuristic techniques, will also be discussed. Examples and projects will be drawn from radar, EW, and ASW systems. Prerequisites: EC2320, EC2010, and MA2043 or consent of instructor.

EC3320 Optimal Control Systems (3-2) Spring

This course addresses the problem of designing control systems which meet given optimization criteria. The student is exposed to the development of the theory, from dynamic programming to the calculus of variation, and learns how to apply it in control engineering. Prerequisites: EC2300, EC2320.

EC3400 Digital Signal Processing (3-2) Spring/Fall

The foundations of one-dimensional digital signal processing techniques are developed. Topics include Fast Fourier Transform (FFT) algorithms, block convolution, the use of DFT and FFT to compute convolution, and design methods for nonrecursive and recursive digital filters. Multirate signal processing techniques are also introduced for sampling rate conversion, efficient analog to digital, digital to analog conversion, time frequency decomposition

using filter banks and quadrature mirror filters. Computer-aided design techniques are emphasized. The algorithms introduced have direct applications in sonar and radar signal processing, IR sensor arrays, modern navy weapon systems, and also in voice and data communications. Prerequisites: EC2410 or EC2400.

EC3410 Discrete-Time Random Signals (3-2) Summer/Winter

Fundamentals of random processes are developed with an emphasis on discrete time for digital signal processing, control, and communications. Parameter estimation concepts are introduced, and impact of uncertainty in parameter evaluation (estimated moments and confidence intervals) are presented. Random processes are introduced. DKLT and applications to image processing and classification problems are considered. Impact of linear transformations to linear systems is discussed. FIR Wiener, and matched filters are introduced. IIR Wiener filter introduced, time permitting. Applications to signal and system characterization in areas such as system identification, forecasting, and equalizations are considered to illustrate concepts discussed during the course. Prerequisites: EC2410 (may be concurrent) and EC2010.

EC3450 Fundamentals of Ocean Acoustics (4-0) Fall

Introduction to various mathematical techniques (both exact and approximate), special functions (e.g., Bessel functions, Hankel functions, and Legendre polynomials), orthogonality relationships, etc., that are used to model and solve real world problems concerning the propagation of sound in the ocean. Topics include, for example, reflection and transmission coefficients, ocean waveguide pulse-propagation models based on normal mode and full-wave theory, the WKB approximation, three-dimensional ray acoustics, and the parabolic equation approximation. Prerequisites: Standard undergraduate sequence of calculus and physics courses for engineering and science students.

<EC Courses EC3500-EC3910, 30,...90>

EC3500 Analysis of Random Signals (4-0) Fall

Fundamental concepts and useful tools for analyzing non-deterministic signals and noise in military communication, control, and signal processing systems are developed. Topics include properties of random processes, correlation functions, energy and spectral densities, linear systems and mean square estimation, noise models and special processes. Prerequisites: EC2500 (may be concurrent) and EC2010, or consent of instructor.

EC3510 Communications Engineering (Unclassified) 3-1 (Winter)

The influence of noise and interference on the design and selection of digital and analog communications systems is analyzed. Topics include link budget analysis and signal-to-noise ratio calculations, receiver performance for various analog and digital modulation techniques, and bandwidth and signal power trade-offs. Examples of military communications systems are included. Prerequisites: EC3500 or EC3410.

EC3600 Antennas and Propagation (3-2) Summer/Winter

A fundamental understanding of antennas, scattering, and propagation is developed. Characteristics and design principles of common antenna types such as dipoles, arrays, horns, reflectors and microstrip patches, are considered. Concepts of antenna gain and effective area are used to develop power link equations. Scattering theory is introduced and propagation phenomena are considered for real-world scenarios. Design applications include phased, Yagi and log-periodic arrays, as well as shaped-beam reflector antennas,

sidelobe suppression, radar target scattering, stealth principles, surface waves, HF and satellite communications. Prerequisite: EC2650 or equivalent.

EC3610 Microwave Engineering (3-2) Spring

This course provides an overview of the circuits and devices used in microwave radar communication and electronic warfare systems. The course covers network analysis using scattering parameters, transmission media, selected circuits, electron tubes, solid state devices, and monolithic integrated circuits. Circuits and devices are studied in the laboratory using both hardware and computer simulation. Prerequisite: EC2650.

EC3630 Radiowave Propagation (3-2) Spring

This course treats the effects of the earth and its atmosphere on the propagation of electromagnetic waves at radio frequencies. Topics covered include ground waves, sky waves, ducting, reflection, refraction, diffraction, scattering, attenuation, and fading. Basic theory is covered and computer models are introduced where appropriate. Emphasis is placed on determination of the transmission loss between transmitting and receiving antennas. Computer laboratory exercises are used to illustrate the propagation characteristics of various indoor and outdoor environments, and their effects on system performance. Prerequisites: EC2650 or consent of instructor.

EC3700 Joint Network-Enabled Electronic Warfare I (3-2) Fall

The concept of information operations (IO) and the critical role for electronic warfare (EW) are examined. The net-enabled force transformation is presented emphasizing how network-enabled EW technology provides a force multiplier for this transformation. Important EW technology components of SeaPower-21 are emphasized. The network space – battlespace duality and the Global Information Grid are also analyzed (FORCEnet). Metrics are presented to quantify the information value from wireless networks of distributed sensors and weapons. A direct assessment of the value of the network (information superiority) to the combat outcome (battlespace superiority) is presented. Integrated air defense suppression examples are studied using game theory to demonstrate the concepts. The role of intelligence also is emphasized. Sensor technologies and their use in the battlespace are presented. Mathematical models for electronic attack (EA) techniques are developed including those against GPS, RF and IR sensors. Off-board EA techniques including chaff, towed and rocket decoys, and digital image synthesizers are emphasized for counter-surveillance, counter-targeting and counter-terminal. High-power microwave and laser-based directed energy weapons are examined. Sensor protection techniques are discussed including an introduction to the new area of counter-electronic support. Students do a research project on a topic of interest from the Force Transformation Roadmap. Laboratory exercises are also conducted in the Radar and Electronic Warfare Laboratory. Prerequisites: EC2500 and EC2650 or equivalent.

EC3710 Computer Communications Methods (3-2) Spring/Fall

The course objective is to develop an understanding of computer communications networks with emphasis on the requirements of military environments and the U.S. Navy's combat platforms. Coverage includes the essential topics of network topology, connectivity, queuing delay, message throughput, and performance analysis. The layered network architectures, such as the seven-layer OSI model and DoD's TCP/IP protocol suite, are covered. The techniques and protocols used in these layers are discussed. Local area networking technologies such as Ethernet, FDDI and wireless Ethernet, and wide area technologies such as X.25 and frame relay are covered. Principles of networking devices (hubs, switches, and routers) are presented. Some distributed applications are presented briefly. Prerequisites: EC2010 and EC2500.

EC3730 Cyber Network and Physical Infrastructures (3-2) Winter

Cyber infrastructure systems and technologies of interest to the military. Copper and fiber media networks, telecommunication networks and signaling, the Internet, enterprise networks, network-centric sensing, collection, monitoring, dissemination, and distribution of critical data. Terrestrial wireless networks: cellular networks, local area and long haul data networks (GSM, WiFi, WiMAX, LTE, Link 16 and Link 22). Space based networks: satellite communication networks, wide area large sensor networks. Heterogeneous networks: end-la-end communication, sensing, collection, and distribution across fiber, terrestrial wireless, and satellite networks, protocols, design and performance analysis. Control and overlay networks such as Supervisory Control and Data Acquisition (SCADA) systems and the National power grid. Prerequisites: EC2500 and understanding of basic communication systems and networks.

EC3740 Reverse Engineering in Electronic Systems (3-2) Summer

Presents fundamental, systems-level concepts for developing an understanding of system functionality - with an emphasis on hardware systems - without a prior access to the system's design specifications. Considers generalized approaches to developing a set of specifications for a complex system through orderly examination of specimens of that system. Illustrates procedures for identifying the system's components and their interrelationships. Demonstrates methods for creating representations of the system in another form or at a higher level of abstraction. Presents fundamental definitions for forward engineering, reverse engineering, design recovery, restructuring and reengineering. Basic analysis techniques such as impulse response will be introduced. System identification techniques such as parameter estimation, Markov models and linear time-invariant (LTI) theory will be used to build dynamical models from observed data. Case studies from several domain areas will be presented to include: integrated circuit (IC) and circuit board analysis, communications protocol analysis, software disassembly, and programmable logic verification. Prerequisite: EC3730 and some knowledge in assembly and/or C, or consent of instructor.

EC3750 Introduction to SIGINT Engineering (3-2) Fall

An introduction to the technology of signals intelligence systems, with particular emphasis on the means for accessing signals of intelligence value. Covers the three major branches of SIGINT: communications intelligence, electronic intelligence, and foreign instrumentation signals intelligence. Collection platform, receivers, and antennas are examined. Emitter location techniques are considered. Prerequisites: EC3410 or EC3500 or EO3512, U.S. citizenship and Top Secret clearance with eligibility for SCI access.

EC3760 Information Operations Systems (3-2) Winter

This course examines the Network-centric Environment that is the focus of the Information Operations (IO) infrastructure with emphasis on current and future implementation models. A Signals Intelligence (SIGINT) approach is taken in which the adversary's computer network system architecture is examined and evaluated for the purpose of exploitation, protection, and/or attack. A thorough review of the fundamentals of communications, computer networks, and advanced digital technologies is discussed. This

course works closely with the Department of Defense to reinforce realistic approaches for solving critical IO issues within the community. Prerequisites: EC2500 OR EO2512 or consent of instructor. Classification: U.S. citizenship and TOP SECRET clearance with eligibility for SCI access.

EC3800 Microprocessor Based System Design (3-2) Fall

Advanced microprocessor system concepts are studied. Microprocessor systems are widely used for embedded control in military systems as well as for stand-alone computers. Topics covered are CPU operation and timing, address decoding, typical LSI support chips, exception processing, design of static and dynamic memory systems, worst-case timing analysis, bus arbitration, and direct memory access controllers. The laboratory consists of a design project integrating hardware and software using a state-of-the-art development system. Prerequisites: EC2820.

EC3820 Computer Systems (3-2) Summer

The course presents a unified approach for the design of computer systems stressing the interacting processes implemented in hardware, software, and firmware. General features of operating systems are studied as well as specific features of an existing system. The elements of a multiprogramming system are introduced. Prerequisite: EC2840.

EC3830 Digital Computer Design Methodology (3-2) Winter

A design and project-oriented course covering basic principles, theories, and techniques for practical design of digital systems. Emphasizes an integrated viewpoint combining essential elements of classical switching theory with a thorough understanding of modern design aids. Current military and commercial systems are used as design examples. Prerequisite: EC2820.

EC3840 Introduction to Computer Architecture (3-2) Spring

The fundamental principles of computer architecture and processor design, including the influences of implementation technology, cost, performance, and the historical development of computer architecture. Levels of abstraction and instruction set/architecture design. Processor design and implementation, including the data path and the control unit. Computer design, including buses, the memory hierarchy, and the input/output subsystem. Factors affecting performance and performance measurement, evaluation, and comparison. The effects of embedded military applications on computer architecture. Prerequisites: EC2820.

EC3860 Trustworthy Computer Hardware Analysis and Design (3-2) Spring

This course initially presents a detailed review of the techniques, methods, and tools used by engineers to design and implement modern, high-performance, digital circuits, systems, and computers. This is followed by a detailed review of implementation technologies, at all levels of integration from discrete devices to complete systems on a chip, including the use of COTS, ASIC, and programmable devices, that are typically used for implementing a wide range of digital systems including servers, desk-top computers, embedded computers, reconfigurable computers, and network routers and switches. Course material then focuses on the vulnerabilities of the design, implementation, and manufacturing processes to the covert addition of malicious functionality, as well as the vulnerabilities of the underlying implementation technology. Finally, the techniques and methods required to design, implement, and manufacture trusted, high-performance, digital circuits, systems, and computers are studied. Corequisite: EC3740.

EC3910, 20, 30,...90 Special Topics in Electrical Engineering (V-V) Spring/Summer/Fall/Winter

Courses on special topics in Electrical Engineering are offered under these numbers. In most cases, new courses are offered as special topics of current interest with the possibility of being developed as regular courses. See the Electrical and Computer Engineering Department's on-line catalog for current offerings.

EC4000 Introduction to Doctoral Research (2-0) Spring/Fall

The main objectives of the course are to foster interaction among the doctoral students and the department faculty and to promote excellence in research. Additional objectives of the course are to prepare the doctoral students to initiate the screening and qualifying steps of the program, to undertake dissertation research, and to publish and present research results. Along with an overview of the ECE Ph.D. program, the course provides guidance on the program preliminaries, such as the screening and qualification exams and minor requirements, and the dissertation research process. A broad overview of the current research problems in the field of electrical and computer engineering relating to the needs of national defense and in the ECE department in particular is presented. Students in the early stages of their program will be exposed to ongoing dissertation research and advances in the field through research presentations delivered by doctoral students in the research phase of their program, NPS faculty and outside researchers. The course provides the opportunity for doctoral students at all levels of progress to meet once a week to discuss their research, share ideas, rehearse conference presentations and dissertation defenses, and to gain exposure to a diversity of research topics and ideas. Graded on Pass/Fail basis only. PREREQUISITE: Approved ECE Ph.D. student or Consent of the ECE Ph.D. Program Committee.

EC4010 Principles of Systems Engineering (3-2) Spring/Fall

An introduction to systems engineering concepts and methods for the design and integration of complex defense systems, with emphasis on electrical engineering applications. Familiarity with the systems engineering process is developed through case studies of representative defense systems and a group design project which includes determination of system requirements from mission needs and operational requirements. Digital simulation models, including those in current use by DoD, are used to determine engineering and performance tradeoffs. Prerequisites: Four quarters in an NPS engineering curriculum or equivalent.

EC4130 Advanced Electrical Machinery Systems (4-2) Spring

Advanced analysis of detailed and reduced-order representations of shipboard electric machinery and power electronic drives. This course will include extensions to 3-phase machine and network connections, constant flux and current source control, extensive simulation examples including saturation and open-phase conditions, comprehensive investigation of linearized and reduced-order machine and drive representations, the modeling and control of a dc link system, and the fundamentals of AC machine vector control. Prerequisites: EC3130.

EC4150 Advanced Solid State Power Conversion (4-1) Fall

Design and analysis of modern power electronic drives with particular emphasis on electric drives for present and future ship propulsion systems and variable frequency/variable speed power converters for advanced shipboard electric power distribution. Electrical and mechanical systems compatibility and electrical

system interfacing topics are addressed. This course begins by examining the non-ideal aspects of power semiconductor switches and other components. In addition, dynamic performance of power electronic circuits is explored. The course includes some more advanced topics like resonant converters and active power line conditioners. Prerequisites: EC3150 and electrical machine theory, or consent of instructor.

EC4210 Electro-Optic Systems Engineering (3-0) Winter
Advanced topics and application of electro-optics. Military applications of electro-optic and infrared technology such as laser communications, laser radar, and Bragg cell signal processors. Signal-to-noise analysis of laser detector performance. Student reports on EO/IR topics of current military interest. Prerequisites: EC3210.

EC4220 Introduction to Analog Vlsi (3-1) Summer
Modern active circuit design topologies; analog and sampled data networks. Analysis of transfer function properties, stability and causality. Higher order filter design and synthesis. Use of computer simulation tools, SPICE, and different device models for network analysis. Transformation methods and switched-capacitor filtering and non-filtering applications. Introduction to analog VLSI techniques using stray-insensitive switched-capacitor networks. Examples of such analog VLSI designs in military applications. Prerequisites: EC2400 and EC3200 or EC2200 with consent of instructor.

EC4230 Reliability Issues for Military Electronics (3-1) Winter
This course investigates where and why semiconductor devices fail in military environments. Topics include limitations of commercial-off-the-shelf (COTS) integrated circuits, thermal failure, electrostatic breakdown, noise in solid state devices, packaging reliability issues, radiation effects due to space and nuclear environments, and the limited availability of military integrated circuit suppliers. Prerequisites: EC3220.

EC4280 Micro Electro Mechanical Systems (MEMS) Design II (2-4) As Required
Same as ME4780 and PH4280. This is the second course in Micro Electro Mechanical Systems (MEMS) Design. This course will expose students to advanced topics on material considerations for MEMS, microfabrication techniques, forces in the micro- and nano-domains, and circuits and systems issues. Case studies of MEMS-based microsensors, microactuators, and microfluidic devices will be discussed. The laboratory work includes computer aided design (CAD) and characterization of existing MEMS devices. The grades will be based on exams, lab projects, and a group design project. Prerequisites: ME/EC/PH3280 or ME3780 or consent of instructor.

EC4300 Advanced Topics in Modern Control Systems (3-1) As Required
Advanced topics and current developments in control systems are presented in this course. The list of special topics includes (but it is not limited to) robotics systems, autonomous vehicles, and design by robust techniques. Prerequisites: Consent of instructor.

EC4310 Fundamentals of Robotics (3-2) Fall
This course presents the fundamentals of land-based robotic systems covering the areas of locomotion, manipulation, grasping, sensory perception, and tele-operation. Main topics include kinematics, dynamics, manipulability, motion/force control, real-time programming, controller architecture, motion planning, navigation, and sensor integration. Several Nomad mobile robots will be used for class projects. Military applications of robotic systems will be discussed. Prerequisites: MA3042; either EC2300 or EC2320, or consent of instructor.

EC4320 Design of Robust Control Systems (3-2) Winter
This course presents advanced topics on control system design. Major emphasis is on robust techniques in order to account for uncertainties on the systems to be controlled. Several applications show the trade-offs in several applications, such as missile and/or underwater vehicles control design. Advanced concepts on H2 and H-infinity will be introduced as part of the course. Prerequisites: EC3310, EC3320.

EC4330 Navigation, Missile, and Avionics Systems (3-2) Spring
Principles of missile guidance, including guidance control laws, basic aerodynamics and six degree-of-freedom motion simulation. Additional topics are selected from the following areas to address the general interests of the class: advanced guidance laws, passive sensors, INS guidance, fire control and tracking systems, and ballistic missile targeting. Prerequisites: EC3310. Classification: U.S. citizenship and SECRET clearance.

EC4350 Nonlinear Control Systems (3-2) Spring
This course presents techniques for automatic control of nonlinear systems with application to current military and robotic systems. Main topics include the analysis and design of nonlinear systems with phase plane and describing function methods, Lyapunov and sliding mode control techniques. Accuracy limit cycles, jump resonances, relay servos, and discontinuous systems will also be considered. Prerequisites: EC2300, EC2320.

EC4400 Advanced Topics in Signal Processing (3-0) As Required
Special advanced topics in signal processing not currently covered in a regularly scheduled course and relevant to advanced naval and other military applications. Topics may include digital filter structures and implementations, advanced computational topics and architectures for signal processing, imaging, recent work in signal modeling, array processing, or other topics of interest. Prerequisites: Consent of instructor.

EC4430 Multimedia Information and Communications (3-1) Fall
The course objective is to present essentials of real-time communication of digital multimedia (audio, video and text) information over packet-switched networks by bringing together topics from digital signal processing (information processing), digital communications (information transmission and reception), and computer networking (information distribution). Algorithms for compression of multimedia information are presented. Related international standards, such as G.728, JPEC, MPE3, MP3, LZW, and IS95, are discussed. Major topics include digital representation and compression of multimedia information, transmission (storage) and distribution of compressed information, and end-to-end delivery issues, such as loss, reliability, security and encryption of multimedia information. Prerequisites: EC3410 or EC3500.

EC4440 Statistical Digital Signal Processing (3-2) Fall
Modern methods of digital signal processing are developed in this course from a statistical point of view. Methods are developed for processing random signals through statistical data analysis and modeling. Topics include adaptive filtering, linear prediction, MA, AR, and ARMA signal modeling, lattice structures, and an

introduction to subspace methods and other modern methods of spectrum estimation. Techniques presented are applied to various engineering problems such as system identification, forecasting, and equalization. The algorithms introduced have direct applications in communication, sonar, radar systems signal processing, and modern Navy weapon systems. Prerequisites: EC3410 or EC3500 and MA2043 or consent of instructor.

EC4450 Sonar Systems Engineering (4-1) Winter
Mathematical development and discussion of fundamental principles that pertain to the design and operation of passive and active sonar systems critical to naval operations. Topics from complex aperture theory, array theory, and signal processing are covered. This course supports the undersea warfare and engineering acoustics curricula and others. Prerequisites: EC3450 or PH3452 or OC3260 and either EC3410 or EC3500 or EO3402 or equivalent.

EC4460 Artificial Neural Networks (3-1) Summer
The basic theory and practice of artificial neural networks and their applications in electrical engineering are presented. Modeling of biological neurons as processing elements, their organization into a network of interconnected artificial neurons, and some basic laws of learning are discussed. Details of learning algorithms, such as LMS, backpropagation, self-organizing map, and adaptive resonance theory are presented. Emphasis is placed on problems related to pattern recognition and classification, control systems, optimization, and data compression. Course projects address DOD specific applications, such as radar/sonar target recognition and classification using image or acoustic data. Prerequisites: EC3500 or EC3410 and knowledge of simple electronic and logic circuits.

EC4480 Image Processing and Recognition (3-2) Winter
This course provides image processing background for understanding modern military applications, such as long range target selection, medium range identification, and short range guidance of new weapons systems. Subjects include image sampling and quantization, image representation, enhancement, transformation, encoding, and data compression. Predictive coding, transform coding, and interframe coding techniques are also introduced. 3D to 2D imaging projections are also introduced to extract 3D information either from motion or stereo imaging. Some effort is directed toward image compression techniques particularly suited for multimedia video conferencing. Prerequisites: EC3400.

EC4500 Advanced Topics in Communications (3-0) As Required
Topics and current developments in communications relevant to advanced naval and other military applications. Offered on an occasional basis with the topics determined by the instructor. Prerequisites: Consent of instructor.

EC4510 Cellular Communications (3-0) Winter
This course presents the fundamentals of cellular communications. Cellular architectures, propagation models, modulation formats, diversity techniques, equalization, error control, multiple access techniques, networking, and standards such as AMPS, N-AMPS, IS-54, GSM, and IS-95 are covered. Prerequisites: May be taken concurrently with EC3510.

EC4530 Soft Radio (3-2) Summer
An introduction to soft radios, devices that generate (transmitter) and/or process (receiver) digital communications signals in software and in reconfigurable hardware. The course covers basic radio frequency (RF) design principles, soft radio architectures, analysis of receiver operation, and existing soft radio efforts. Prerequisite: EC3510 or consent of instructor.

EC4550 Digital Communications (4-0) Spring
This course presents the advantages and limitations of modern military M-ary digital communications systems. M-ary modulation formats, matched filter receivers, probability of symbol error calculations, coherent and non-coherent receivers, carrier and symbol synchronization, modems, bandwidth and signal energy, diversity combining, and fading channels are covered. Examples of current operational and proposed military and commercial space and earth links are treated. Prerequisites: EC3510.

EC4560 Spread Spectrum Communications (3-2) Summer
Methods of reducing the effects of hostile jamming on military radio communications systems are considered. Direct sequence spread spectrum systems and frequency-hopped spread spectrum systems are examined with regard to their LPI, LPD, AJ, and multiple access capabilities. Time-hopped and hybrid systems are also considered. Coarse and fine synchronization problems and techniques are presented. Prerequisites: EC3510.

EC4570 Signal Detection and Estimation (4-0) Winter
Principles of optimal signal processing techniques for detecting signals in noise are considered. Topics include maximum likelihood, Bayes risk, Neyman-Pearson and min-max criteria and calculations of their associated error probabilities (ROC curves). Principles of maximum likelihood, Bayes cost, minimum mean-square error (MMSE), and maximum a posterior estimators are introduced. Integral equations and the Karhunen-Loeve expansion are introduced. The estimator-correlator structure is derived. Emphasis is on dual development of continuous time and discrete time approaches, the latter being most suitable for digital signal processing implementations. This course provides students the necessary foundation to undertake research in military radar and sonar systems. Prerequisites: EC3410 or EC3500.

EC4580 Error Correction Coding (4-0) Fall
Digital military communication systems often employ error control coding to improve effectiveness against noise, fading, and jamming. This course, together with EC4560, provides students the necessary foundations for understanding the principles of such systems. Topics include Shannon's channel capacity theorem and coding methods for error control in digital communications systems, including convolutional, block, concatenated, and turbo codes, as well as trellis-coded modulation. Applications of error control coding to modern digital communications systems are discussed. Prerequisites: EC3510.

EC4590 Communications Satellite Systems Engineering (3-0) Winter
Communication satellite systems including the satellite and user terminals. Subjects include orbital mechanics, satellite description, earth terminals, detailed link analysis, frequency division multiple access, time division multiple access, demand assignment, random multiple access, and spread spectrum multiple access. Various military satellite communications systems are introduced. Prerequisites: EC3510 or EO4516.

EC4600 Advanced Topics in Electromagnetics (3-0) As Required
Selected advanced topics in electromagnetics that are not currently covered in regular courses offerings, and relevant to naval and other military applications. Topics may include, but are not limited to, computational electromagnetics, scattering and radiation,

propagation, and new device and antenna concepts. Prerequisites: EC3600 or consent of instructor.

EC4610 Radar Systems (3-2) Summer

The radar range equation is developed in a form including signal integration, the effects of target cross-section, fluctuations, and propagation losses. Modern techniques discussed include pulse compression frequency modulated radar, moving target indicator (MTI) and pulse Doppler systems, monopulse tracking systems, multiple unit steerable array radars, and synthetic aperture systems. Laboratory sessions deal with basic pulse radar systems from which the advanced techniques have developed, with pulse compression, and with the measurement of radar cross-section of targets. Prerequisites: EC3600.

EC4630 Radar Cross Section Prediction and Reduction (3-2) Fall

This course covers the design and engineering aspects of stealth and its impact on platform and sensor design. Signature prediction methods in the radar, infrared (IR), and laser frequency bands are discussed. Radar cross section (RCS) analysis methods include geometrical optics and diffraction theory, physical optics and the physical theory of diffraction, and numerical solutions to integral and differential equations. Prediction methods for IR and laser cross sections (LCS) are also introduced. Signature reduction by shaping, materials selection, and active and passive cancelation are applied to each frequency regime. The measurement of these cross sections is also covered. Prerequisites: EC3600 or consent of instructor.

EC4640 Airborne Radar Systems (3-2) Fall

The main objective of this course is to discuss concepts and digital signal processing techniques involved in modern airborne radars, which detect targets in presence of large ground clutter and other interferences. Radar waveform (or modes) are treated as continuous wave (CW), high pulse repetition frequency (HPRF), medium pulse repetition frequency (MPRF), and low pulse repetition frequency (LPRF). Practical implementation and the signal processing associated with each mode will be elaborated. Advantages and limitations of each mode shall be discussed. Military applications of these modes will be discussed in the existing airborne and surface based radar systems. Concepts and algorithms are covered for digital pulse compression, MTI clutter cancelation, Doppler processing, constant false alarm rate (CFAR) detection, ambiguity resolution, synthetic array radar (SAR) processing and other associated techniques and algorithms. Prerequisites: EC4610 or equivalent.

EC4680 Joint Network-Enabled Electronic Warfare II (3-2) Spring

The course is intended for U.S. students with Secret clearance. The course continues the discussion of counter electronic support and begins with an introduction to low-probability-of-intercept (LPI) emitter signaling techniques and technologies. The origin and importance of the LPI emitter are emphasized. Case studies are shown to demonstrate the capability of the LPI emitter as an anti-ship capable missile seeker. Network enabled receiver techniques are presented highlighting the benefits of the sensor-shooter-information grid and swarm intelligence. The new challenges facing the intercept receiver design and the trends in receiver technology are addressed. To increase the processing gain of the receiver, time-frequency signal processing methods are presented and include the pseudo Wigner-Ville distribution, quadrature mirror filter bank trees for wavelet decomposition and the Choi-Williams distribution. Bi-frequency techniques are also emphasized

and include cyclostationary processing for estimating the spectral correlation density of the intercepted signal. Calculations using each signal processing method are shown to demonstrate the output information and its correlation with the input signal parameters. New detection results are then derived by the student for various LPI signaling schemes to illustrate the parameter extraction methods developed. Autonomous emitter classification architectures are also presented. Laboratory simulation exercises are conducted to demonstrate the concepts. Prerequisites: EC3700, U.S. citizenship, and Secret clearance.

EC4690 Joint Network-Enabled Electronic Warfare II (3-2) Spring

The course is intended for international students and contains the same material as EC4680. The course continues the discussion of counter electronic support and begins with an introduction to low-probability-of-intercept (LPI) emitter signaling techniques and technologies. The origin and importance of the LPI emitter are emphasized. Case studies are shown to demonstrate the capability of the LPI emitter as an anti-ship capable missile seeker. Network enabled receiver techniques are presented highlighting the benefits of the sensor-shooter-information grid and swarm intelligence. The new challenges facing the intercept receiver design and the trends in receiver technology are addressed. To increase the processing gain of the receiver, time-frequency signal processing methods are presented and include the pseudo Wigner-Ville distribution, quadrature mirror filter bank trees for wavelet decomposition and the Choi-Williams distribution. Bi-frequency techniques are also emphasized and include cyclostationary processing for estimating the spectral correlation density of the intercepted signal. Calculations using each signal processing method are shown to demonstrate the output information and its correlation with the input signal parameters. New detection results are then derived by the student for various LPI signaling schemes to illustrate the parameter extraction methods developed. Autonomous emitter classification architectures are also presented. Laboratory simulation exercises are conducted to demonstrate the concepts. Prerequisites: EC3700.

EC4710 High-Speed Networking (3-2) Summer

The course systematically develops the traffic characteristics of DoD and commercial broadband services (video, voice, text, and other multimedia information) and determines the need for high-speed networks with emphasis on quality of service. Queuing theory is used in the design and analysis of the various modules of a high-speed network: traffic modeling, switches, admission control, scheduling, traffic monitoring, and congestion control. Emerging trends and technologies that enable deployment of high-speed global networks for tactical, commercial, and residential use are discussed. Topics include queuing theory, traffic models, traffic management, and broadband technologies, such as ATM, Gigabit Ethernet, DSL, and cable access. Laboratory is concerned with the use of OPNET for simulation studies of various network topologies. Prerequisites: EC3710 or consent of instructor.

EC4715 Cyber System Vulnerabilities and Risk Assessment (3-2) Summer

The course utilizes reverse engineering principles to identify and assess vulnerabilities in electronic, communication, and control systems and analyze risk to provide tradeoffs. Vulnerabilities in cyber systems based on genetic, developmental, and those caused by system overload are presented. Widely accepted industry and military standards, underlying technologies, specification mismatches and interoperability, and resource constraints are

examined to identify vulnerabilities of interest. Vulnerability assessment at component and system level along with prioritization and elimination procedures are discussed. Risk analysis for secure operation of the system and relevant tradeoffs are presented. Laboratory exercises provide hands-on experience. Prerequisite: EC3730, EC3740.

EC4725 Advanced Telecommunication Systems Engineering (3-2) Summer
Studies the engineering of communications transport networks with a particular emphasis on telephony systems. Presents basic concepts in conventional telephony and traffic engineering such as availability, blockage, dimensioning and survivability. Introduces the architecture of Public Switched Telephone Networks (PSTN) and Mobile Switching Networks (MSN). Presents alternatives for enterprise architectures including Private Automatic Branch Exchange (PABX) and Media Gateways (MG). Examines DoN implementations from intra-ship, ship-to-ship and long haul. Discusses approaches to signaling and provisioning. Presents the Signaling System No. 7 (SS7) architecture. Surveys a variety of transport network technologies to include the Synchronous Optical Network (SONET)/Synchronous Digital Hierarchy (SDH) standard, Dense Wavelength Division Multiplexing (DWDM), dark fiber, and metro Ethernet. Introduces carrier-grade Voice-over-Internet Protocol (VoIP) implementations. Concludes with a discussion of Network Management. Prerequisite: EC3710.

EC4730 Covert Communications (3-2) Winter
Electronic signal and data communication mechanisms in which the presence of a message being transmitted is concealed in plain sight of other signals or data are presented. Information hiding in user data, protocol data, and radio, electronic, acoustic and other sensory signals is examined. The techniques of steganography, covert channels, low probability exploitation, and information concealment in analog signals are studied. Techniques and mechanisms for establishing robust, secure covert communication schemes are introduced. The detection, analysis, and abortion of adverse covert communication schemes are discussed. Design of systems suitable for attack and defense of covert communications using programmable logic devices is introduced. Low probability of detect, low probability of intercept, and anti-jamming techniques are reviewed. Embedding and extraction algorithms of steganography are presented. Related topics of watermarking and embedded malware are reviewed. Prerequisite: EC3730 or EC3710.

EC4735 Telecommunications Systems Security (3-2) Fall
Examines underlying technical security issues, policies, standards, implementations, and technologies associated with large-scale commercial telecommunications systems. Reviews the infrastructure and components of carrier class networks to include transport multiplexers and multi-protocol switches. Discusses the public switched telephone network (PSTN) and public land mobile network (PLMN). Begins with a review of the need for Signaling System No. 7 (SS7) and how security is implemented in SS7 networks. Presents fundamental trust assignments in second generation (2G) cellular mobile networks and specifically analyzes trust relationships between core components of the PLMN subsystems. Specifically discusses air interface (Um, Gm) protection measures and presents case studies of systemic flaws. Presents evolutionary changes in security practices in third (3G) and fourth generation (4G) protocols and standards. Examines underlying principles of lawful intercept (LI) implementation and discusses the evolution of LI capability from the PSTN through 3G and 4G networks. Studies the protection of data services in the PLMN and IP Multimedia Subsystem (IMS). Specifically focuses on the General Packet Radio Service (GPRS) Tunneling Protocol (GTP) and Roaming Exchanges (GRX). Discusses future research and proposed security standards in next generation systems. Prerequisite: EC3710 or EC3730.

EC4745 Mobile Ad-Hoc Wireless Networks (3-2) Spring
The course presents the fundamental principles, design issues, performance analysis, and military applications of infrastructure and ad hoc wireless packet switched networks. Radio wave propagation, wireless channel characteristic, orthogonal frequency division multiplexing, transceiver design, channel coding, and other physical layer technologies are reviewed. Principles of wireless local area and wide area (cellular) networks are presented. Design and performance analysis of medium access control mechanisms - contention, reservation and scheduling - are covered. Mobile IP protocol is presented, and reactive and proactive protocols for routing in ad hoc networks are introduced. The performance of TCP over wireless networks is analyzed. Security in infrastructure and ad hoc networks is addressed. Sensor networks are introduced. Energy management is discussed. The widely used and emerging wireless networking standards are reviewed. Hardware laboratory assignments provide hands-on experience and OPNET projects allow simulation of large scale networks to complement the theory presented in the course. Prerequisite: EC3710 or consent of instructor.

EC4750 Sigint Systems II (3-4) Winter
Detailed problems and principles of Signals Intelligence (SIGINT) are presented. Several SIGINT scenarios are studied in class, and students select one for a team project. The scenarios taught are based on SIGINT needs from the National Security Agency (the scenarios are highly classified). The selected SIGINT scenario will require a conceptual design or realignment of national SIGINT systems to satisfy the operational commander's SIGINT needs. Prerequisites: EC3750 or consent of instructor. Classification: U.S. citizenship and TOP SECRET clearance with eligibility for SCI access.

EC4755 Network Traffic, Activity Detection, and Tracking (3-2) Spring
Network traffic characterization, traffic engineering/management and detection and tracking of traffic anomalies are covered with a focus on statistical and information theoretic concepts, signal processing, and control theory. Network (cyber) traffic is characterized based on statistical and information theoretic approaches such as self similarity and information entropy. Traffic flows and traffic flow analysis are presented; multimedia nature of network traffic discussed. Traffic engineering techniques of congestion control, traffic redirection, and admission control are examined utilizing network flows and queue management and analysis. Detection theory is introduced. Detection of threat activity based on traffic anomalies is examined. Neyman-Peason criterion and the receiver operating characteristic are presented. Traffic flow analysis for activity tracking is discussed. Case studies of local area networks, the Internet, sensor networks, and wireless networks including the 4G systems are conducted. Laboratories will provide hands-on experience and introduce tools of traffic characterization, detection, monitoring, and tracing. Prerequisite: EC3730, EC3500.

EC4765 Cyber Warfare (TS/SCI) (3-2) Summer
Cyber warfare explored from an electrical engineering perspective. Historical examples of military cyber warfare operations are reviewed. Rudimentary denial-of-service techniques are initially

discussed and progress to intelligent waveform-specific forms of computer network attack (CNA). The effect of communications signaling manipulation is analyzed in examples involving mobile wireless networks such as Global Systems Mobile (GSM), and the IEEE 802.11 and 802.16 standards. Extension of cyber warfare concepts to large scale systems is presented to include concepts in distributed denial of service attacks, distributed storage, distributed sensor coordination, and information exfiltration. Prerequisites: EC3760; Classification: U.S. citizenship and TOP SECRET clearance with eligibility for SCI access.

EC4770 Wireless Communications Network Security (3-2) Fall

Examines the impact of the radio frequency environment on the security of wireless communications networks. Specifically, considers access and availability issues related to jamming and associated countermeasures such as spread spectrum transmission. Investigates diversity applications such as Multiple Input Multiple Output (MIMO) and Orthogonal Frequency Division Multiplexing (OFDM). Examines confidentiality assurance in the form of encryption and analyzes the impact of the RF environment on various cipher types such as stream and block ciphers. Discusses approaches to integrity assurance in the form of digital hashing, interleaving, and convolutional coding. Examines all of the above factors in the context of a variety of topologies to include personal area networks (PAN), local area networks (LAN), metropolitan area networks (MAN) and wide area networks (WAN). Provides a brief overview of encryption and digital signaling. Analyzes and compares protocol implementations such as Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), the WiMax Cipher Block Chaining Message Authentication Code Protocol (CCMP) and the Mobile Application Part (MAP) of Signaling System No. 7 (SS7). Discuss general aspects of wireless communication vulnerabilities. Prerequisite: EC3710 or EC3730.

EC4775 Computer Network Hardware Security (3-2) Summer

This course initially reviews computer network hardware from the architectural, design, implementation, and manufacturing perspectives. The operational vulnerabilities of networking hardware are then presented. Techniques and methods for improving network hardware security, that are appropriate for both existing and future high-speed networks, are then discussed. Today's cyber networks operate at multi-gigabit wire speeds and future networks are projected to operate at tera-bit speeds. Network security techniques which require packet processing and analysis at these high speeds will be examined, and special hardware implementations will be presented. Additional topics include critical high speed hardware for network security applications, encryption and decryption processors, and hardware intrusion detection schemes. Prerequisite: EC3730, EC3860.

EC4785 Internet Engineering (3-2) Winter

This course examines the optimal design and analysis of interconnected, heterogeneous computer networks, specifically those employed by the US Navy (e.g., IT-21). A common theme throughout will be the confluence of connection-oriented and connectionless data communications and their overarching networking methodologies. The course will focus primarily on the TCT/IP suite. Techniques for segmentation and reassembly, routing, transfer agent placement, error control, throughput analysis, broadcasting, and multicasting will be examined in detail. Performance of common distributed applications will be analyzed. Prerequisite: EC3710 or consent of the instructor.

EC4790 Cyber Architectures and Engineering (3-2) Fall

The course addresses the holistic design, analysis and integration of the three-tiered cyber architecture of the medium, network, and services. Interoperability and interconnection of heterogeneous networks are discussed. Service oriented architectures and service orchestration mechanisms to include such techniques as artificial intelligence, control theory, min-max algorithm and feedback analysis are introduced. Network centric services and system design for both wired and wireless platforms are emphasized. Tools such as WSDL and SoaML will be introduced. System availability calculations and quality of service issues at different levels of the system are discussed in-depth. Comprehensive approaches to security across all levels of the system-medium, network, and services-are analyzed. Development of network centric, distributed engineering applications will be considered for static as well as mobile services. Sensor networks, information fusion, and end-to-end services are studied. Prerequisite: EC3730 or EC3710.

EC4795 Wireless Device Security (3-1) Spring

This advanced course extends earlier study in communications devices and software defined radio to include security vulnerabilities and countermeasures from the perspective of the radio signal and the wireless device. Radio signal vulnerabilities include signal interception, rouge access points, wireless intrusion, client misassociation, unauthorized association, emitter geographical location, direction finding, RF energy detection, and emitter fingerprinting. Wireless device vulnerabilities include backdoor access, tempest, reverse engineering, cloning and tampering of static random access memory field programmable gate arrays, bus snooping, side channel attacks, covert channels, red/black separation, and aspects of software defined and cognitive radios. Prerequisites: EC3500, EC4530.

EC4800 Advanced Topics in Computer Engineering (3-0) As Required

Advanced topics and current developments in computer architecture including such subjects as: graphics and multimedia processors relevant to military applications and workstations; computer structures for artificial intelligence and large data bases; supercomputers and massively parallel architectures; advanced logic design, hardware/software co-design, and multiple-valued logic. Prerequisites: Consent of instructor.

EC4810 Fault-Tolerant Computing (3-2) Summer

Introduction to fault-tolerant computing. The causes and effects of computer, digital system, and software failure. The fundamental concepts and techniques for the design and implementation of fault-tolerant computers, testing digital systems, and software. Modeling, simulation, and evaluation of fault-tolerant systems. Military and space applications of fault-tolerant computing. Prerequisites: EC3800 or EC3840.

EC4820 Advanced Computer Architecture (3-2) Fall

Techniques to achieve high-performance computing, including advanced architectural features and highly parallel processors. Techniques for improving processor, memory subsystem, and I/O subsystem performance, including pipelining, memory interleaving, multi-level caching, and parallel I/O. Parallel computer models, scalability, and clustering. Parallel programming, the role of the compiler, and compiler parallelization techniques. Performance metrics, evaluation, and comparisons between parallel processors. Enabling technologies for highly parallel computers, including the use of microprocessors and field-programmable gate arrays.

Distributed memory. Processor/cluster interconnection networks. Advanced implementation technologies and techniques, including reconfigurable computing. Military applications of high-performance computers and parallel processors. Prerequisites: EC3840.

EC4830 Digital Computer Design (3-2) Spring

This course presents digital system design techniques that can be used in tactical embedded systems. It involves a study of the architecture of and the design process for digital computer systems. Topics covered include instruction set architectures, advanced computer arithmetic, hierarchical design techniques, and design of systems using standard and custom VLSI devices. Modern computer-aided design tools are emphasized. Laboratory project is the design of a digital computer. Prerequisites: EC3800 or EC3830.

EC4870 VLSI Systems Design (3-2) Winter

Introduction to the design and implementation of Complementary Metal Oxide Semiconductor (CMOS) and Bipolar CMOS (BiCMOS) Very Large Scale Integration (VLSI) digital Integrated Circuits (ICs). Topics covered include the specification of the high-level functional design, the design, implementation, and simulation of low-level cells, floor planning and the assembly of low-level cells into the high-level design using hierarchical place-and-route techniques, circuit extraction and simulation for functional verification, timing analysis, and power estimation, and the principles of bulk CMOS, BiCMOS, and SOS/SOI IC fabrication. Applications of VLSI ICs in military systems are also covered. The course is centered around laboratory projects where student groups design, implement, simulate, and submit for fabrication, a full-custom CMOS, BiCMOS, VLSI IC. IC functionality is selected by each student group. A field trip to a commercial foundry and clean room tour is also included. Prerequisites: EC2200 and either EC3800 or EC3830 or EC3840.

EC4900 Topics for Individual Study in Electrical Engineering (V-V) Spring/Summer/Fall/Winter

Supervised study in selected areas of Electrical Engineering to meet the needs of the individual student. A written report is required at the end of the quarter. Prerequisites: Consent of the department chairman. Graded on Pass/Fail basis only.

EC4910, 20,...90 Advanced Special Topics In Electrical Engineering (V-V) Fall

Courses on advanced special topics in Electrical Engineering are offered under these numbers. In most cases, new courses are offered as special topics of current interest with the possibility of being developed as regular courses. See the Electrical and Computer Engineering Department's on-line catalog for current offerings.

EC5810 Dissertation Research (0-8) As Required

Dissertation research for doctoral studies. Required in the quarter following advancement to candidacy and then continuously each quarter until dissertation is approved by the Academic Council.

EO Courses

EO2402 Introduction to Linear Systems (4-1) Summer

A course in the rudiments of linear systems for naval officers in non-electrical engineering curricula. Principles of discrete and continuous-time systems. Topics include difference equations, discrete and continuous convolution, correlation, transfer functions, and system diagrams. Transform applications in communication and control systems. Prerequisites: Ability to program in a higher level language.

EO2512 Introduction to Communications and Countermeasures (4-2) Spring

A first course in communications and countermeasures for the Information Warfare curriculum. The course considers basic electricity and electronics, noise analysis, amplitude modulation, frequency modulation, digital coding, and transmission. Prerequisites: MA3139.

EO2513 Introduction to Communication Systems Engineering (4-2) Winter

A first course in communications systems for the C4I curriculum. The course considers basic electricity and electronics, signals and systems, and amplitude modulation transmission and reception. Prerequisite: MO1901

EO2525 Probabilistic Analysis of Signals and Communications Systems (4-1) Spring

Basic analog and digital communications techniques are discussed. The foundations of signals and systems are developed from probabilistic and statistical approaches. Emphasis is on communication systems relevant to military applications. Topics include AM, FM, probability, random variables, probability density and distribution functions; deterministic versus nondeterministic signals; expectation, the dc and rms values of nondeterministic signals, correlation and covariance; LTI systems, transformation of random variables, and the central limit theorem. Prerequisites: MA2121 and PH1322

EO2652 Fields, Waves, and Electromagnetic Engineering (4-1) Winter

This course covers electromagnetic field theory and engineering applications. Static electric and magnetic field theory is developed and Maxwell's equations are presented. Applications include plane wave propagation, analysis and design of transmission lines, waveguides, resonators, and high frequency components. Labs provide practical experience with microwave instruments, components, and measurement techniques. The objective of the course is to provide a foundation for subsequent study of microwave engineering, antennas, scattering, and radio wave propagation for application in the areas of communications, radar, and electronic warfare. Prerequisites: MA1116 and PH1322, or consent of instructor.

EO3402 Signals and Noise (3-1) Fall

A course in the rudiments of modern signal processing for naval officers in non-electrical engineering curricula. Topics include signal processing in the frequency domain using the DFT and FFT, random signals, their description and processing. Applications to signal detection, demodulation, filtering, beam forming, target tracking, and other relevant naval and military operations. Prerequisites: EO2402 and OS2103 or equivalent.

EO3404 Applied Digital Signal Processing (3-2) As Required

This course introduces the fundamentals of Digital Signal Processing as applied to one dimensional acoustic signals. The course covers the fundamental theory of Signals and Systems, the application of the DFT (Discrete Fourier Transform) to problems in spectral estimation, digital filter design, detection of pulses by correlation and fundamentals of array processing. The laboratories are entirely based on processing of acoustic signals using Metlab. Prerequisites: Permission of the instructor.

EO3502 Telecommunications Systems Technology (4-0) Winter/Summer

A broad-based course in telecommunications systems technology for a multidisciplinary audience. The course considers analog and

digital communications systems. Specific topics include amplitude and angle modulation transmission and reception; baseband and passband digital modulation; system noise; transmission lines, waveguides and antennas; fiber optics; satellite communications. Prerequisites: MO1901.

EO3512 Telecommunications Engineering (4-1) Summer

The second course in communications and countermeasures for the Information Warfare curriculum. The course considers signals and protocols for networks, time and frequency domain multiplexing, transmission lines, antennas, and fiber optics, and cellular communication concepts. Prerequisites: EO2512.

EO3513 Communications Systems Engineering (4-2) Spring

The second course in communications systems engineering for the C4I curriculum. The course considers analog and digital communications systems. Specific topics include angle modulation transmission and reception; the sampling theorem; spectral representation of pulse and digital signals; pulse and digital modulations; baseband coding forms; frequency and time division multiplexing; transmission lines, waveguides and antennas. Prerequisites: EO2513.

EO3516 Introduction to Communication Systems Engineering (4-2) Spring

A first course in communication systems for the Space Systems Operations curriculum. The course considers basic electricity and electronics, signals and systems, and amplitude modulation transmission and reception. Prerequisites: None.

EO3525 Communications Engineering (4-1) Summer

The influence of noise and interference on the design and selection of digital communications systems is analyzed. Topics include link budget analysis and signal-to-noise ratio calculations, receiver performance for various digital modulation techniques, bandwidth and signal power trade-offs, an introduction to spread spectrum communications, and multiple access techniques. Examples of military communications systems are included. Prerequisites: EO2525.

EO3602 Electromagnetic Radiation, Scattering and Propagation (4-2) Spring

The principles of electromagnetic radiation are applied to antenna engineering, scattering, and propagation. The characteristics of various practical antenna types are considered including arrays and reflectors. Scattering concepts are introduced and propagation phenomena are considered. Applications include sidelobe suppression, radar target scattering and stealth approaches, HF and satellite communications. This course is intended for students not in the 590 curriculum. Prerequisites: EO2652 or equivalent.

EO3730 Cyber Communications Architectures (same as CY3300) (4-0) As Required

The purpose of this course is to develop literacy and familiarity with Navy, DoD, and allied enterprise information systems and emerging technology trends. It presents basic concepts in conventional and military telephony and telecommunication networks; examines DoN implementations from intra-ship, ship-to-ship and long haul; and discusses architectures and components of the GIG including both classified and unclassified networks. It discusses interoperability of diverse network architectures and the impact of mobile platforms on operations. Prerequisites: CY3100, CY3110 and CS3030, SECRET.

EO3911 Interdisciplinary Studies in Electrical and Computer Engineering (V-V) Fall

Courses on special topics of joint interest to electrical and computer engineering and other areas are offered under these numbers. In most cases new courses are offered as special topics of current interest with the possibility of being developed as regular courses. See the Electrical and Computer Engineering Department's on-line catalog for current offerings.

EO4512 Communications and Countermeasures (3-2) Fall

The final course in communications and countermeasures for the Information Warfare curriculum. The course develops encryption and decryption concepts, secure communications, and communications countermeasures. Prerequisites: EO3512. Classification: U.S. citizenship and SECRET clearance.

EO4513 Communications Systems Analysis (4-2) Summer

The final course in communications systems engineering for the C4I curriculum. The course considers propagation effects on signal transmission; end-to-end path calculations for wire/coax, optical fiber, and RF systems including terrestrial ground links and satellite communications; spread spectrum; wireless/cellular communications. Prerequisites: EO3513.

EO4516 Communications Systems Analysis (4-2) Summer

The final course in communications systems engineering for the Space Systems Operations curriculum. The course considers propagation effects on signal transmission; end-to-end path calculations for wire/coax, optical fiber, and RF systems including terrestrial ground links and satellite communications; spread spectrum; wireless/cellular communications. Prerequisites: EO3516.

EO4612 Microwave Devices and Radar (4-2) Summer

Those microwave devices most important in radar and in electronic warfare systems are studied, including magnetrons, traveling-wave tubes, and solid-state diodes. The radar range equation is developed. In addition to basic pulse radar, modern techniques are discussed including Doppler systems, tracking radar, pulse compression, and electronically steerable array radars. Electromagnetic compatibility problems involving radar systems from which the advanced techniques have developed, with performance measurement methods, automatic tracking systems, pulse compression, and the measurement of radar cross-section of targets. Prerequisites: EO3602 (may be concurrent) or consent of instructor.

EO4911 Advanced Interdisciplinary Studies in Electrical and Computer Engineering (V-V) Fall

Courses on advanced special topics of joint interest to electrical and computer engineering and other areas are offered under these numbers. In most cases, new courses are offered as special topics of current interest with the possibility of being developed as regular courses. See the Electrical and Computer Engineering Department's on-line catalog for current offerings Prerequisites: None.

Electronic Systems Engineering - Curriculum 590

Website

http://www.nps.edu/Academics/GSEAS/ECE/index.html

Program Officer

LCDR Thor Martinsen
Code EC/MA, Spanagel Hall, Room 401A

(831)656-2678, DSN 756-2859
Fax (831)656-2760 (ECE) and (831)656-2355 (MA)
tmartins@nps.edu

Academic Associate

Monique P. Fargues, Ph.D.
Code EC/Fa, Spanagel Hall, Room 456

(831) 656-2859, DSN 756-2859
fargues@nps.edu

Academic Associate

Roberto Cristi, Ph.D.
Code EC/Cr, Spanagel Hall, Room 452

(831) 656-2223, DSN 756-2223
rcristi@nps.edu

Brief Overview

This curriculum is designed to educate officers in current electronics technology and its application to modern naval warfare. It establishes a broad background of basic engineering knowledge, leading to selected advanced studies in electronic systems, ship/weapon control systems, and communication/information processing applicability. It will enhance individual performance in all duties throughout a naval career, including operational billets, technical management assignments, and policy making positions, thereby preparing Naval officers for progressively increasing responsibility, including command, both ashore and afloat. U. S. Naval officer students are required to complete the requirements for the MSEE degree as well as certain additional requirements specified by the program sponsor for award of a Navy P-code. Other students are not required to satisfy these additional requirements.

Requirements for Entry

A baccalaureate degree in engineering or the physical sciences is desired. Differential and integral calculus, one year of calculus-based college physics and at least one semester of college chemistry are required. The Engineering Science Program within the ESE curriculum is available for candidates who do not meet all admission requirements. The time required will vary with the candidate's background. Prior to undertaking the program, or as a part of the program, each officer will earn/have earned the equivalent of an accredited BSEE. An APC of 323 is required for direct entry.

Entry Date

Electronic Systems Engineering is typically an eight-quarter course of study with entry dates in every quarter. A six-quarter program is available for officers with an ABET EAC accredited BSEE degree on a case-by-case basis. If further information is needed, contact the Academic Associate or the Program Officer.

Degree

Requirements for the Master of Science in Electrical Engineering degree are met en route to satisfying the educational skill requirements.

Subspecialty

Completion of this curriculum qualifies an officer as an Engineering Electronics Subspecialist with a subspecialty code 53XXP. A limited number of particularly well-qualified students may be able to further their education beyond the master's degree and obtain the Degree of Electrical Engineer and a 53XXN subspecialty code. The curriculum sponsor is the Space and Naval Warfare Systems Command.

Typical Subspecialty Jobs

Instructor: Naval Academy, Annapolis, MD
Project Manager: SPAWARSYSCOM; NAVSEASYSCOM; NIWA
Operations Test and Evaluation: COMOPTEVFOR
Electronics Research Manager: NSA/CSS, FT. Meade
C3 Staff Officer: DISA HQ, Washington, DC
Project Officer: Warfare Systems Architecture and Engineering, SPAWARHDQTRS
Electrical Engineer: USSTRATCOM

Typical Course of Study:
Computer Systems Option

Quarter 1

EC2100	(4-2)	Circuit Analysis
EC2820	(3-2)	Digital Logic Circuits
MA1115	(4-0)	Multi-Variable Calculus
NW3230	(4-2)	Strategy & Policy

Quarter 2

EC2110	(3-2)	Circuit Analysis II
EC2200	(3-1)	Introduction to Electronic Engineering
EC2400	(3-3)	Discrete Systems
EC2840	(3-2)	Introduction to Microprocessors

Quarter 3

CS2971	(4-2)	Introduction to Object-Oriented Programming with C++
EC2300	(3-2)	Control Systems

EC2410	(3-1)	Analysis of Signals and Systems
EC3800	(3-2)	Microprocessor Based System Design
EC3000	(1-0)	Introduction to Graduate Research

Quarter 4

ECXXXX		BSEE Elective I
EC3830	(3-2)	Digital Computer Methodology
EC3500	(4-0)	Analysis of Random Signals
EC2320	(3-1)	Linear Systems
EC3000	(1-0)	Introduction to Graduate Research

Quarter 5

ECXXXX		BSEE Elective II
EC2220	(3-4)	Applied Electronics
EC3820	(3-1)	Computer Systems
ECXXXX		BSEE Elective III

Quarter 6

EC4010	(3-2)	Principles of Systems Engineering
EC4830	(3-2)	Digital Computer Design
EC3830	(3-2)	Digital Computer Design Methodology
EC0810	(0-8)	Thesis Research

Quarter 7

ECXXXX		MSEE Elective I
EC3850	(3-1)	Computer Communications Methods
EC0810	(0-8)	Thesis Research
EC0810	(0-8)	Thesis Research

Quarter 8

ECXXXX		MSEE Elective II
EC4800	(3-0)	Advanced Topics in Computer Engineering
EC4870	(3-2)	VLSI Systems Design
EC0810	(0-8)	Thesis Research

The Communications Systems option is designed to provide an advanced education in modern communication engineering topics such as digital communications, spread spectrum communication including anti-jam and low probability of intercept applications, forward error correction coding, wireless networks, and satellite communications.

The Computer Systems option is designed to provide an advanced education in the design, implementation, and application of military computer systems, including such topics as logic circuits, logic design and synthesis, microprocessors, computer and digital systems architecture, military computer architectures, fault tolerant computing, high-speed networking, silicon VLSI and gallium arsenide digital IC design, parallel processing, and the hardware/software interface.

The Guidance, Control, and Navigation Systems option is designed to provide an advanced education in the modeling and simulation advanced dynamic systems, the current state of knowledge regarding state estimation (linear and nonlinear filtering), system identification, and the control of dynamic systems, and to unite the theory with military applications. Courses in specific areas of military application include military robotics, missile guidance and control, and integrated target tracking.

The Solid State Microelectronics and Power Systems option is designed to provide advanced education in the analysis, design, simulation and control of power electronic and electromechanical components and integrated topologies common to existing and proposed military systems.

The Signal Processing Systems option is designed to provide advanced education in algorithms and design of systems for analysis and processing of signals and images encountered in communications, control, surveillance, radar, sonar and underwater acoustics.

The Sensor Systems Engineering option is designed to provide the educational curriculum and thesis research opportunities in a wide range of sensor systems utilized by Navy, DoD and other national agencies. Research efforts cover a wide range of topics dealing with sensor related problems -- from basic research in electromagnetic scattering, propagation and compatibility, or underwater acoustic propagation, to applications to electronic warfare and sonar systems, sensor networks, submarine EM signatures and shielding, weather processing for tactical military radars, digital/optical receivers, low probability of intercept (LPI) emitters and digital phased arrays for sensors and communication systems.

The Network Engineering option offers advanced education in design, implementation and analysis of modern communication networks. Courses cover the infrastructure of network-centric military communication systems to include wireless, mobile ad-hoc and sensor networks, high-speed networks, large-scale network deployment, intrusion prevention systems and architectures for multimedia distribution. Hands-on experimentation and implementation is provided using state-of-the-art networking equipment consisting of optical switches, routers, wireless access points, advanced sensor motes, traffic generators, channel simulators, protocol analyzers, high-resolution vector spectrum analyzers, wireless signal generators, multimedia encoder/decoder transmission systems, and simulation software.

Educational Skills Requirements (ESR)
Electronic Systems Engineering - Curriculum 590
Subspecialty Codes: 5300P-5311P

1. **Mathematics**: The officer will have a thorough knowledge of mathematical tools, which are intrinsic to electrical and computer systems engineering, including but not limited to differential equations, vector analysis, linear algebra, probability, and Fourier and Laplace methods.

2. **Engineering Science and Design**: To acquire the requisite background needed to meet the other military

education requirements, the officer will acquire proficiency in modern physics, electromagnetic, electronic devices and circuits, system theory, modern electronic system design, and integrated electrical power systems and their controls. In addition, proficiency will be gained in other appropriate fields, such as underwater acoustics, dynamics, fluid mechanics or thermo-dynamics, that provide the requisite breadth to a military engineering education.

3. **Cyber Networks and Physical Infrastructures**: The officer will have a sound understanding of cyber infrastructure systems and technologies of interest to the military. Knowledge will include but not be limited to cover copper and fiber media networks, telecommunication networks and signaling, the Internet and enterprise networks, wireless and cellular networks, and spaced based networks. Additionally, officers will gain an understanding of control and overlay networks such as Supervisory Control and Data Acquisition (SCADA) systems and the National power grid. In addition, the officer will have introductory knowledge of computer hardware and their integration into military systems.

4. **Electronic and Electrical Engineering**: In order to provide officers skilled in the application of electronic systems to military needs, the officer will have competence in the broad area of electrical engineering including circuits, electronics, computer and communications networks, and systems engineering. The officer will select elective courses to obtain breadth in his/her understanding of military electronic systems. To achieve depth of understanding, the officer shall specialize in one of the following areas: (a) Communication Systems (including electronic counter-counter measures, low probability of intercept systems, low probability of detection systems, and other military issues) (b) Guidance, Navigation, and Control Systems (c) Microelectronics and Power Systems (d) Signal Processing Systems (as applied to surveillance, underwater acoustic data acquisition and processing, imaging and target location, and other military issues) (e) Computer Systems (including advanced integrated circuits, networking and data communications, parallel and distributed systems, reliable real time military platforms) (f) Sensors (including radar, electro-optical, electronic and information warfare systems) (g) Network Engineering (including wireless networks, sensor networks, high speed data networking, and telecommunication systems) (h) Cyber Systems (including a rigorous treatment of the cyber network and physical infrastructure, cyber system vulnerabilities and risk

assessment, telecommunications systems engineering, trustworthy hardware, and Internet engineering).

5. **System Engineering**: The officer will have a sound understanding of engineering principles utilized in the systems engineering process, particularly as they relate to military systems, including establishment of system related operational requirements and criteria.

6. **Conducting and Reporting Independent Investigation**: The officer will demonstrate the ability to conduct independent investigation of a Navy and/or DoD relevant electronic systems problem, to resolve the problem, and to present the results of the analysis in both written and oral form.

Electronic Systems Engineering (DL) - Curriculum 592

ECE DL Business Manager

Roberto Cristi, Ph.D.
Code EC/Cx, Spanagel Hall
Room 462

(831) 656-2223, DSN 756-2223
rcristi@nps.edu

ECE Associate Chair for Students

Monique P. Fargues, Ph.D.
Code EC/Fa, Spanagel Hall
Room 456

(831) 656-2859, DSN 756-2859
fargues@nps.edu

Brief Overview

Electrical and Computer Engineering Department Distance learning programs are tailored to customer requirements and may lead to one of several master's degrees. Options include the Master of Science in Electrical Engineering (MSEE), the Master of Science in Engineering Science with a major in electrical engineering (MSES(EE)) and the Master of Engineering (MEng). Courses are delivered on a schedule determined in consultation with the customer, with one course per quarter being typical (four courses per year). A typical program can be completed in two to three years. MS degree programs are research-based and require submission and approval of a written thesis. The MEng degree is course-based and may require a capstone project. A 3.0 GQPR in course work is required for award of a master's degree. Non-resident students enrolled in ECE Department certificate programs may, upon completion of the certificate program(s), transfer from the certificate

curriculum to the 592 curriculum and apply certificate program courses toward requirements for a master's degree.

Research or Capstone Project

Course work is followed by research and submission of a written thesis in MSEE and MSES(EE) degree programs. The MSEE Degree Program is accredited by the Engineering Accreditation Commission of ABET and requires that students have a baccalaureate degree from an ABET EAC accredited engineering program or establish equivalency. The ECE Department can provide transition education for the purpose of establishing equivalency, but additional course work is required. The MSES(EE) Degree Program is also research-based but is not accredited by the Engineering Accreditation Commission of ABET. It is intended for students who have not satisfied ABET EAC undergraduate program criteria but by their academic preparation and on-the-job experience can successfully complete graduate courses in a chosen area of electrical engineering. Theses must be submitted and approved within a three year period following the completion of course work in research-based degree programs.

The MEng degree program is course-based, and the degree may be awarded solely on the basis of course work. MEng programs may include a capstone project if a customer wants one. The total time required to complete a degree program ranges from four to seven years, depending on the courses selected.

DL Program Delivery Mode

To maintain quality, it is ECE Department policy to enroll non-resident students in courses offered synchronously to resident students. Courses are delivered to the remote site via video tele-education (VTE) using two-way audio and video. Lectures are recorded and streaming video is made available to accommodate those DL students whose attendance at the remote site is interrupted by job-related travel. Course materials are provided online using SAKAI (http://www.nps.edu/Technology/CLE/). Student mentoring sessions will be scheduled by each instructor and conducted via e-mail or phone. Courses can also be delivered synchronously using Elluminate Live (www.elluminate.com).

Requirements for Entry

An APC score of 323.

Acceptance by the ECE Department: Entrance to the Electrical and Computer Engineering curriculum at Naval Postgraduate School is through a three-part requirement consisting of a minimum grade point average at the undergraduate level, a sufficient mathematics background, and a sufficient background in technical undergraduate studies. Applicants with a B.S.E.E. degree usually will satisfy the last two requirements automatically.

Command/Company endorsement.

Entry Dates

At the beginning of any quarter in the academic year.

Degree

MSEE, MSES(EE) or MEng.

Subspecialty

This program does not lead to a subspecialty code.

Typical course of study (MEng with specialization in EW):

Employment years 1-2

EC3600	(3-2)	Antennas and Propagation
EC3630	(3-2)	Radiowave Propagation
EC3700	(3-2)	Joint Network Enabled Electronic Warfare

Employment years 3-4

EC3210	(3-2)	Introduction to Electro-Optical Engineering
EC3610	(3-2)	Microwave Engineering
EC4610	(3-2)	Radar Systems

Employment years 5-6

EC4630	(3-2)	Radar Cross Section Prediction and Reduction
EC4640	(3-2)	Airborne Radar Systems
EC4680	(3-2)	- Joint Network Enabled Electronic Warfare II

Employment year 7

EC0820	(0-8)	Capstone Project in Electrical Engineering
EC0830	(0-8)	Capstone Project in Electrical Engineering
EC4900		Topics for Individual Study in Electrical Engineering

Electrical Systems Engineering (Energy) - Curriculum 593

Program Officer

LCDR Thor Martinsen
Code EC/MA, Spanagel Hall, Room 401A

(831)656-2678, DSN 756-2859
Fax (831)656-2760 (ECE) and (831)656-2355 (MA)
tmartins@nps.edu

Academic Associate

Monique P. Fargues, Ph.D.
Code EC/Fa, Spanagel Hall, Room 456

(831) 656-2859, DSN 756-2859
fargues@nps.edu

Brief Overview

This curriculum is designed to educate officers in current electronics and power systems technology and its application to modern naval warfare, particularly as it applies to energy consumption and production. It establishes a broad background of basic engineering knowledge, leading to selected advanced studies in electronic systems and ship power control systems. It will enhance individual performance in all duties throughout a naval career, including operational billets, technical management assignments, and policy making positions, thereby preparing Naval officers for progressively increasing responsibility, including command, both ashore and afloat. U. S. Naval officer students are required to complete the requirements for the MSEE degree as well as certain additional requirements specified by the program sponsor for award of a Navy P-code. Other students are not required to satisfy these additional requirements.

Requirements for Entry

A baccalaureate degree in electrical engineering or closely related field is required. Differential and integral calculus, one year of calculus-based college physics are required. The Engineering Science Program within the ESE curriculum is available for candidates who do not meet all admission requirements. The time required will vary with the candidate's background. Prior to undertaking the program, or as a part of the program, each officer will earn/have earned the equivalent of an accredited BSEE. An APC of 323 is required for direct entry.

Entry Date

Electronic Systems Engineering – Energy Specialty is typically an eight-quarter course of study with entry dates in the fall quarter. If further information is needed, contact the Academic Associate or the Program Officer.

Degree Requirements

Degree Requirements for the Master of Science in Electrical Engineering degree are met en route to satisfying the educational skill requirements. Subspecialty Completion of this curriculum qualifies an officer as an Engineering Electronics Subspecialist with a subspecialty code 5311P. The curriculum sponsors are the Space and Naval Warfare Systems Command and the Navy Energy Coordination Office.

Course Matrix

Quarter One:

MA1113	4-0	Single Variable Calculus I
MA1114	4-0	Single Variable Calculus II with Matrix Algebra
AE2440	3-2	Introduction to Digital Computation
EC2500	3-2	Communications Systems
EN3000	2-0	Defense Energy Seminar

Quarter Two:

PH3998	(V-0)	Special Topics in Intermediate Physics
EC2100	(3-2)	Circuit Analysis
EC2300	(3-2)	Control Systems
	(V-V)	JPME
EN3000	2-0	Defense Energy Seminar

Quarter Three:

EC3730	(3-2)	Cyber Network and Physical Infrastructures
EC2110	(3-2)	Circuit Analysis II
EC4010	(3-2)	Principles of Systems Engineering
	(V-V)	JPME
EN3000	2-0	Defense Energy Seminar

Quarter Four:

EC3150	(3-2)	Solid State Power Conversion
EC2200	(3-3)	Introduction to Electronics Engineering
EC3xxx		TBD
	(V-V)	JPME
N3000	2-0	Defense Energy Seminar

Quarter Five:

EC4150	(4-1)	Advanced Solid State Power Conversion
EC0810	(0-8)	Thesis Research
EC3220	(3-2)	Semiconductor Device Technologies
	(V-V)	JPME
EN3000	2-0	Defense Energy Seminar

Quarter Six:

EC3130	(4-2)	Electrical Machinery Theory
EC4230	(3-1)	Reliability Issues for Military Electronics
EC0810	(0-8)	Thesis Research
EC49xx		TBD
EN3000	2-0	Defense Energy Seminar

Quarter Seven:

EC4130	(4-2)	Advanced Electrical Machinery Systems
EC2000		TBD
EC0810	(0-8)	Thesis Research
EC3xxx		TBD
EN3000	2-0	Defense Energy Seminar

Quarter Eight:

EC4950	(V-V)	Advanced Special Topics in Electrical Engineering
EC0810	(0-8)	Thesis Research
EC0810	(0-8)	Thesis Research

| OS3007 | (4-0) | Operations Research for Energy Systems Analysts |
| EN3000 | 2-0 | Defense Energy Seminar |

Total Ship Systems Engineering (Under Department of Electrical and Computer Engineering)

Program Director

Fotis A. Papoulias, Ph.D.
Code ME/PA, Watkins Hall, Room 323

(831) 656-3381, DSN 756-3381
papoulias@nps.edu

Total Ship Systems Engineering

The objective of this program is to provide a broad-based, design oriented education focusing on the warship as a total engineering system including hull, mechanical, electrical and combat systems. The program is for selected Naval Mechanical Engineering, Electrical Engineering, and Combat Systems Sciences and Engineering students and is structured to lead to the MSME, MSEE, or MS in Physics. Entry to the Total Ship Systems Engineering program is through the standard 533/570/590/591 curricula.

Entry Date

Total Ship Systems Engineering will generally fit as part of an eight or nine-quarter program, with TSSE elective commencing in October. The ease of accommodating TSSE in a student's program is influenced by the student's NPS entry quarter and undergraduate background and performance. Individuals interested in the program should explore the necessary course sequencing with the program officer or academic associate as early as possible.

Subspecialty

Completion of this program will contribute toward the graduate's subspecialty code within his/her designated curriculum. The student will also receive 5602P subspecialty code for completion of the TSSE Program.

Typical Subspecialty Jobs

Upon award of the subspecialty code, the officer would be eligible for assignments typical of the P-Code. The expectation is that the combination of education and experience would lead to individuals qualified for assignment later in their career to more responsible positions in systems design and acquisition in NAVSEA, SPAWAR and OPNAV, and as Program Managers.

Cyber Warfare Certificate - Curriculum 288

Academic Associate

Monique P. Fargues, Ph.D.
Code EC/Fa, Spanagel Hall
Room 456

(831) 656-2859, DSN 756-2859
fargues@nps.edu

Brief Overview

The Cyber Warfare Certificate addresses the network threat environment, network infrastructure, network design and security for both wired and wireless environments as well as all facets of computer network operations, depending on the choice of certificate electives. The coursework equips students with an ability to apply techniques for network operations with both wired and wireless computer networks based on an ability to analyze, design and evaluate networks. Electives can be chosen to satisfy requirements for workforce education in both the DoD and Intelligence Community. Non-DoD sectors of government and the private sector which traditionally focus on network defense may also wish to consider this certificate to provide their employees with a more insightful understanding of computer and network defense challenges.

A minimum of 12 credit hours must be completed.

Requirements for Entry

· An APC score of 323.
· Acceptance by the ECE Department: Entrance to the Electrical and Computer Engineering curriculum at the Naval Postgraduate School is through a three-part requirement consisting of a minimum grade point average at the undergraduate level, a sufficient mathematics background, and a sufficient background in technical undergraduate studies. Applicants with a B.S.E.E. degree usually will normally satisfy the last two requirements automatically.
· Command/Company endorsement.
· TS/SCI clearance is required

Entry Dates

Any Quarter

Program Length

9 months

Graduate Certificate Requirements

The academic certificate program must be completed within three years of admission to the program. A student must maintain a 3.0 GQPR in the certificate courses to be awarded a certificate.

Required Courses: Curriculum 288

EC3760	Information Operations Systems (TS/SCI)
EC4765	Cyber Warfare
Elective(s)	From Approved List: DA3105, EC3750, EC4730, EC4755

Signal Processing Certificate - Curriculum 290

Academic Associate & Technical Point of Contact

Monique P. Fargues, Ph.D.
Code EC/Fa, Spanagel Hall
Room 456

(831) 656-2859, DSN 756-2859
fargues@nps.edu

Brief Overview

Provides students an understanding of digital signal processing fundamentals, principles, and applications at the advanced level. The certificate provides a solid engineering foundation which covers the fundamental concepts needed to analyze and process digital information in many current applications including video, imaging, audio, communications, networking, underwater, and control applications. This program provides a mixture of instruction and computer-based laboratory exercises that offer students the opportunity to explore concepts and investigate applications in signal processing.

The four course sequence is extracted from the current set of graduate courses required to complete the Signal Processing Systems specialization track offered by the ECE Department.

The total number of NPS graduate credits obtained for the certificate varies between 15 and 16 depending on the elective choice. This certificate program can also be applied toward a master's degree program (Curriculum 592).

Requirements for Entry

An APC score of 323.

Acceptance by the ECE Department: Entrance to the Electrical and Computer Engineering curriculum at NPS is through a three-part requirement consisting of a minimum grade point average at the undergraduate level, a sufficient mathematics background, and a sufficient background in technical undergraduate studies. Applicants with a B.S.E.E. degree usually will satisfy the last two requirements automatically.

Command/Company endorsement.

Entry Date

At the beginning of Summer or Winter quarters (July or January).

Program Length

Four quarters.

Graduate Certificate Requirements

The academic certificate program must be completed within three years of admission to the program. A student must maintain a 3.0 GQPR in the certificate courses to be awarded a certificate.

Required Courses

EC3400	Digital Signal Processing
EC3410	Discrete-Time Random Signals
EC4440	Statistical Digital Signal Processing

And one advanced graduate level specialization signal processing (EC44XX) course:

EC4410	Speech Signal Processing
EC4430	Multimedia Information and Communications
EC4450	Sonar Systems Engineering
EC4460	Neural Networks
EC4480	Image Processing and Recognition
EC4910	DSP for Wireless Applications

Electric Ships and Power Systems Certificate - Curriculum 291

Academic Associate

Monique P. Fargues, Ph.D.
Code EC/Fa, Spanagel Hall
Room 456

(831) 656-2859, DSN 756-2859
fargues@nps.edu

Technical Point of Contact

Alexander Julian, Ph.D.
Code EC/Jl
Spanagel Hall
Room 448A

(831) 656-2101, DSN 756-2101
ajulian@nps.edu

Brief Overview

The Electric Ship Power Systems graduate certificate program provides a solid engineering foundation which covers the fundamental concepts in electrical power conversion and electromechanical power conversion at the advanced level. This coherent program is obtained by taking a 4-graduate-course sequence which provides a mixture of instruction and computer-based laboratories offering students the opportunity to study the behavior and performance power systems in a virtual environment.

The 4-graduate-course sequence is extracted from the current set of graduate courses required to complete the Solid State Microelectronics and Power Systems specialization track to the MSEE Degree offered by the ECE department.

The total number of NPS graduate credits obtained for the certificate is 18.5.

Requirements for Entry

· An APC score of 323.
· Acceptance by the ECE Department: Entrance to the Electrical and Computer Engineering curriculum at the Naval Postgraduate School is through a three-part requirement consisting of a minimum grade point average at the undergraduate level, a sufficient mathematics background, and a sufficient background in technical undergraduate studies. Applicants with a B.S.E.E. degree usually will satisfy the last two requirements automatically.
· Command/Company endorsement.

Entry Dates

At the beginning of any quarter in the academic year (Oct, Jan, Apr, Jul)

Program Length

Four quarters

Graduate Certificate Requirements

The academic certificate program must be completed within 3 years of admission to the program. A student must maintain a 3.0 GQPR in the certificate courses to be awarded a certificate.

Required Courses: Curriculum 291

EC3130	Electrical Machine Theory
EC4130	Advanced Electrical Machinery Systems
EC3150	Solid State Power Conversion
EC4150	Advanced Solid State Power Conversion

Electronic Warfare Engineer Academic Certificate - Curriculum 292

Academic Associate & Technical Point of Contact

David C. Jenn, Ph.D.
Code EC/Jn, Spanagel Hall, Room 414

(831) 656-2254, DSN 756-2254
jenn@nps.edu

Brief Overview

Provides students an understanding of the technical foundations found in electronic warfare at the system level and examines the impact of the physical environment. The certificate provides a solid engineering foundation which covers the fundamental concepts needed to understand how EW signals are affected by the environment and includes a survey of existing EW systems and analysis techniques. This program provides a mixture of instruction and computer-based laboratory exercises which offer students the opportunity to explore concepts and investigate applications in the electronic warfare area.

The three-course sequence is extracted from the current set of graduate courses required to complete the Sensor Systems Engineering specialization track offered by the ECE Department.

The total number of NPS graduate credits obtained for the certificate is 12.0. This certificate program can also be applied toward a master's degree program (Curriculum 592).

Requirements for Entry

An APC score of 323.

Acceptance by the ECE Department: Entrance to the Electrical and Computer Engineering curriculum at Naval Postgraduate School is through a three-part requirement consisting of a minimum grade point average at the undergraduate level, a sufficient mathematics background, and a sufficient background in technical undergraduate studies. Applicants with a B.S.E.E. degree usually will satisfy the last two requirements automatically.

Command/Company endorsement.

Entry Date

At the beginning of any quarter in the academic year.

Program Length

Four quarters.

Graduate Certificate Requirements

The academic certificate program must be completed within three years of admission to the program. A student must maintain a 3.0 GQPR in the certificate courses to be awarded a certificate.

Required Courses

EC3600	Antennas and Propagation
EC3630	Radiowave Propagation
EC3700	Joint Network Enabled Electronic Warfare I

Journeyman EW Engineer Academic Certificate Program - Curriculum 293

Academic Associate & Technical Point of Contact

David C. Jenn, Ph.D.
Code EC/Jn, Spanagel Hall, Room 414

(831) 656-2254, DSN 756-2254
jenn@nps.edu

Brief Overview

Provides students an understanding of the microwave and optical aspects of sensor and electronic warfare systems. State-of-the-art material on microwave and optical devices and their use in systems are discussed during the courses. The certificate material also includes a description of the operation of devices and trade-offs involved in component selection. This program provides a mixture of instruction and computer-based laboratory exercises that offer students the opportunity to explore concepts and investigate applications in the electronic warfare area.

The three-course sequence is extracted from the current set of graduate courses required to complete the Sensor Systems Engineering specialization track offered by the ECE Department.

The total number of NPS graduate credits obtained for the certificate is 12.0. This certificate program can also be applied toward a master's degree program (Curriculum 592).

Requirements for Entry

An APC score of 323.

Acceptance by the ECE Department: Entrance to the Electrical and Computer Engineering curriculum at the Naval Postgraduate School is through a three-part requirement consisting of a minimum grade point average at the undergraduate level, a sufficient mathematics background, and a sufficient background in technical undergraduate studies. Applicants with a B.S.E.E. degree usually will satisfy the last two requirements automatically.

Command/Company endorsement.

Entry Date

At the beginning of Fall or Spring quarter.

Program Length

Four quarters.

Graduate Certificate Requirements

The academic certificate program must be completed within three years of admission to the program. A student must maintain a 3.0 GQPR in the certificate courses to be awarded a certificate.

Required Courses

EC3210	Introduction to Electro-Optical Engineering
EC3610	Microwave Engineering
EC4610	Radar Systems

Senior EW Engineer Academic Certificate Program - Curriculum 294

Academic Associate & Technical Point of Contact

David C. Jenn, Ph.D.
Code EC/Jn, Spanagel Hall, Room 414

(831) 656-2254, DSN 756-2254
jenn@nps.edu

Brief Overview

Provides students an understanding of advanced topics commonly found in EW. Among them are signature control (stealth) and low probability of intercept techniques for radar and electronic warfare. This program provides a mixture of instruction and computer-based laboratory exercises that offer students the opportunity to explore concepts and investigate applications in the electronic warfare area.

The three-course sequence is extracted from the current set of graduate courses required to complete the Sensor Systems Engineering specialization track offered by the ECE Department.

The total number of NPS graduate credits obtained for the certificate is 12.0. This certificate program can also be applied toward a master's degree program (Curriculum 592).

Requirements for Entry

An APC score of 323.

Acceptance by the ECE Department: Entrance to the Electrical and Computer Engineering curriculum at the Naval Postgraduate School is through a three-part requirement consisting of a minimum grade point average at the undergraduate level, a sufficient mathematics background, and a sufficient background in technical undergraduate studies. Applicants with a B.S.E.E. degree usually will satisfy the last two requirements automatically.

Command/Company endorsement.

Entry Date

At the beginning of Fall or Spring quarter in the academic year.

Program Length

Four quarters.

Graduate Certificate Requirements

The academic certificate program must be completed within three years of admission to the program. A student must maintain a 3.0 GQPR in the certificate courses to be awarded a certificate.

Required Courses

EC4630   Radar Cross Section Prediction and Reduction
EC4640   Airborne Radar Systems
EC4680/ or   Joint Network Enabled Electronic Warfare II
EC4690
(DL)

Other Academic Certificates

Several additional graduate certificate programs have been approved and will be described in detail in future NPS catalogs:

- Fault Tolerant Computing (Curriculum 285)
- Reconfigurable Computing (Curriculum 286)
- Digital Communications (Curriculum 287)
- Network Engineering (Curriculum 295)
- Guidance Navigation & Control (Curriculum 284)

Prospective students should request additional information on these certificate programs which are currently available for enrollment.

Network Engineering Certificate - Curriculum 295

Academic Associate

Roberto Cristi, Ph.D.
Code EC/Cx, Spanagel Hall
Room 462

(831) 656-2223, DSN 756-2223
rcristi@nps.edu

Program Manager

Roberto Cristi, Ph.D.
Code EC/Cx, Spanagel Hall
Room 462

(831) 656-2223, DSN 756-2223
rcristi@nps.edu

Brief Overview

The Network Engineering Certificate is comprised of three or four courses (EC3710, EC4745 and one or two elective courses). Upon completion of this certificate program, students will be awarded a certificate of completion from the Naval Postgraduate School. The Network Engineering Certificate addresses the design, implementation, traffic, signaling and performance analysis

of modern enterprise and telecommunications network infrastructures integrating both wired and wireless media..

Requirements for Entry

For entry, the student must have a baccalaureate degree. An academic profile code (APC) of 323 is required.

Entry Date

Spring or Fall

Program Length

Four Quarters

Required Courses

EC3710   (3-2)   Computer Communications Methods
EC4745   (3-2)   Mobile Ad Hoc Wireless Networking

And one or two of the following electives to total a minimum of 12 credit hours:

EC4725   (3-2)   Advanced Telecommunication Systems Engineering
EC4785   (3-1)   Internet Engineering
EC4710   (3-2)   High Speed Networking
EC4430   (3-1)   Multimedia Information and Communications

Cyber Systems Certificate - Curriculum 296

Academic Associate

Monique P. Fargues, Ph.D.
Code EC/Fa, Spanagel Hall, Room 456
(831) 656-2859, DSN 756-2859
fargues@nps.edu

Program Manager

Roberto Cristi, Ph.D.
Code EC/Cx, Spanagel Hall
Room 462

(831) 656-2223, DSN 756-2223
rcristi@nps.edu

Brief Overview

This certificate is designed to provide students with a graduate level focus on cyber systems, system reverse engineering, and depending on elective choice, an ability to assess vulnerability and risk, architecture and engineering, or network traffic.

Requirements for Entry

Students who plan to enroll in the Cyber Systems Certificate Program should have a BSEE degree or a degree in another area of science or engineering with additional coursework and on-the-job experience, including a basic communications course, that will allow

them to successfully complete the certificate courses. An APC of 323 is required for entry.

Entry Date

Fall

Program Length

9-12 months

Required Courses

EC3730	(3-2)	Cyber Network and Physical Infrastructures
EC3740	(3-2)	Principles of Reverse Engineering of Electronic Systems

And one or two of the following electives to total a minimum of 12 credit hours:

EC4715	(3-2)	Cyber Systems Vulnerability and Risk Assessment
EC4790	(3-2)	Cyber Architectures and Engineering
EC4755	(3-2)	Network Traffic, Activity Detection and Tracking

Wireless Network Security Certificate - Curriculum 297

Academic Associate

Monique P. Fargues, Ph.D.
Code EC/Fa, Spanagel Hall, Room 456
(831) 656-2859, DSN 756-2859
fargues@nps.edu

Program Manager

Roberto Cristi, Ph.D.
Code EC/Cx, Spanagel Hall
Room 462

(831) 656-2223, DSN 756-2223
rcristi@nps.edu

Brief Overview

This certificate is designed to provide students with a graduate level focus on the security of wireless communications networks, and depending on elective choice, an ability to assess the security of wireless devices or telecommunications systems, to maintain situational awareness on wireless networks or assess the risk of covert malicious functionality in system hardware components.

Requirements for Entry

Students who plan to enroll in the Wireless Network Security Certificate Program should have a BSEE degree or a degree in another area of science or engineering with additional coursework and on-the-job experience, including a basic communications course, that will allow

them to successfully complete the certificate courses. An APC of 323 is required for entry.

Entry Date

Fall

Program Length

9-12 months

Required Courses

EC4770	(3-2)	Wireless Communications Network Security
EC4745	(3-2)	Mobile Ad Hoc Wireless Networking

And one or two of the following electives to total a minimum of 12 credit hours:

EC3860	(3-2)	Trustworthy Computer Hardware Analysis and Design
EC4735	(3-2)	Telecommunications Systems Security
EC4755	(3-2)	Network Traffic, Activity Detection and Tracking
EC4795	(3-2)	Wireless Device Security

Engineering Acoustics Academic Committee

Chairman

Daphne Kapolka, Ph.D.
Code PH Spanagel Hall, Room 200A

(831) 656-1825, DSN 756-1825
dkapolka@nps.edu

Steven R. Baker*, Associate Professor, Department of Physics (1985); Ph.D., University of California at Los Angeles, 1985.

Roberto Cristi*, Associate Professor, Department of Electrical and Computer Engineering (1985); Ph.D., University of Massachusetts, 1983.

Monique P. Fargues*, Associate Professor, Department of Electrical and Computer Engineering (1989); Ph.D., Virginia Polytechnic Institute and State University, 1988.

Daphne Kapolka*, Senior Lecturer, Department of Physics (2000); Ph.D., Naval Postgraduate School, 1997.

Joseph A. Rice*, Research Professor (2000); M.S., University of California at San Diego, 1990.

Kevin B. Smith*, Professor, Department of Physics (1995); Ph.D., University of Miami, 1991.

(* indicates faculty member has a joint appointment to another department at NPS)

Brief Overview

The academic character of the programs in Engineering Acoustics is interdisciplinary, with courses and laboratory work drawn principally from the fields of physics and electrical engineering. Although broadly based, the emphasis of the programs is on those aspects of acoustics and signal processing applied to undersea warfare. Subjects covered include the generation, propagation and reception of sound in the ocean; military applications of underwater sound; and acoustic signal processing. These programs are designed specifically for students in the Combat Systems Sciences and Engineering, Undersea Warfare, and Underwater Acoustic Systems curricula, government employees in acoustics-related laboratories and systems commands, and international students.

Degree

Master of Science in Engineering Acoustics

The Master of Science in Engineering Acoustics degree will be awarded as an interdisciplinary program in accordance with the following degree requirements:

1. A student pursuing a program leading to a Master of Science in Engineering Acoustics must have completed work which would qualify him/her for a Bachelor of Science degree in engineering or physical science. Credit requirements for the Master of Science degree must be met by courses in addition to those used to satisfy this requirement.

2. The Master of Science in Engineering Acoustics requires a minimum of 32 graduate credit quarter-hours of course work; at least 20 graduate quarter-hours must be taken in acoustics and its applications. Three 4000 level courses must be included from any three of the following six areas: wave propagation; transducer theory and design; noise, shock, and vibration control; sonar systems; signal processing; and communications. In addition, these courses must include at least one from each of the sponsoring disciplines (physics and electrical engineering).

3. An acceptable thesis must be completed.

Approval of each program by the Chair of the Engineering Acoustics Academic Committee must be obtained prior to reaching the mid-point of the degree program.

Master of Engineering Acoustics

The Master of Engineering Acoustics degree is limited to non-resident students and is awarded as an interdisciplinary program in accordance with the following degree requirements:

1. A student pursuing a program leading to a Master of Engineering Acoustics must have completed work which would qualify him/her for a Bachelor of Science degree in engineering or physical science. Credit requirements for the Master's degree must be met by courses in addition to those used to satisfy this requirement.

2. The Master of Engineering Acoustics requires a minimum of 32 graduate credit quarter-hours of course work; at least 20 graduate quarter-hours must be taken in acoustics and its applications. Three 4000 level courses must be included from any three of the following six areas: wave propagation; transducer theory and design; noise, shock, and vibration control; sonar systems; signal processing; and communications. In addition, these courses must include at least one from each of the sponsoring disciplines (physics and electrical engineering).

3. In lieu of a thesis, a one-quarter capstone project is required.

Approval of each program by the Chair of the Engineering Acoustics Academic Committee must be obtained prior to reaching the mid-point of the degree program.

Doctor of Philosophy and Doctor of Engineering

The Department of Electrical and Computer Engineering and the Department of Physics jointly sponsor an interdisciplinary program in Engineering Acoustics leading to either the Doctor of Philosophy or Doctor of Engineering degree. Areas of special strength in the departments are physical acoustics, underwater acoustics, acoustic signal processing, and acoustic communications. A noteworthy feature of this program is that a portion of the student's research may be conducted away from the Naval Postgraduate School at a cooperating laboratory or other federal government installation. The degree requirements and examinations are as outlined under the general school requirements for the doctorate degree. In addition to the school requirements, the departments require a preliminary examination to show evidence of acceptability as a doctoral student.

Underwater Acoustic Systems - Curriculum 535

Chair, EAAC

Daphne Kapolka, Ph.D.
Code PH/Kd, Spanagel Hall, Room 202

(831) 656-1825, DSN 756-1825
dkapolka@nps.edu

Program Manager

Kevin B. Smith, Ph. D.

Code PH/Sk, Spanagel Hall, Room 114

(831) 656-2107, DSN 756-2107

kbsmith@nps.edu

Academic Associate

Daphne Kapolka, Ph.D.
Code PH/Kd, Spanagel Hall, Room 202

(831) 656-1825, DSN 756-1825
dkapolka@nps.edu

ECE Representative

Monique Fargues, Ph.D.
Code EC/Fa, Spanagel Hall, Room 456

(831) 656-2859, DSN 756-2859
fargues@nps.edu

Brief Overview

The Underwater Acoustic Systems curriculum is currently available to Distance Learning students and leads to either a Master of Science in Engineering Acoustics or a Master of Engineering Acoustics depending on whether the student completes a thesis. Students typically take one course per quarter for a period of 8 quarters (24 months) followed by a thesis or capstone project. They must also complete a one-week residency during their first 4000-level physics course to gain experience in experimental techniques. The courses are taught primarily via video-teleconferencing (VTC.) Downloadable recordings of the classes are available for students who do not have access to VTC or miss a class. Instructors also use the virtual classroom software, Elluminate, for problem-solving sessions or individual help. The classes are usually timed to coincide with resident offerings. The course of studies is designed to improve the student's performance in operational, maintenance, and acquisition positions by providing them with a firm background in the fundamental science and engineering of acoustic systems.

Requirements for Entry

This curriculum is open to US and allied active duty military, government civilians, and defense contractors. Admission requires a baccalaureate degree with a major in engineering or physical science, completion of mathematics through differential equations and integral calculus, plus one year of calculus-based physics. An APC of 323 is required for direct entry.

Entry Date

The Underwater Acoustic Systems Program starts in the summer quarter.

Typical Course of Study

Quarter 1
PH3119   (4-2)   Oscillations and Waves

Quarter 2
PH3451   (4-2)   Fundamental Acoustics

Quarter 3
PH3452   (4-2)   Underwater Acoustics

Quarter 4
PH4454   (4-2)   Sonar Transducer Theory and Design

Quarter 5
EO2402   (4-1)   Intro to Linear Systems

Quarter 6
EO3402   (3-1)   Signals and Noise

Quarter 7
EC4450   (4-1)   Sonar Systems Engineering

Quarter 8
PH4455   (4-0)   Sound Propagation in the Ocean

Quarter 9
EC0820   (0-12)   Integrated Project

Department of Mechanical and Aerospace Engineering

www.nps.edu/MAE

Chairman

Knox T. Millsaps, Ph.D.
Code ME/Mi, Watkins Hall, Room 338

(831) 656-2586, 656-3382, DSN 756-3382
millsaps@nps.edu

Associate Chairman for Operations

Garth V. Hobson, Ph.D.
Code ME/Hg , Bldg 215

(831) 656-2888
gvhobson@nps.edu

Associate Chairman for Academics

Joshua H. Gordis, Ph.D.
Code ME/Go, Watkins Hall, Room 313

(831) 656-2866, DSN 756-2866
jgordis@nps.edu

Associate Chairman for Research
Marcello Romano, Ph.D.
Code ME/Ro, Watkins Hall, Room 324

(831)656-2885
mromano@nps.edu

Christopher A. Adams, Lecturer (2008); M.S., Naval Postgraduate School, 1996.

Brij N. Agrawal, Distinguished Professor (1989); Ph.D., Syracuse University, 1970.

Kyle (Terry) Alfreind, Distinguished Visiting Professor(1989); Ph.D., Virginia Tech, 1967

Luke N. Brewer, Associate Professor (2010); Ph.D., Northwestern University, 2001.

Christopher M. Brophy, Associate Professor (1998); Ph.D., University of Alabama-Huntsville, 1997.

Muguru S. Chandrasekhara, Research Professor (1987); Ph.D., University of Iowa, 1983.

Jarema M. Didoszak, Assistant Professor (2004); M.S., Naval Postgraduate School, 2003.

Vladimir N. Dobrokhodov, Research Associate Professor (2001); Ph.D., Zhukovskiy Air Force Engineering Academy, Russia, 1999.

Morris R. Driels, Professor (1989); Ph.D., City University of London, 1973.

Noel E. Du Toit, Research Assistant Professor (2012); Ph.D., California Institute of Technology, 2010.

Joseph C. Farmer, Visiting Professor (2010); Ph.D., University of California Berkley, 1983.

Stephen N. Frick, Visiting Professor (2011); M.S., Naval Postgraduate School, 1994.

Anthony J. Gannon, Research Assistant Professor (2006); Ph.D., University of Stellenbosch (2002).

Joshua H. Gordis, Associate Professor and Associate Chair for Academics for ME (1992); Ph.D., Rensselaer Polytechnic Institute, 1990.

Garth V. Hobson, Professor (1990); Ph.D., Pennsylvania State University, 1990.

Douglas P. Horner, Research Assistant Professor (2005); M.S., Naval Postgraduate School, 1999.

Kevin D. Jones, Research Associate Professor (1997); Ph.D., University of Colorado, 1993.

Isaac I. Kaminer, Professor (1992); Ph.D., University of Michigan, 1992.

Mark Karpenko, Research Assistant Professor (2012); Ph.D., University of Manitoba, Canada, 2009.

Jae Jun Kim, Research Assistant Professor (2007); Seoul National University, 2004.

Young W. Kwon, Distinguished Professor (1990); Ph.D., Rice University, 1985.

Jack (John) R. Lloyd, Research Professor (2007); Ph.D., University of Minnesota, 1971.

Claudia C. Luhrs, Associate Professor (2011); Ph.D., Autonomous University of Barcelona (UAB-ICMAB), 1997.

Sarath K. Menon, Research Professor (2007); Ph.D., Carnegie Mellon University, 1985.

Knox T. Millsaps, Professor and Chairman (1992); Ph.D., Massachusetts Institute of Technology, 1991.

Sebastian Osswald, Assistant Professor (2010); Drexel University, 2008.

Marcello Romano, Associate Professor (2004); Ph.D., Politecnico di Milano, Italy, 2001.

I. Michael Ross, Professor (1990); Ph.D., Pennsylvania State University, 1990.

Sanjeev Sathe, Research Associate Professor (2012); Ph.D., Arizona State University, 1989.

Alan D. Scott, Senior Lecturer and Academic Associate for 591 and Astronautical Engineering(2008); Aeronautical and Astronautical Engineer, Naval Postgraduate School, 1996.

Douglas L. Seivwright, Research Associate (2005), M.S. Naval Postgraduate School, 1996.

Ramesh Sharma, Senior Lecturer (2012); Ph.D., University of Oxford, U.K., 1973.

Oleg A. Yakimenko, Professor (1989); Ph.D., Russian Academy of Sciences, 1991.

Professors Emeriti:

Robert E. Ball, Distinguished Professor Emeritus (1967); Ph.D., Northwestern University, 1962.

Oscar Biblarz, Professor Emeritus (1968); Ph.D., Stanford University, 1968.

Charles N. Calvano, Professor Emeritus (1991); ED, Massachusetts Institute of Technology, 1970.

Allen E. Fuhs, Distinguished Professor Emeritus (1966); Ph.D., California Institute of Technology, 1958.

Anthony J. Healey, Distinguished Professor Emeritus (1986); Ph.D., Sheffield University, United Kingdom, 1966.

Matthew D. Kelleher, Professor Emeritus(1967); Ph.D., University of Notre Dame, 1966.

Paul J. Marto, Distinguished Professor Emeritus (1965); Sc.D., Massachusetts Institute of Technology, 1965.

Terry R. McNelley, Distinguished Professor Emeritus (1976); Ph.D., Stanford University, 1973.

David W. Netzer, Distinguished Professor Emeritus (1968); Ph.D., Purdue University, 1968.

Maximilian F. Platzer, Distinguished Professor Emeritus (1970); Dr. Tech. Science; Technical University of Vienna, Austria, 1964.

Turgut Sarpkaya, Distinguished Professor Emeritus (1967); Ph.D., University of Iowa, 1954.

Young S. Shin, Distinguished Professor Emeritus (1981); Ph.D., Case Western Reserve University, 1971.

Raymond P. Shreeve, Professor Emeritus (1971); Ph.D., University of Washington, 1970.

E. Robert Wood, Professor Emeritus (1988); D. Eng., Yale University, 1967.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

Brief Overview

The Department of Mechanical and Aerospace Engineering (MAE) provides a strong academic program which spans the engineering disciplines of thermal-fluid sciences, structural and computational autonomous vehicles mechanics, dynamic systems, guidance and control, materials science and engineering, propulsion, and systems engineering, including total ship systems engineering, spacecraft, and missile design. These disciplines are blended together with a strong emphasis on Naval engineering applications required by surface vessels, submarines, aircraft, rotorcraft and spacecraft. Furthermore, the Department provides advanced education in classified topics in Astronautical Engineering. Programs leading to the degrees of Master of Science in Mechanical Engineering and Master of Science in Astronautical Engineering are accredited by the Engineering Accreditation Commission of ABET. A specific curriculum must be consistent with the general minimum requirements for the degree as determined by the Academic Council. Any program leading to a degree must be approved by the Department Chairman at least two quarters before completion. In general, approved programs will require more than the stated minimum degree requirements in order to conform to the needs and objectives of the United States Navy, and satisfy the applicable subspecialty-code requirements.

Program Educational Objectives

Mechanical Engineering

The overall Program Educational Objective of the Mechanical Engineering Program is to support the NPS Mission by producing graduates who have knowledge and technical competence at the advanced level in Mechanical Engineering in support of national security. In order to achieve this goal, the specific objectives are to produce graduates who are expected to achieve the following within a few years of graduation:

1. Have become technical experts who are able to formulate and solve important engineering problems associated with national security in Mechanical Engineering and related disciplines using the techniques, skills and tools of modern practice, including experiments, and modeling and simulation. These problems may include issues of research, design, development, procurement, operation, maintenance or disposal of engineering components and systems for military applications.

2. Have assumed positions of leadership in the specification of military requirements in the organization and performance of research, design, testing, procurement and operation of technically advanced, militarily effective systems. The graduate must be able to interact with personnel from other services, industry, laboratories and academic institutions, and be able to understand the role that engineering and technology have in military operations, and in the broader national and global environment.

3. Can communicate advanced technical information effectively in both oral and written form.

Astronautical Engineering

The overall Program Educational Objective of the NPS Astronautical Engineering Program is to support the NPS Mission by producing graduates who have knowledge and technical competence in astronautical engineering at the advanced level and who can apply that knowledge and competence to fill technical leadership roles in support of national security. In order to achieve this goal, the specific objectives are to produce graduates who achieve the following within a few years of graduation:

1. Are established as a valued source of technical expertise in research, design, development, acquisition, integration and testing of national security space (NSS) systems including formulation of operational requirements, plans, policies, architectures, and operational concepts for the development of space systems.

2. Have assumed positions of leadership involving program management, systems engineering, and/or operational employment of space systems within the national security space (NSS) enterprise.

3. Have effectively managed the operation, tasking, and employment of national security space (NSS) systems to increase the combat effectiveness of the Naval

Services, other Armed Forces of the U.S. and our partners, to enhance national security.

Degrees

The following degrees are available. Consistent with NPS Academic Policy, with the exception of the Engineer's or Doctoral degrees, all degree requirements must be satisfied independently. A student is able to earn an academic degree listed below while enrolled in Naval Mechanical Engineering (Curriculum 570), Reactors/Mechanical Engineering DL (Curriculum 571), Nuclear Power School/Mechanical Engineering DL (Curriculum 572), Space Systems Engineering (Curriculum 591), and Combat Systems Science and Engineering (Curriculum 533).

Master of Science in Mechanical Engineering

A candidate shall have completed academic work equivalent to the requirements of this department for the Bachelor of Science degree in Mechanical Engineering. Candidates who have not majored in mechanical engineering, or who have experienced significant lapses in continuity with previous academic work, will initially take undergraduate courses in mechanical engineering and mathematics to fulfill these requirements in preparation for their graduate program.

The Master of Science degree in Mechanical Engineering requires a minimum of 48 quarter-hours of graduate level work. The candidate must take all courses in an approved study program, which must satisfy the following requirements: There must be a minimum of 32 quarter-hours of credits in 3000 and 4000 level courses, including a minimum of 12 quarter-hours at the 4000 level. Of the 32 quarter-hours at least 24 quarter-hours must be in courses offered by the MAE Department.

A student seeking the Master of Science degree in Mechanical Engineering must also demonstrate competence at the advanced level in at least one of the available disciplines of Mechanical Engineering. These disciplines are the thermal-fluid sciences; solid mechanics, shock and vibration; dynamic systems and control; system design; and materials science. This may be accomplished by completing at least eight quarter-hours of the 4000 level credits by courses within one discipline, and a thesis in the same discipline.

An acceptable thesis for a minimum of 16 credits is also required for the Master of Science degree in Mechanical Engineering. An acceptable thesis for the degree of Mechanical Engineer may also meet the thesis requirement of the Master of Science in Mechanical Engineering degree. The student's thesis advisor, the Academic Associate, the Program Officer and the Department Chairman must approve the study program and the thesis topic.

Master of Science in Astronautical Engineering

The Master of Science degree in Astronautical Engineering requires a minimum of 48 quarter-hours of graduate level work. The candidate must take all courses in an approved study program, which must satisfy the following requirements: There must be a minimum of 32 quarter-hours of credits in 3000 and 4000 level courses, including a minimum of 12 quarter-hours at the 4000 level. Of the 32 quarter-hours, at least 24 quarter-hours must be in courses offered by the MAE Department.

A student must demonstrate knowledge of orbital mechanics, attitude determination, guidance and control, telecommunications, space structures, spacecraft rocket propulsion, space power, spacecraft thermal control, and spacecraft design and testing.

The student must also demonstrate competence at the advanced level in one of the above disciplines of Astronautical Engineering. This may be accomplished by completing at least eight quarter-hours of the 4000 level credits by courses in this Department in a particular area and a thesis in the same discipline area. The typical specialization track is in Structures, Dynamics, and Control, and requires two (2) non-design AE48XX courses.

An acceptable thesis for a minimum of 16 credits is also required. The student's thesis advisor, the Academic Associate, the Program Officer, and the Department Chairman must approve the study program and the Thesis Proposal.

Master of Science in Engineering Science (Mechanical Engineering)

Candidates with acceptable academic background may enter a program leading to the degree of Master of Science in Engineering Science (with major in Mechanical Engineering). Candidates who have not majored in mechanical engineering or closely related subject areas, or who have experienced significant lapses in continuity with previous academic work, will initially take undergraduate courses in mechanical engineering and mathematics to prepare for their graduate program.

The Master of Science in Engineering Science (with major in Mechanical Engineering) degree requires a minimum of 48 quarter-hours of graduate level work. The candidate must take all courses in an approved study program, which must satisfy the following requirements: there must be a minimum of 32 quarter-hours of credits in 3000 and 4000 level courses, including a minimum of 12 quarter-hours at the 4000 level. Of the 32 quarter-hours, at least 24 quarter-hours must be in courses offered by the MAE Department.

A student seeking the Master of Science in Engineering Science degree must also demonstrate competence at the advanced level in at least one of the available disciplines of

Mechanical Engineering. These disciplines are the thermal-fluid sciences; solid mechanics, shock and vibration; dynamic systems and control; system design; and materials science. This may be accomplished by completing at least eight quarter-hours of the 4000 level credits by courses within one discipline, and a thesis in this same discipline.

An acceptable thesis for a minimum of 16 credits is also required for the Master of Science in Engineering Science (with major in Mechanical Engineering) degree. The student's thesis advisor, the Academic Associate, the Program Officer, and the Department Chairman must approve the study program and the thesis topic.

Under special circumstances as approved by the Academic Associate, the Program Officer, and the Department Chair, students may take four additional courses in lieu of a thesis. Those four additional courses should be at least 3000 and 4000 level courses offered by the MAE Department, and among them at least two courses should be at the 4000 level.

Entrance into the 571 Reactors/Mechanical Engineering Curriculum Program, leading to the degree Master of Science in Engineering Science (with major in Mechanical Engineering), is restricted to individuals who have successfully completed the Bettis Reactor Engineering School (BRES) and who have an academic profile code (APC) of 121 or better. All entrants must be nominated for the program by the designated program coordinator and primary consultant for Naval Reactors (SEA-08). See Curriculum 571 for details.

Entrance into the 572 Nuclear Power School/Mechanical Engineering Curriculum Program is restricted to graduates of the Officers Course of Naval Nuclear Power School and having an APC of (323), and undergraduate engineering degree or equivalent, and being nominated by their command. See Curriculum 572 for details.

Master of Science in Engineering Science (Astronautical Engineering)

Candidates with acceptable academic background may enter a program leading to the degree of Master of Science in Engineering Science (with major in Astronautical Engineering). Candidates who have not majored in astronautical engineering or closely related subject areas, or who have experienced significant lapses in continuity with previous academic work, will initially take undergraduate courses in astronautical engineering and mathematics to prepare for their graduate program.

The Master of Science in Engineering Science (with major in Astronautical Engineering) degree requires a minimum of 48 quarter-hours of graduate level work. The candidate must take all courses in an approved study program, which must satisfy the following requirements: there must be a minimum of 32 quarter-hours of credits in 3000 and 4000

level courses, including a minimum of 12 quarter-hours at the 4000 level. Of the 32 quarter-hours, at least 24 quarter-hours must be in courses offered by the MAE Department.

A student must demonstrate knowledge of orbital mechanics, attitude determination, guidance and control, telecommunications, space structures, spacecraft/rocket propulsion, space power, spacecraft thermal control, and spacecraft design and testing.

The student must also demonstrate competence at the advanced level in one of the above disciplines of Astronautical Engineering. This may be accomplished by completing at least eight quarter-hours of the 4000 level credits by courses in this department and a thesis in the same discipline area. The typical specialization track is in Structures, Dynamics, and Control, and requires two (2) non-design AE48XX courses.

An acceptable thesis for a minimum of 16 credits is also required. The student's thesis advisor, the Academic Associate, the Program Officer, and the Department Chairman must approve the study program and the Thesis Proposal.

Master of Science in Engineering Science (Aerospace Engineering)

Candidates with acceptable academic background may enter a program leading to the degree of Master of Science in Engineering Science (with major in Aerospace Engineering). Candidates who have not majored in aeronautical/aerospace engineering or closely related subject areas, or who have experienced significant lapses in continuity with previous academic work, will initially take undergraduate courses in aeronautical engineering and mathematics to prepare for their graduate program.

The Master of Science in Engineering Science (with major in Aerospace Engineering) degree requires a minimum of 48 quarter-hours of graduate level work. The candidate must take all courses in an approved study program, which must satisfy the following requirements: there must be a minimum of 32 quarter-hours of credits in 3000 and 4000 level courses, including a minimum of 12 quarter-hours at the 4000 level. Of the 32 quarter-hours, at least 24 quarter-hours must be in courses offered by the MAE Department.

A student must demonstrate knowledge of aerodynamics, aircraft stability and control, avionics, aircraft structures, aircraft and missile propulsion.

The student must also demonstrate competence at the advanced level in one of the above disciplines of Aeronautical Engineering. This may be accomplished by completing at least eight quarter-hours of the 4000 level credits by courses in this department and a thesis in the same discipline area. The typical specialization track is in

Aircraft Structures, Aerodynamics, Stability and Control, Avionics or Propulsion.

An acceptable thesis for a minimum of 16 credits is also required. The student's thesis advisor, the Academic Associate, the Program Officer, and the Department Chairman must approve the study program and the Thesis Proposal.

Mechanical Engineer

A graduate student with a superior academic record (as may be demonstrated by a graduate QPR of 3.70 or better) may apply to enter a program leading to the Mechanical Engineer Degree. A candidate must prepare his or her application and route it through the Program Officer to the Department Chairman for a decision. Typically, the selection process occurs after completion of the candidate's first year of residence.

A candidate must take all courses in a curriculum approved by the Chairman of the MAE Department. At a minimum, the approved curriculum must satisfy the requirements stated in the following paragraphs.

The Mechanical Engineer Degree requires at least 64 quarter-hours of graduate level credits in Mechanical Engineering and Materials Science, at least 32 of which must be at the 4000 level. At least 12 quarter-hours of graduate level credits must be earned outside of the MAE Department. At least one advanced mathematics course should be included in these 12 quarter-hours.

An acceptable thesis of 28 credit hours is required for the Mechanical Engineer Degree. Approval of the thesis advisor and program must be obtained from the Chairman of the MAE Department.

Astronautical Engineer

A graduate student with a superior academic record (as may be demonstrated by a graduate QPR of 3.70 or better) may apply to enter a program leading to the Astronautical Engineer Degree. A candidate must prepare his or her application and route it through the Program Officer to the Department Chairman for a decision. Typically, the selection process occurs after completion of the candidate's first year of residence.

A candidate must take all courses in a curriculum approved by the Chairman of the MAE Department. At a minimum, the approved curriculum must satisfy the requirements stated in the following paragraphs.

The Astronautical Engineer Degree requires at least 64 quarter-hours of graduate level credits in Astronautical Engineering or Mechanical Engineering and Materials Science, at least 32 of which must be at the 4000 level. At least 12 quarter-hours of graduate level credits must be earned outside of the MAE Department. At least one advanced mathematics course should normally be included in these 12 quarter-hours.

An acceptable thesis of 28 credit hours is required for the Astronautical Engineer Degree. Approval of the thesis advisor and program must be obtained from the Chairman of the MAE Department.

Aeronautical Engineer

A graduate student with a superior academic record (as may be demonstrated by a graduate QPR of 3.70 or better) may apply to enter a program leading to the Aeronautical Engineer Degree. A candidate must prepare his or her application and route it through the Program Officer to the Department Chairman for a decision. Typically, the selection process occurs after completion of the candidate's first year of residence.

A candidate must take all courses in a curriculum approved by the Chairman of the MAE Department. At a minimum, the approved curriculum must satisfy the requirements stated in the following paragraphs.

The Aeronautical Engineer Degree requires at least 64 quarter-hours of graduate level credits in Aeronautical Engineering or Mechanical Engineering and Materials Science, at least 32 of which must be at the 4000 level. At least 12 quarter-hours of graduate level credits must be earned outside of the MAE Department. At least one advanced mathematics course should normally be included in these 12 quarter-hours.

An acceptable thesis of 28 credit hours is required for the Aeronautical Engineer Degree. Approval of the thesis advisor and program must be obtained from the Chairman of the MAE Department.

Doctor of Philosophy

The Department offers Doctor of Philosophy (Ph.D.) degrees in Mechanical Engineering, Astronautical Engineering, and Aeronautical Engineering. Students having a superior academic record may request entrance into the doctoral program. All applicants will be screened by the departmental doctoral committee for admission. The department also accepts officer students selected in the Navy-wide doctoral program, qualified international officers, and DoD civilian students.

An applicant to the doctoral program who is not already at NPS should submit transcripts of previous academic and professional work. Also all applicants are required to submit a current Graduate Record Examination (GRE) general test to the Director of Admissions, Naval Postgraduate School, 1 University Circle, He-022, Monterey, California 93943.

Every applicant who is accepted for the doctoral program will initially be enrolled in one of the following programs: Mechanical Engineer, Astronautical Engineer, or Aeronautical Engineer Program; under a special option which satisfies the broad departmental requirements for the Engineer's degree, which includes research work. As

soon as feasible, the student must identify a faculty advisor to supervise research and to help formulate a plan for advanced study. As early as practicable thereafter, a doctoral committee shall be appointed to oversee that student's individual doctoral program as provided in the school-wide requirements for the doctor's degree. Joint programs with other departments are possible.

Special Programs

Along with degree programs, the department offers special programs that are sequences of courses along with capstone design projects that focus on the design of important military systems, such as platforms and weapons.

Total Ship Systems Engineering Program

The Total Ship Systems Engineering Program is an interdisciplinary, systems engineering and design-oriented program available to students enrolled in Mechanical or Astronautical or Aeronautical Engineering, Electrical and Computer Engineering or Combat Systems programs. The program objective is to provide a broad-based, design-oriented education focusing on the warship as a total engineering system. The sequence of electives introduces the student to the integration procedures and tools used to develop highly complex systems such as Navy ships. The program culminates in a team-performed design of a Navy ship, with students from all three curricula as team members. Students enrolled in programs leading to the Engineer's degree are also eligible for participation. Entry requirements are a baccalaureate degree in an engineering discipline with a demonstrated capability to perform satisfactorily at the graduate level. The appropriate degree thesis requirements must be met, but theses that address system design issues are welcome.

Missile Systems Engineering Program

The Missile Systems Engineering Track is an option that can be perused within the framework of the Master of Science in Mechanical Engineering (MSME) or Master of Science in Engineering Science Degree programs. This program is a regular part of the TEMASEK program, but is also open to DoD contractors, as well and all U.S. Military and DoD Civilian Students. The program provides a solid engineering foundation in analysis and design techniques involved in developing offensive and defensive missile systems.

This option consists of a four-course sequence of special missile courses embedded in the normal MSME or MSES(ME) degree program of courses and a thesis.

The courses for this program are:
1. ME3205 Missile Aerodynamics
2. AE4452 Advanced Missile Propulsion
3. ME4703 Missile Flight Dynamics and Control
4. ME4704 Missile Design

NPS works with industry, primarily with Raytheon Missile Systems Division in Tucson, AZ, to create this unique blend of high-quality academic courses and "real word" systems engineering focus in missile design and manufacturing, leading to a program of unique military relevance.

Autonomous Systems Engineering Program

The Autonomous Systems Engineering Track is an option that can be perused within the framework of the Master of Science in Mechanical Engineering (MSME) or Master of Science in Engineering Science degree programs. This program is open to DoD contractors, as well and all U.S. Military and DoD Civilian Students. The program can be completed in four to six quarters, depending on academic preparedness of the student, and is developed around several core courses related to modeling and guidance navigation and control algorithms design for autonomous underwater, surface, ground, aerial systems, satellites and spacecraft. Additional course electives can be taken to enhance specialty areas, along with thesis research related to a specific type of an autonomous system or its component, or a wide range of other useful military technologies.

The core courses of the program are:
· Introduction to Unmanned Systems
· Low-Level Control of Unmanned Vehicles
· Unmanned Vehicles Navigation
· High-Level and Discrete Event Control of Autonomous Systems
· Computer Vision
· C3 Networks for Unmanned Systems
· Collaborative Control of Multiple Autonomous Systems
· Unmanned Systems Design

The final course in this sequence, Unmanned Systems Design, is a capstone course that integrates the material into a design of (a component of) an autonomous underwater, surface, ground, aerial, or space system, its algorithm or sensor to be tested within the tactical network environment during quarterly field experiments at Camp Roberts Training Site.

Laboratories

MAE Laboratories are designed to support the educational and research mission of the Department. In addition to extensive facilities for the support of student and faculty research, a variety of general use equipment is available. This includes equipment and facilities for the investigation of problems in engineering mechanics; a completely equipped materials science laboratory, an oscillating water tunnel, an underwater towing tank and a low turbulence water channel; a vibration and structural dynamics laboratory; a fluid power controls laboratory; a robotics and

real-time control laboratory; facilities for experimentation with low velocity air flows.

NPS Center for Autonomous Vehicle Research: The primary goal of the NPS Center for Autonomous Vehicle Research (CAVR) is to educate students in the development and use of technologies needed for unmanned vehicles through coursework, thesis and dissertation research. The secondary goal of the CAVR is to advance Naval autonomous vehicle operations by providing support to the fleet, Navy labs and Program offices, testing and experimentation of advanced technologies, independent verification and validation of a variety of novel autonomous vehicles concepts, and by innovative concept development. Currently the CARV houses two autonomous submarines (Aries and REMUS), Sea Fox surface vehicle and a wide variety of Tier I and Tier II class unmanned aerial vehicles (UAV) staring from Scan Eagle UAV and all way down to miniature flapping-wing vehicles.

CAD/CAE Computer Laboratory: This lab consists of Windows PCs and is used heavily by students for both class and thesis related work. This lab has a wide range of special mechanical engineering software for analysis and design. This facility includes a 128 processor cluster for large scale computations.

Additional Laboratories

Nano/MEMS Laboratory: This laboratory provides a facility for teaching the emerging technologies of Nano/MEMS.

Fluid Mechanics and Hydrodynamics Laboratories: The fluid mechanics laboratory supports instruction in basic courses in fluid mechanics. It is equipped with a small wind tunnel for specific instructional purposes. The hydrodynamics laboratory includes a unique U-shaped oscillating water tunnel for the study of a wide range of phenomena, such as flow about stationary and oscillating bodies, vortex-induced vibrations, stability of submarines and boundary layers, and vortex-free-surface interactions. The hydrodynamics laboratory also houses a recirculating water tunnel for numerous flow-separation and vibration phenomena and a vortex-breakdown facility for the investigation of the stability of swirling flows. These facilities are supported by a 3-beam Laser-Doppler-Velocimeter, numerous other lasers, high-speed motion analyzers, data-acquisition systems, and dedicated computers for numerical simulations.

Materials Laboratory: Laboratory supports teaching and research in processing, characterization, and testing of advanced structural, functional, and nanotechnology materials for defense applications.

- **Auger Surface Analysis Laboratory**: It consists of an ultrahigh vacuum system and an electron beam source to probe the surface and interface structure of composites and microelectronic devices.

- **Transmission Electron Microscopy Lab**: Contains a TOPCON 002B TEM used for materials science and engineering teaching and research.
- **Scanning Electron Microscopy Lab:** Contains a TOPCON 540 SEM used for materials science and engineering teaching and research.
- **X-Ray Diffraction Laboratory:** Two Philips X-ray Systems are used for materials science and engineering teaching and research.
- **Optical Microscopes Laboratory:** This lab includes several optical microscopes as well as electronic imaging and image analysis systems that are used for materials science and engineering teaching and research.
- **Metallurgical Sectioning/Polishing Laboratory:** This supports all teaching and research by provision of facilities to prepare samples for examination.
- **Transmission Electron Microscopy II Lab**: This laboratory is equipped with a JEOL-100CX microscope and is used primarily for instruction of students in the techniques of electron microscopy.
- **Scanning Electron Microscopy Laboratory**: This laboratory is equipped with an older model Cambridge Instruments SEM.
- **Physical Testing (Dilatometer) Laboratory**: This laboratory is dedicated to dilatometry and is primarily used for research applications.
- **Heat Treatment Laboratory:** This laboratory supports courses and research mainly in the materials area and includes a selection of conventional furnaces.
- **Corrosion Laboratory**: This laboratory supports the instructional program in the area of corrosion science and engineering.
- **Metallurgical Etching Laboratory:** This laboratory supports all teaching and research in materials by provision of facilities for the chemical treatment of samples for metallo-graphic examination.
- **Welding Laboratory**: Welding is the primary method of fabrication for Naval vessels, and instruction and research on welding/joining of both conventional and advanced alloys is carried out in this facility.
- **Materials Processing Laboratory**: This supports both teaching and research involving deformation and thermal processing of materials. It is equipped with presses, a rolling mill, and various heat treatment furnaces.
- **Creep Test Laboratory**: This laboratory supports research in high-temperature structural metals and composites.
- **Mechanical Test Laboratory**: This lab supports mechanical testing with impact, creep, and fatigue instrument and electromechanical properties.

· **Ceramics Laboratory**: This laboratory is devoted primarily to research on high temperature materials based on various ceramic compositions.
· **Composites Laboratory**: This laboratory supports research in composite materials, especially metal matrix composites.

Marine Propulsion Laboratory

This laboratory has gas turbine (Allison C-250) and diesel (Detroit 3-53) engines connected to water brake dynamometers, located in separate, isolated engine test cells. These engines are instrumented to obtain steady-state performance and high-frequency, time-resolved measurements. Aerothermodynamic, acoustic, and vibration phenomena in turbo-machinery and reciprocating engines are being investigated, particularly relating to non-uniform flow and condition-based maintenance (CBM) in naval machinery. These engines are used for both instructional and applied research programs in the area of marine power and propulsion. In addition, this lab has bench-top rotordynamics experiments for demonstrating high-speed machinery balancing and investigating rotordynamic instabilities. The lab has sub-scale flow facilities for developing and testing low observable (stealth) technologies for engine inlets and exhausts.

Rocket Propulsion Laboratory

This lab conducts research on advanced concepts in solid, liquid, and combined mode propellants. Experimental and computational research is conducted in the areas of propellant mixing, combustion, pulse detonation, thrust control, and plume mixing. A full range of mechanical and optical diagnostic techniques are used on small and subscale experiments.

Structural Dynamics Laboratory

This lab is devoted to structural dynamics and is especially designed to facilitate both teaching and research into vibration and shock effects associated with underwater explosions, as well as related shipboard vibration problems. The ability to validate simulation models with lab-scale tests is critical for student education. The lab includes a state of the art multi-channel data acquisition system, and a large variety of transducers and instrumentation.

Thermal Engineering Laboratories

These labs are used mainly for instruction in heat transfer to investigate convection phenomena of single and multi-phase flows and include facilities for measurement of temperature change and fluid motion in a range of systems. The lab also includes equipment/instrumentation for measurements in microelectronics and micro-heat exchanger systems.
· **Convection Heat Transfer Laboratory:** Used mainly for instruction in heat transfer by convection phenomena and includes facilities for measurement of temperature change and fluid motion in a range of systems.
· **Electronic Cooling Laboratory:** The operation of microelectronic devices results in intense, but very localized, heating of electronic devices.
· **Two-Phase Heat Transfer Laboratory**: This is an instructional and research laboratory for the study of heat transfer involving more than one phase, e.g., heat transfer involving liquid and vapor phases during boiling or condensation.

Ship Systems Engineering (TSSE) Laboratory

This is an integrated design center in which student teams perform a capstone design project of a Navy ship. Ship design encompasses hull, mechanical, and electrical systems as well as combat systems, and is done in cooperation with the Meyer Institute.

Astronautical Engineering Laboratories
· **Spacecraft Design Laboratory**: This laboratory houses computer-aided design tools for spacecraft design and a spacecraft design library. It is used heavily by students for three spacecraft design courses, AE3870, AE4870, and AE4871. Students can do collaborative spacecraft design using the unique design tools not available in other educational institutions.
· **Smart Structure and Attitude Control Laboratory**: This lab consists of five major ongoing experiments to facilitate the instruction and research by students in the area of both smart structures, sensors, and actuators for active vibration control, vibration isolation, and shape control in space applications and attitude control of flexible spacecraft and space robotic manipulators. In addition to students' thesis research, it also supports courses AE4816, AE3811, and AE3818.
· **Optical Relay Spacecraft Laboratory**: This joint laboratory of NPS and AFRL is used for both instruction and research on acquisition, tracking, and pointing of flexible military spacecraft. The main facilities include a bifocal relay mirror spacecraft attitude simulator, actuated by variable speed control moment gyros; a single focal spacecraft attitude simulator, actuated by reaction wheels; and an optical beam and jitter control test bed. This laboratory is used for courses AE3811, AE3818, and AE4818.
· **Spacecraft Robotics Laboratory:** The Spacecraft Robotics Laboratory, funded by NPS and AFRL, hosts the Autonomous Docking and Spacecraft Servicing Simulator (AUDASS). This test bed, consisting of two independent robotic vehicles (a chaser and a target), aims to carry out on-the-ground testing of satellite servicing and proximity formation

flight technologies. The vehicles float, via air pads, on a smooth epoxy floor, providing a frictionless support for the simulation in 2-D of the zero-g dynamics. This is used for course AE3811.

· **FLTSATCOM Laboratory**: This laboratory consists of a qualification model of the Navy communications satellite, FLTSATCOM and the associated ground support equipment for testing the satellite. This is an instructional laboratory and is used by students in laboratory course AE3811. Students get operational experience including spin-up of a reaction wheel, rotation of a solar array drive, firing sequence of thrusters, and receiving telemetry on the satellite operational parameters.

· **Segmented Mirror Telescope (SMT):** The SMT is a unique platform for research into advanced Adaptive Optics (AO) techniques employing a prototype satellite imaging system with approximately 1,000 degrees of freedom.

Research Centers

The following Research Centers are organized in the MAE Department:

· **Aerodynamic Decelerator Systems Center and Laboratory:** Payload delivery has always played a vital role in a variety of combat and humanitarian operations. In the recent years the touchdown accuracy improved drastically allowing delivering not only traditional bundle supplies, but also smaller, time-critical items like munitions, medical resupplies, sensors, autonomous ground robots. Moreover, the delivery of these articles is possible using smaller autonomous aerial vehicles as opposed to conventional military aircraft. The center focuses on a variety of novel research topics that support technologies vital to the Army's and Navy's future force, combating terrorism and new emerging threats. It includes the development of guidance, navigation and control algorithms for a family of various-weight precision guided airdrop systems to be deployed from fixed- and rotary-wing unmanned platforms, along with research on different sensors to support airdrop missions. The center is constantly working on different challenging projects, providing a wide variety of thesis opportunities in different areas: conceptual design, CFD analysis, computer modeling, image processing, control design, sensor integration; supports coursework in Control and Autonomous Systems.

· **Center for Materials Sciences and Engineering:** The Center for Materials Sciences and Engineering provides a focus for research and education in Materials Science and Engineering at NPS.

· **Center for Autonomous Underwater Vehicle Research:** The primary goal of the NPS Center for AUV Research is to educate Navy and USMC officer students in the development and use of technologies needed for unmanned underwater vehicles through coursework, thesis, and dissertation research. The secondary goal of the Center is to advance Naval UUV operations by providing: Support to the Fleet, Navy Labs and Program Offices.

· **Turbo-Propulsion Laboratory:** The Turbo Propulsion Laboratory houses a unique collection of experimental facilities for research and development related to compressors, turbines, and advanced air-breathing propulsion engine concepts. In a complex of specially designed concrete structures, one building, powered by a 750 HP compressor, contains 10 by 60 inch rectilinear and 4 to 8-foot diameter radial cascade wind tunnels, and a large 3-stage axial research compressor for low speed studies. A two-component, automated traverse, LDV system is available for CFD code verification experiments. A second building, powered by a 1250 HP compressed air plant, contains fully instrumented transonic turbine and compressor rigs in explosion-proof test cells. A spin-pit for structural testing of rotors to 50,000 RPM and 1,800 degrees Fahrenheit is provided. Data acquisition from 400 channels of steady state and 32 channels of non-steady measurements, at up to 200 kHz, is controlled by the laboratory's Pentium workstations. A third building houses a 600 HP radial and 150 HP boost compressor capable of delivering 2000 scfm of air at 10 and 20 atmospheres respectively. These charge four tanks for blow-down to a supersonic wind tunnel (4 x 4 inches), a transonic cascade wind tunnel (2 x 3 inches), and two free jets (one 6-inch and one 1-inch in diameter). The large free jet is equipped with an instrumented thrust stand for the testing of small gas turbine engines. The building also houses a 3-inch diameter shock tube.

· **Spacecraft Research and Design Center:** The Spacecraft Research and Design Center at the Naval Postgraduate School consists of six state-of-the-art laboratories: Fltsatcom Laboratory, Spacecraft Attitude Dynamics and Control Laboratory, Smart Structures Laboratory, Spacecraft Design Center, NPS-AFRL Optical Relay Mirror Spacecraft Laboratory, and Satellite Servicing Laboratory. These laboratories are used for instruction and research in the Space System Engineering and Space Systems Operations curricula. The emphasis has been on providing students with hands-on experience in the design, analysis, and testing of space systems, and to provide students with facilities for experimental research. The emphasis in the research is on

acquisition, tracking, and pointing of flexible spacecraft with optical payloads; active vibration control, isolation, and suppression using smart structures; space robotics, satellite servicing, space system design, and computer aided design tools. These laboratories have been used in joint projects with Naval Satellite Operational Center, NRL, AFRL, Columbia University, and Boeing. See www.nps.edu/SRDC.

· **Center for Survivability and Lethality:** The Center provides research and education in a broad range of technologies and methodologies to make platforms more survivable to attack and more lethal to hostile platforms and systems. Work in submarines, surface ships, fixed wing and rotorcraft, and space systems are supported. The Center also conducts research in improving the survivability of civilian infrastructure and transportation systems. Twenty NPS faculty members from MAE, Physics, and Electrical Engineering participate in the Center. See www.nps.edu/csl.

Mechanical and Aerospace Engineering Course Descriptions

AE Courses

AE0810 Thesis Research (0-8)
Every student conducting thesis research will enroll in this course. Prerequisites: None.

AE2440 Introduction to Scientific Programming (Same as EC2440) (3-2) Fall/Spring
This course offers an introduction to computer system operations and program development using NPS computer facilities. The main goal of this course is to provide an overview of different structured programming techniques, along with introduction to MATLAB/Simulink/GUIDE and to use modeling as a tool for scientific and engineering applications. The course discusses the accuracy of digital computations, ways to incorporate symbolic computations, and presents numerical methods in MATLAB functions. PREREQUISITES: Knowledge of single variable calculus and matrix algebra. This course can be offered as an online course.

AE2820 Introduction to Spacecraft Structures (3-2)
Review of statics and strength of materials. Beam theory: axial, bending, shear and torsional loading, stress analysis and deflection of beams. Design of spacecraft structures for launch loads and a survey of typical launch vehicles. Beam buckling and vibration, critical buckling loads, natural frequencies, and mode shapes. Truss structures and introduction to the finite element method. Prerequisites: None.

AE3804 Thermal Control of Spacecraft (3-0)
Conduction, radiation, thermal analysis, isothermal space radiator, lumped parameter analytical model, spacecraft passive and active thermal control design, heat pipes, and louvers. Prerequisites: None.

AE3811 Space Systems Laboratory (2-2)
Principles of spacecraft test programs; component, subsystem, and system level tests; military standard test requirements for space vehicles, laboratory experiments in Fltsatcom Laboratory on satellite performance, in Spacecraft Test Laboratory for vibration, modal and thermal tests; and in Spacecraft Attitude Control Laboratory for spacecraft control performance. Graded Pass/Fail. Prerequisites: Consent of instructor.

AE3815 Spacecraft Rotational Mechanics (3-2)
Coordinate system transformations (GCI, LVLH, etc.), time differentiation operator, velocity and acceleration in 3D-frames of reference, Poisson's equations, spacecraft application examples (strapdown INS, etc.), angular momentum, inertia tensor transformations, Newton-Euler equations of motion, spin stability, single-spin spacecraft, nutation and precession, energy-sink analysis, passive nutation control, dynamics and stability of dual spin spacecraft, gravity-gradient stabilization. Prerequisites: SS3500, MA2121, MA3046, and AE2440 or equivalent.

AE3818 Spacecraft Attitude, Determination, and Control (3-2)
Spacecraft attitude linear control: linearized attitude control, three-axis-stabilized spacecraft. Non-linear attitude control design: minimum-time slewing maneuver, quaternion feedback. Actuators for attitude control: Thrusters, Reaction Wheels, Control Moment Gyroscopes, Magnetotorquers, and related topics (thrust modulation and mapping, CMG steering laws and singularities, momentum dumping). Sensors for attitude and rate determination: star sensors, horizon sensor, sun sensor, gyroscopes. Attitude determination methods: deterministic approach (Triad algorithm), statistic approach (Wabha problem), stochastic approach (Kalman Filter). The labs focus on the practical solution of significant attitude control and determination problems by simulations in Matlab-Simulink. Prerequisites: EC2300 or equivalent, and AE3815.

AE3820 Advanced Mechanics and Orbital Robotics (3-2)
This course is an intermediate level analysis of the dynamics of space systems, including: ascent and descent of rockets, tethers, yo-yo despin, spinning hubs with flexible appendages, single stage to orbit, and various problems in spacecraft attitude dynamics such as nutation dampers. The analysis will include developing the equation of motion, equilibrium and stability analysis, solutions of nonlinear systems using perturbation methods and numerical techniques. Computational and symbolic manipulator packages will be used extensively. Prerequisites: MA2121.

AE3830 Spacecraft Guidance and Control (3-2)
Overview of the Spacecraft Guidance, Navigation, and Control System. Sources and effects of navigation and modeling errors on guidance and control systems. Error propagation techniques: linearization of spacecraft dynamical equations, covariance propagation and Monte Carlo simulations. Applications to spacecraft rendezvous and attitude control. Introduction to optimal control theory. Optimal bang-bang control for spacecraft thrusters. Linear-quadratic control problems and feedback control. Selection of weights and performance analysis. Perturbation guidance. Application of the matrix Riccati equation to spacecraft stability, control and guidance. Prerequisites: MA2121, SS3500, EC2300 or equivalent, and AE3815.

AE3851 Spacecraft Propulsion (3-2)
Introduces concepts and devices in spacecraft propulsion. It reviews fundamental fluid mechanics, electricity and magnetism, and

thermodynamics with molecular structure. Conventional chemical means such as H2/O2 and monopropellants are discussed. Electric propulsion schemes (resistojets, arc-jets, ion, magneto-plasma-dynamic, etc.) are introduced and their performances contrasted with chemical schemes. Characteristics of more advanced concepts (laser, solar, nuclear, etc.) are also considered. Prerequisites: None.

AE3852 Propulsion for Launch Vehicles (4-0)

Introduction to propulsion for launch vehicles, beginning with mission energy requirements and an overview of current and proposed launch propulsion devices. Performance analysis, operating characteristics and propellant selection criteria are considered for air breathing and solid, liquid and nuclear rocket motor propulsion systems. Advanced cycles and concepts are presented. Design of components and subsystems. Prerequisites: ME3201.

AE3870 Computational Tools for Spacecraft Design (2-4)

In this course, the students become familiar with the use of computer aided design tools for spacecraft subsystems and system design. The tools are for conceptual spacecraft design trade-offs and detailed subsystem design, such as for structures, thermal, attitude control, and communications. Prerequisites: Consent of instructor.

AE4362 Astrodynamics (3-0)

Review of the two-body problem. The effects of a third point mass and a distributed mass. Expansion of the disturbing potential in series of Legendre functions. Variation of parameter equations for osculating orbital elements. Perturbation and numerical solution techniques. Statistical orbit determination. Codes used by the military to maintain the catalog of artificial satellites and space debris. Prerequisites: SS3500 or equivalent.

AE4452 Advanced Missile Propulsion (4-1)

Analysis and design of solid propellant rockets, ramjets, dual-combustion ramjets, scramjets and ducted rockets. Propellant selection criteria and characteristics, combustion models and behavior, performance analysis, combustor design, combustion instabilities and damping, mission and flight envelope effects on design requirements and technology requirements. Use of performance and grain design codes (SPP, PEP, and NASA SP233) and laboratory test firings for comparison with measured performance. Prerequisites: AE3852 or consent of instructor.

AE4502 Supersonic and Hypersonic Flows (4-0)

One-dimensional, compressible flow is reviewed. Two-dimensional and axis-symmetric supersonic of ideal gases. Oblique shocks and expansion waves. General compressible flow equations. Potential supersonic and conical flows. Compressible scaling and transonic area ruling. Effects of very high velocity and low density. Hypersonic flow. Mach number independence and equivalence principles. Newtonian method. Blunt and slender body solutions. Real gas behavior and effect on shock and boundary layers. Applications are presented to satellite parasitic drag and re-entry flows. Prerequisites: ME3201 or consent of instructor.

AE4506 Rarefied Gas Dynamics (4-0)

Topics include advanced thermodynamics with molecular structure, kinetic theory, distribution functions, Boltzmann equation and transport phenomena from a kinetic theory point of view. Types of flow range from free-molecule to transition, to high temperature continuum. Numerical approaches are discussed. Applications to

space problems and hypersonics are treated. Prerequisites: ME3201 or equivalent.

AE4816 Dynamics and Control of Space Structures (4-0)

Review of dynamics, finite element method, structural natural frequencies, mode shapes, and control of flexible structures. Smart sensors and actuators and applications to active vibration control, shape control, vibration isolation and fine beam pointing. Equation of motion of spacecraft with flexible structures, and control of spacecraft and flexible structures. The interaction of flexibility and control. Impact of flexibility on the performance of military spacecraft and future trends. Prerequisites: Graduate AE3830, ME3521, and EC2300 or equivalent.

AE4818 Acquisition, Tracking, and Pointing of Military Spacecraft (3-2)

Acquisition, tracking, and pointing (ATP) requirements for military spacecraft, effects of jitter on ATP performance, jitter control, acquisition system, tracking algorithms, laser beam control, spacecraft attitude control using control moment gyros, example of ATP designs for military spacecraft, laboratory experiments on spacecraft attitude control and laser beam control. Prerequisites: AE3818.

AE4830 Spacecraft Systems I (Intended For Curriculum 366) (3-2)

This course emphasizes the systems analysis of geosynchronous spacecraft and covers the analysis of GNC (orbit and attitude control), structures, propulsion, thermal and electrical power subsystems. Basic mathematical equations will be used in the preliminary design of the subsystems and the tradeoff studies involved. The differences and similarities between dual-spin and three-axis stabilized spacecraft will be covered in detail. Systems aspect of a typical mission profile will be illustrated. Throughout, emphasis will be on the spacecraft bus. Students will be engaged in problem solving during most of the laboratory period. Prerequisites: Completion of Space Operations core-curriculum.

AE4831 Spacecraft Systems II (Intended for Curriculum 366) (3-2)

In this course, students will be involved in a group project to design a spacecraft to meet mission requirements. Material presented in AE4830 as well as AE4831 will be utilized. In parallel, this course covers some or all of the following aspects of spacecraft systems: spacecraft testing, TT&C subsystem, and design of observation payloads. Differences and similarities between geosynchronous spacecraft and LEO/HEO spacecraft will be discussed. Topics include gravitational perturbation (J2 effects), gravity-gradient stabilization, and atmospheric drag effects. Prerequisites: AE4830.

AE4850 Astrodynamic Optimization (3-2)

This course develops basic measures of performance of a space vehicle (including launch vehicles) with methods to target a set of conditions and optimize the performance. Topics include an overview of the Guidance, Navigation and Control System, fundamentals of nonlinear programming, state-space formulation, vehicle and environmental models, performance measures, problem of Bolza, the Maximum Principle, and transversality conditions. A significant focus of the course will be in practical methods and numerical techniques, particularly pseudospectral methods. Computational methods will be used to solve a wide range of problems in astrodynamic optimization arising in military space, such as rapid spacecraft reorientation and targeting problems, launch-on-demand, strategic low-thrust orbital maneuvers, and optimal formation-keeping strategies. Where appropriate, the

course will illustrate systems aspects of mission design. Prerequisites: MA2121, SS3500, and AE3815.

AE4860 Military Space Maneuvers (2-2)

This course develops the fundamentals of tactical and strategic space maneuvers and addresses the issues pertaining to space warfare. The course covers a wide range of specific military maneuvers that include their mathematical modeling, mission definitions, mission design and optimization. Special attention will be paid to the class of following maneuvers: pursuit-evasion problems, orbital intercept, destructive and nondestructive asset denial problems, rapid retargeting and minimum-time space maneuvers. These maneuvers and certain elements of high-speed velocity guidance will be modeled, simulated, optimized and analyzed as part of the laboratory sessions. Students will also gain practical experience in a state-of-the-art software to analyze the implementation of future military space maneuvers. Additional details pertaining to the course are classified. Prerequisites: MA2121, SS3500, and AE3815. Classification: Security Clearance Required: Secret/NOFORN

AE4870 Spacecraft Design and Integration I (4-0)

Principles of spacecraft design considerations, spacecraft configurations, design of spacecraft subsystems, interdependency of designs of spacecraft subsystems, launch vehicles, mass power estimation, and trade-offs between performance, cost, and reliability. The emphasis is on military geosynchronous communications satellites. The course includes an individual design project. Prerequisites: AE2820, AE3804, AE3851, AE3818, EC3230.

AE4871 Spacecraft Design and Integration II (2-4)

A team project-oriented course on design of non-geosynchronous spacecraft systems. Provides understanding of the principles of space system design, integration, and systems engineering, and their application to an overall spacecraft mission. Considerations are given to cost, performance, and test plan. Several DoD/NASA organizations, such as Naval Research Laboratory and Jet Propulsion Laboratory, provide support in the definition of the mission requirements for the project, spacecraft design, and design reviews. Prerequisites: AE4870.

AE4902 Directed Study in Astronautical Engineering (V-V)

Directed advanced study in Astronautical Engineering on a subject of mutual interest to student and staff member after most of a student's electives have already been taken. May be repeated for credit with a different topic. This course is graded on a Pass/Fail basis only. Prerequisites: Consent of Department Chairman.

AE5810 Dissertation Research (0-8)

Dissertation research for doctoral studies. Required in the quarter following advancement to candidacy and then continuously each quarter until dissertation is approved by the Academic Council.

ME Courses

ME0810 Thesis Research (0-8)

Every student conducting thesis research will enroll in this course.

ME0820 Integrated Project (0-12)

Integrated project.

ME0951 MAE Seminars (No Credit) (0-1)

Lectures on subjects of current interest are presented by NPS faculty and invited experts from other universities and government or industrial activities. All ME students must register for this course every quarter.

ME1000 Preparation for Professional Engineers Registration (3-0)

The course will cover the topics from the 8-hour Professional Examination given by the State of California for Professional Engineer. Discussion will involve applicable engineering techniques, including design and analysis of mechanical systems and components. Prerequisites: Prior passage of Fundamentals of Engineering (FE) Exam or consent of instructor. Graded on Pass/Fail basis only.

ME2101 Engineering Thermodynamics (4-2)

A comprehensive coverage of the fundamental concepts of classical thermodynamics, with insight toward microscopic phenomena. The laws of thermodynamics. Equations of state. Thermodynamic properties of substances. Entropy, irreversibility and availability. Cycle analysis, gas-vapor mixtures, combustion. Prerequisites: MA1115.

ME2201 Introduction to Fluid Mechanics (3-2)

Properties of fluids, hydrostatics and stability of floating and submerged bodies. Fluid flow concepts and basic equations in steady flows: mass, momentum, and energy considerations. Dimensional analysis and dynamic similitude. Viscous effects and fluid resistance. Drag and separated flow over simple bluff bodies. Prerequisites: ME2503.

ME2501 Statics (3-0)

Forces and moments, particles and rigid bodies in equilibrium. Simple structures, friction, first moments and centroids. Prerequisite: MA1115 (may be taken concurrently).

ME2502 Dynamics (4-1)

Kinematics and kinetics of particles and rigid bodies. Rectilinear, plane curvilinear, and space curvilinear motion. Newton's laws of motion. Work, energy, impulse and momentum, and impact. Plane motion of rigid bodies. Relative motion in translating and rotating frames of reference. Gyroscopic forces and motion. Prerequisite: ME2501.

ME2503 Engineering Statics and Dynamics (5-0)

Forces and moments, equilibrium equations, statically indeterminate objects, trusses, methods of joints and sections, centroids, composites, rectilinear and plane curvilinear motion, absolute and relative motion, work and energy, virtual work, impulse and momentum, impact, system of particles, rigid body motion, moving frame, plane motion, fixed-axis rotation. Prerequisites: MA1115 (may be concurrent).

ME2601 Mechanics of Solids I (4-1)

Stress-strain. Plane stress and plane strain, principal stresses, maximum shear stress, thermal stress, Mohr's circle, axial loading, indeterminate members, pressure vessels, elastic torsion, indeterminate torsion, shear moment diagram, elastic bending, beam deflection, combined loading, theory of failure. Supporting laboratory work. Prerequisites: ME2502 or ME2503 and MA1115 or equivalent.

ME2801 Introduction to Control Systems (Offered Jointly) (3-2) Fall/Spring

This course presents classical analysis of feedback control systems using basic principles in the frequency domain (Bode plots) and in the s-domain (root locus). Performance criteria in the time domain such as steady-state accuracy,

transient response specifications, and in the frequency domain such as bandwidth and disturbance rejection are introduced. Simple design applications using root locus and Bode plot techniques will be addressed in the course. Laboratory experiments are designed to expose the students to testing and evaluating mathematical models of physical systems, using computer simulations and hardware implementations.ME2801 and EC2300 are equivalent courses. PREREQUISITES: AE2440/EC2440 and MA2121. This course can be offered as an online course. Familiarity with the MATLAB development environment is assumed.

ME3150 Heat Transfer (4-1)
Introduction to the various modes of heat transfer and their engineering applications. Steady and unsteady conduction involving the use of thermal circuit analogs, analytical, and numerical techniques. Introduction to conservation of mass, momentum and energy. External and internal forced convection fundamentals and correlation. External natural convection. Boiling. Condensation. Heat exchanger analysis and design including a design project. Thermal radiation. Prerequisites: ME2101, ME2201, and MA3132 (may be taken concurrently).

ME3201 Applied Fluid Mechanics (4-1)
Steady one-dimensional compressible flow. Fundamentals of ideal-fluid flow, potential function, stream function. Analysis of viscous flows, velocity distribution in laminar and turbulent flows, introduction to the elements of the Navier-Stokes equations, solution of classical viscious laminar flow problems. Applications to Naval Engineering. Prerequisites: ME2101, ME2201, and MA3132 (may be taken concurrently).

ME3205 Missile Aerodynamics (4-1)
Potential flow, thin-airfoil and finite wing theories. Linearized equations, Ackeret theory, Prandtl-Glauert transformations for subsonic and supersonic wings. Planform effects. Flow about slender bodies of revolution, viscous crossflow theory. Prerequisites: ME3201.

ME3240 Marine Power and Propulsion (4-2)
This course provides an introduction to the basic principles of power and propulsion systems, with an emphasis on performance of platforms and weapons for naval applications. The laws of thermodynamics and fluid mechanics are applied to analyze and design of components and systems. The thermodynamics of simple gas and vapor cycles are presented, including the Otto, Diesel, Brayton and Ranking cycles, and complex and combined cycles with intercooling, reheat, regeneration and combined cycles. The aerothermodynamics of compressors, combustors, turbines, heat exchangers, inlets and nozzles are presented along with preliminary design methods, such as meanline design of turbomachinery. Component matching and engine operation of simple gas generators is treated. Mechanical and structural design aspects of engine development are presented. Propeller characteristics and propulsion/vehicle integration are presented. This course includes laboratories on gas turbines, diesels and turbomachinery. Prerequisites: ME2101, ME3201, ME3521, (ME3201 and ME3521 may be taken concurrently).

ME3410 Mechanical Engineering Instrumentation and Measurement Lab (2-4)
Introduction to measurement systems, statistical analysis of data, error analysis, uncertainty analysis, manipulation of data including electrical readout and processing, data acquisition fundamentals and Fourier decomposition and dynamic signals. Measurements of temperature, pressure, velocity, flow rates. Energy balances, surface temperature visualization, flow visualization. Measurement of motion using accelerometers and encoders. Measurement of strain and force. Operational amplifiers, analog computers, filters. Prerequisites: ME3611, ME2801, ME3150, ME3521 (ME3150 and ME3521 may be taken concurrently).

ME3440 Engineering Analysis (4-0)
Rigorous formulation of engineering problems arising in a variety of disciplines. Approximate methods of solution. Finite difference methods. Introduction to finite element methods. Prerequisites: ME2201, ME2502 or ME2503, and ME3611.

ME3450 Computational Methods in Mechanical Engineering (3-2)
The course introduces students to the basic methods of numerical modeling for typical physical problems encountered in solid mechanics and the thermal/fluid sciences. Problems that can be solved analytically will be chosen initially and solutions will be obtained by appropriate discrete methods. Basic concepts in numerical methods, such as convergence, stability and accuracy, will be introduced. Various computational tools will then be applied to more complex problems, with emphasis on finite element and finite difference methods, finite volume techniques, boundary element methods and gridless Lagrangian methods. Methods of modeling convective non-linearities, such as upwind differencing and the Simpler method, will be introduced. Discussion and structural mechanics, internal and external fluid flows, and conduction and convection heat transfer. Steady state, transient and eigenvalue problems will be addressed. Prerequisites: ME3150, ME3201, ME3611.

ME3521 Mechanical Vibration (3-2)
Elements of analytical dynamics, free and forced response of single degree and multi-degree of freedom systems. Dynamic response using modal superposition method. Properties of stiffness and inertia matrices, orthogonality of modal vectors, eigenvalue problem, modal truncation, vibration isolation and suppression. Vibration of bars, shafts, and beams. Supporting laboratory work. Prerequisites: ME2503, ME2601, MA2121 or equivalent (may be taken concurrently).

ME3611 Mechanics of Solids II (4-0)
Differential equations of bars, shafts and beams with Macauley functions. Unsymmetric bending. Curved beams. Shear flow in thin walled sections. Shear center. Torsion of thin walled open sections. Thick walled cylinders. Energy including Castigliano and unit dummy load methods for displacements. Statically indeterminate systems including beams, frames, trusses, arches and combined structures. Prerequisite: ME2601.

ME3711 Design of Machine Elements (4-1)
Design of representative machine elements with consideration given to materials selection, tolerances, stress concentrations, fatigue, factors of safety, reliability, and maintainability. Typical elements to be designed include fasteners, columns, shafts, journal bearings, spur and helical gears, and clutches and brakes. In addition to traditional design using factors of safety against failure, particular emphasis is placed on design for specified reliability using probabilistic design methods. Prerequisites: ME3611.

ME3712 Capstone Design (1-6)
Design teams apply integrated and systematic design processes to real multifunctional and multidisciplinary problems in mechanical systems. Students develop process concepts, planning, design methodology, material selection, manufacturing and engineering analysis. Capstone design projects include projects provided by

industry partners as well as DoD sponsors. The scope of design problems range across both engineering and non-engineering issues in the integrated design process. Prerequisites: ME2801, ME3150, ME3201, ME3450, ME3521, ME3711, MS3202, OS3104.

ME3720 Introduction to Unmanned Systems (3-2)

This course provides an overview of unmanned systems technology and operations, including navigation, vehicle dynamics, power and propulsion, communications, navigation, motion planning fundamentals. Operational and design considerations for single and multi-vehicle operations are presented. Volume and weight limitations on payload and range are covered as are energy and power constraints. Prerequisites: Permission of instructor.

ME3750 Platform Survivability (4-0)

This course introduces the concepts and analytical tools used in designing and testing survivable combat platforms and weapon systems. The applications are to a broad range of platforms and weapons, including submarines, surface ships, fixed and rotary wing aircraft, cruise missiles, and satellites in a hostile (non-nuclear) environment. The technology for increasing survivability and the methodology for assessing the probability of surviving hostile environments are presented. Topics covered include: current and future threat descriptions; the mission/threat analysis; combat analysis of SEA, vulnerability reduction technology for the major systems and subsystems; susceptibility reduction concepts, including stealth; vulnerability, susceptibility, and survivability assessment; and trade-off methodology. Prerequisites: None.

ME3780 Introduction to Micro Electro Mechanical Systems Design (3-3)

This is a class introducing students to Micro Electro Mechanical Systems (MEMS). Topics include material considerations for MEMS and microfabrication fundamentals; Surface, bulk and non-silicon micromachining; forces and transduction; forces in micro- nano- domains and actuation techniques. Case studies of MEMS based microsensor, microactuator and microfluidic devices will be discussed. The laboratory work includes computer aided design (CAD) of MEMS devices and group design projects. Prerequisites: EC2200, or MS2201 or PH1322 or consent of instructor.

ME3801 Dynamics and Control of Marine and Autonomous Vehicles I (3-2)

First part of the course develops 6DOF equations of motion of marine and autonomous vehicles. Initially we discuss kinematics, followed by vehicle dynamics and overview of forces and moments acting on the marine/autonomous vehicles. Second part of the course introduces basic concepts of linear systems analysis as well as linear systems design using state-space techniques. All the examples used in the second part of the course are based on the model of an Autonomous Underwater Vehicle derived in the first part. The course includes a lab that further illustrates the concepts developed in class using hardware-in-the-loop simulation of an autonomous vehicle. Prerequisite: ME2801.

ME4101 Advanced Thermodynamics (4-0)

This course reviews elementary definitions, concepts and laws of thermodynamics and then extends these to cover general thermodynamics, and advanced topics. The concepts of availability, exergy, irreversibility, and general equilibrium conditions in single and multi-component systems are presented. Ideal and non-ideal solutions and chemical potential are treated along with an introduction to statistical thermodynamics and non-equilibrium

concepts such as Osager's reciprocal relations. Prerequisites: ME2101.

ME4160 Applications of Heat Transfer (4-0)

Applications of heat transfer principles to engineering systems. Design topics include heat exchangers (e.g., boilers, condensers, coolers), cooling electronic components, heat pipes, solar collectors, turbine blade cooling. Prerequisites: ME3150.

ME4161 Conduction Heat Transfer (4-0)

Steady-state heat conduction in multi-dimensions with and without heat sources. Transient conduction. Numerical methods for heat conduction. Mechanical Engineering applications. Prerequisites: ME3150.

ME4162 Convection Heat Transfer (4-0)

Fundamental principles of forced and free convection. Laminar and turbulent duct flows and external flows. Dimensionless correlations. Heat transfer during phase changes. Heat exchanger analysis with Mechanical Engineering applications. Prerequisites: ME3150, ME3201, ME4220, or consent of instructor.

ME4163 Radiation Heat Transfer (4-0)

Basic laws and definitions. Radiation properties of surfaces. Radiant interchange among diffusely emitting and reflecting surfaces. Applications and solutions of the equations of radiant interchange. Radiant interchange through participating media. Combined conduction and radiation. Prerequisites: ME3150.

ME4202 Compressible and Hypersonic Flow (4-0)

One-dimensional, compressible flow is reviewed. Two-dimensional and axis-symmetric supersonic of ideal gases. Oblique shocks and expansion waves. General compressible flow equations. Potential supersonic and conical flows. Compressible scaling and transonic area ruling. Effects of very high velocity and low density. Hypersonic flow. Mach number independence and equivalence principles. Newtonian method. Blunt and slender body solutions. Real gas behavior and effect on shock and boundary layers. Applications are presented to satellite parasitic drag and re-entry flows. Prerequisites: ME3201 or consent of instructor.

ME4211 Applied Hydrodynamics (4-0)

Fundamental principles of hydrodynamics. Brief review of the equations of motion and types of fluid motion. Standard potential flows: source, sink, doublet, and vortex motion. Flow about two-dimensional bodies. Flow about axisymmetric bodies. Added mass of various bodies and the added-mass moment of inertia. Complex variables approach to flow about two-dimensional bodies. Conformal transformations. Flow about hydro and aerofoils. Special topics such as dynamic response of submerged bodies, hydroelastic oscillations, etc. Course emphasizes the use of various numerical techniques and the relationship between the predictions of hydrodynamics and viscous flow methods. Prerequisites: ME3201.

ME4220 Viscous Flow (4-0)

Development of continuity and Navier-Stokes equations. Exact solutions of steady and unsteady viscous flow problems. Development of the boundary-layer equations. Similarity variables, numerical and integral techniques. Separation, boundary-layer control. Time-dependent boundary layers. Origin and nature of turbulence, phenomenological theories, calculation of turbulent flows with emphasis on naval engineering applications, and numerical models and CFD. Prerequisites: ME3201 and consent of instructor.

ME4225 Computational Fluid Dynamics and Heat Transfer (3-2)

This course presents numerical solution of sets, of partial differential equations, that describe fluid flow and heat transfer. The governing equations for fluid dynamics are reviewed and turbulence modeling is introduced. Discretization techniques are applied to selected model equations and numerical methods are developed for inviscid and viscous, compressible and incompressible flows. Individual term projects include application of CFD to thesis research and to current military problems. Prerequisites: ME3201 or ME3450.

ME4231 Advanced Turbomachinery (3-2)

The underlying principles governing flow through and energy exchange in turbomachines are developed to provide a basis for understanding both design and advanced computational methods. Key considerations and procedures followed in the design of new aircraft engine fans, compressors and turbines are introduced. Lectures are coordinated with experimental test experience at the Turbopropulsion Laboratory. Prerequisites: ME3240.

ME4240 Advanced Topics in Fluid Dynamics (4-0)

Topics selected in accordance with the current interests of the students and faculty. Examples include fluid-structure interactions, cable strumming, wave forces on structures, free-streamline analysis of jets, wakes, and cavities with emphasis on computational fluid dynamics. Prerequisites: ME4220 and ME4211.

ME4251 Engine Design and Integration (3-2)

The conceptual and preliminary component, subsystem, and systems design of military, or military related, airbreathing engines, along with the integration of the engine in a platform, is experienced within student design teams. The course is focused on a team response for a Request-for-Proposal (RFP) for an engine meeting specific requirements. Performance, cost, supportability, deployment, manufacturing, product quality and environmental considerations may be included in the design process. The project draws on all of the mechanical engineering disciplines. Prerequisites: ME3240.

ME4420 Advanced Power and Propulsion (4-0)

This course presents an advanced treatment of power and propulsion topics, primarily for naval applications. Thermodynamic analysis of simple, advanced and complex cycles, such as combined and augmented cycles (e.g., RACER and STIG) are presented along with new and direct energy conversion concepts. Design integration of single and multi-type (CODAG, CODOG, etc.) power and propulsion systems with vehicles. Engine installation considerations, including the design of auxiliary equipment and inlet/exhaust systems, are presented. Design and current research topics in fluid mechanics and rotordynamics of turbomachinery are presented. Repair, condition-based maintenance and machinery operation, including balance techniques, are discussed. Prerequisites: ME3240.

ME4522 Finite Element Methods in Structural Dynamics (4-0)

This course provides an introduction to the principles and methods of computational structural dynamics and vibration analysis. Modern computational methods make use of the matrix structural models provided by finite element analysis. Therefore, this course provides an introduction to dynamic analysis using the finite element method, and introduces concepts and methods in the calculation of modal parameters, dynamic response via mode superposition, frequency response, model reduction, and structural synthesis techniques. Experimental modal identification techniques will be introduced. Prerequisites: ME3521.

ME4525 Naval Ship Shock Design and Analysis (4-0)

Characteristics of underwater explosion phenomena, including the shock wave, bubble behavior and bubble pulse loading, and bulk cavitation. Surface ship/submarine bodily response to shock loading. Application of shock spectra to component design. Dynamic Design Analysis Method (DDAM) and applications to shipboard equipment design. Fluid-Structure Interaction (FSI) analysis, including Doubly Asymptotic Approximation (DAA) and surface ship FSI. Current design requirements for shipboard equipment. Prerequisites: ME3521 or equivalent.

ME4550 Random Vibrations and Spectral Analysis (3-2)

Engineering application of spectral analysis techniques to characterize system responses under a random vibration environment. Characteristics of physical random data and physical system responses. Application of probability concepts to random data and response analysis. Correlation and spectral density functions. Transmission of random vibration. System responses to single/multiple random excitations. Failure due to random vibration. Supporting laboratory work. Prerequisites: ME3521 or equivalent.

ME4612 Advanced Mechanics of Solids (4-0)

Selected topics from advanced mechanics of materials and elasticity. Stress and strain tensors. Governing equations such as equations of equilibrium, constitutive equations, kinematic equations and compatibility equations. Two-dimensional elasticity problems in rectangular and polar coordinate systems. Airy stress function and semi-inverse technique. Energy methods with approximate solution techniques including Rayleigh-Ritz method. Buckling of imperfect columns. Introduction to plate and shell bending theory. Prerequisites: ME3611.

ME4613 Finite Element Methods (4-0)

Introduction to the fundamental concepts of the finite element method. Weighted residual methods and weak formulation. Element discretization concept and shape functions. Generation of element matrices and vectors, and their assembly into the matrix equation. Application of boundary and initial conditions. Isoparametric elements and numerical integration techniques. Computer programming and application to engineering problems such as boundary value, initial value and eigenvalue problems. Prerequisites: ME3611, ME3440 or equivalent or consent of instructor.

ME4620 Theory of Continuous Media (4-0)

Tensor analysis. Stress and strain tensors. Motion of continuum. Energy and entropy. Constitutive equations. Applications to elasticity and fluid dynamics. Prerequisites: ME3201 and ME3611.

ME4700 Weaponeering (3-2)

Describes and quantifies methods commonly used to predict the probability of successfully attacking ground targets. Initial emphasis is on air launched weapons, including guided and unguided bombs, air-to-ground missiles, LGBs, rockets and guns. Course outlines the various methodologies used in operational products used widely in the USN, USAF and Marine Corps. Prerequisites: ME2502 or MA2121, or equivalent. Some capability in MS Excel and MATLAB, or permission of instructor.

ME4702 Engineering Systems Risk Benefit Analysis (3-2)

This course emphasizes three methodologies, Decision Analysis (DA), Reliability and Probabilistic Risk Assessment (RPRA) and

Cost-Benefit Analysis (CBA). The course is designed to give students an understanding of how these diverse topics can be applied to decision making process of product design that must take into consideration significant risk. The course will present and interprets a framework for balancing risks and benefits to applicable situations. Typically these involve human safety, potential environmental effects, and large financial and technological uncertainties. Concepts from CBA and RPRA are applied for real world problems resulting in decision models that provide insight and understanding, and consequently, leading to improved decisions. Same course as OS4010. Prerequisites: OS3104/EO4021 or equivalent course in probability, or consent of instructor.

ME4703 Missile Flight and Control (4-1)
Static and dynamic stability and control; transient modes; configuration determinants; subsonic, transonic, supersonic force and moment data for performance calculations with short and long-range cruciform missiles and cruise missiles; acceleration, climb, ceiling, range and agility in maneuvering trajectories. Principles of missile guidance, including guidance control laws, and six degree-of-freedom motion simulations. Additional topics are selected from the following areas to address the general interests of the class: advanced guidance laws, passive sensors, INS guidance, fire control and tracking systems. Prerequisites: ME3205 and ME2801 or equivalent.

ME4704 Missile Design (3-2)
Conceptual missile design methodology centered around a student team design project, focused on a military need defined by a Request-for-Proposal. It stresses the application aerodynamics, propulsion, flight mechanics, cost, supportability, stability and control and provides the student with their application to design. Consideration is given to trade-offs among propulsion requirements, air loads, quality sensors, guidance laws, quality, controls, and structural components. Prerequisites: PREREQUISITE: ME3205, ME4703 or equivalent, AE4452.

ME4731 Engineering Design Optimization (4-0)
Application of automated numerical optimization techniques to design of engineering systems. Algorithms for solution of nonlinear constrained design problems. Familiarization with available design optimization programs. State-of-the-art applications. Solution of a variety of design problems in mechanical engineering, using numerical optimization techniques. Prerequisites: ME3450, ME3150, ME3201, ME3611.

ME4751 Combat Survivability, Reliability, and systems Safety Engineering (4-1)
This course provides the student with an understanding of the essential elements in the study of survivability, reliability and systems safety engineering for military platforms including submarines, surface ships, fixed-wing and rotary wing aircraft, as well as missiles, unmanned vehicles and satellites. Technologies for increasing survivability and methodologies for assessing the probability of survival in a hostile (non-nuclear) environment from conventional and directed energy weapons will be presented. Several in-depth studies of the survivability various vehicles will give the student practical knowledge in the design of battle-ready platforms and weapons. An introduction to reliability and system safety engineering examines system and subsystem failure in a non-hostile environment. Safety analyses (hazard analysis, fault-tree analysis, and component redundancy design), safety criteria and life cycle considerations are presented with applications to aircraft maintenance, repair and retirement strategies, along with the

mathematical foundations of statistical sampling, set theory, probability modeling and probability distribution functions. Prerequisites: Consent of instructor.

ME4753 Risk Analysis and Management for Engineering Systems (3-2)
This course covers three areas in the risk field - Qualitative Risk Analysis, Quantitative Risk Analysis, and Decision Risk Analysis. Qualitative Risk Analysis presents techniques for risk identification/evaluation, risk handling, risk monitoring and risk management. Quantitative Risk Analysis includes Probabilistic Risk Assessment (RPRA) of system performance and project cost/schedule. Decision Risk Analysis gives the students an understanding of how to apply risk and cost benefit techniques in decision making when one must deal with significant risk or uncertainty. The course will present a framework for balancing risks and benefits to applicable situations. Typically these involve human safety, potential environmental effects, and large financial and technological uncertainties. Concepts are applied toward representative problems resulting in risk and decision models that provide insight and understanding, and consequently lead to more successful projects/programs with better system performance within cost and schedule. This is the same course as SE4353. Prerequisites: OS3180/OS3104, or equivalent graduate level course in probability, or consent of the instructor.

ME4780 Micro Electro Mechanical Systems (MEMS) Design II (2-4)
Same as EC4280 and PH4280. This is the second course in Micro Electro Mechanical Systems (MEMS) Design. This course will expose students to advanced topics on material considerations for MEMS, microfabrication techniques, forces in the micro- and nano- domains, and circuits and systems issues. Case studies of MEMS based microsensors, microactuators and microfluidic devices will be discussed. The laboratory work includes computer aided design (CAD) and characterization of existing MEMS devices. The grades will be based on exams, lab projects, and a group design project. Prerequisites ME/EC/PH3280 or ME3780 or consent of instructor.

ME4811 Autonomous Systems and Vehicle Control II (3-2)
Multivariable analysis and control concepts for MIMO systems. State Observers. Disturbances and tracking systems. Linear Optimal Control. The linear Quadratic Gaussian compensator. Introduction to non-linear system analysis. Limit cycle behavior. Prerequisites: ME3801.

ME4812 Fluid Power Control (3-2)
Fluids and fluid flows in high-performance actuators and controllers. Power flow and fluid power elements, valve and pump control, linear and rotary motion. State space descriptions. Design of electro-hydraulic position and velocity control servo-mechanisms for high performance with stability. Prerequisite: ME3801.

ME4821 Marine Navigation (3-2)
This course presents the fundamentals of inertial navigation, principles of inertial accelerometers, and gyroscopes. Derivation of gimbaled and strapdown navigation equations and corresponding error analysis. Navigation using external navigation aids (navaids): LORAN, TACAN, and GPS. Introduction to Kalman filtering as a means of integrating data from navaids and inertial sensors. Prerequisite: ME3801.

ME4822 Guidance Navigation and Control of Marine Systems (3-2)

This course takes students through each stage involved in the design, modeling and testing of a guidance, navigation and control (GNC) system. Students are asked to choose a marine system such as an AUV, model its dynamics on a nonlinear simulation package such as SIMULINK and then design a GNC system for this system. The design is to be tested on SIMULINK or a similar platform. Course notes and labs cover all the relevant material. Prerequisites: ME4801 or consent of instructor.

ME4823 Cooperative Control of Multiple Marine Autonomous Vehicles (4-0)

This course covers selected topics on trajectory generation and control of multiple marine autonomous vehicles. First part of the course addresses techniques for real-time trajectory generation for multiple marine vehicles. This is followed by introduction to algebraic graph theory as a way to model network topology constraints. Using algebraic graph theory formalism Agreement and Consensus problems in cooperative control of multiple autonomous vehicles are discussed, followed by their application to cooperative path following control of multiple autonomous vehicles. Lastly, the course covers topics suggested by the students, time permitting. Prerequisites: ME3201, ME3801 or permission of instructor.

ME4825 Marine Propulsion Control (3-2)

Introduction to dynamic propulsion systems modeling and analysis methods. Control design specifications and design strategies. Introduction to modern control design theory and multivariable methods. Theory and applications of optimal control and discrete-time control systems. Case studies of current naval propulsion control systems. Prerequisites: ME3801, ME3240 (may be taken concurrently), and MA3132.

ME4901 Advanced Topics in Mechanical (Aerospace) Engineering (V-V)

Advanced study in Mechanical (Aerospace) Engineering generally on a subject not covered in existing courses. May be repeated for credit with a different topic. This course number should be used to initiate new advanced courses. Prerequisite: Permission of Department Chairman and instructor. This course may not be taken on a Pass/Fail Basis.

ME4902 Directed Study in Mechanical (Aerospace) Engineering (V-V)

Directed advanced study in Mechanical (Aerospace) Engineering on a subject of mutual interest to student and faculty member after most of a student's electives have already been taken. This is typically a "Reading" course directed by a faculty member. This course may be repeated for credit with a different topic. Prerequisite: Permission of Department Chairman and instructor. Graded on Pass/Fail basis only.

ME5810 Dissertation Research (0-8)

Dissertation research for doctoral studies. Required in the quarter following advancement to candidacy and then continuously each quarter until dissertation is approved by the Academic Council.

MS Courses

MS2201 Introduction to Materials Science and Engineering (3-2)

This is a first course in Materials Science and Engineering and emphasizes the basic principles of microstructure-property relationships in materials of engineering and naval relevance.

Topics include crystalline structure and bonding, defects, thermodynamics and kinetics of reactions in solids, deformation, strengthening mechanisms and heat treatment. Students will acquire a working vocabulary and conceptual understanding necessary for advance study and for communication with materials experts. Prerequisites: Undergraduate courses in calculus, physics and chemistry.

MS3202 Properties, Performance and Failure of Engineering Materials (3-2)

The purpose of this course is to advance the students' understanding of the fundamentals of materials science, while putting that understanding in the context of the behavior of materials in engineering applications. Contemporary developments in engineering materials such as composites, ceramics and polymers are considered, as well as traditional engineering alloys such as steels and aluminum alloys. Performance and failure histories of materials in service will be studied, as well as conventional textbook subjects. Examples pertinent to Naval, Aero and Combat Systems Science are emphasized. Topics include mechanical properties, fracture, fatigue, failure analysis and corrosion. Prerequisites: MS2201 or equivalent or consent of instructor.

MS3203 Structural Failure, Fracture and Fatigue (3-2)

Theories of yield and fracture for aircraft design limit loads and ultimate loads; stress-life and strain-life fatigue theories of crack initiation in aircraft structures subjected to realistic flight load spectra, using Neuber's approximation and incorporating the Miner concept of cumulative damage. Fatigue crack propagation concepts and Navy methods of fleet structural fatigue tracking and monitoring. Prerequisites: MS3202, ME2601.

MS3214 Intermediate Materials Science and Engineering (4-0)

The purpose of this course is to provide a bridge between the introductory courses in materials science, MS2201 and MS3202, and the 4000 level elective courses in materials science. The emphasis is on a deepening of understanding of basic principles which govern the behavior of solid materials. Principles of physical metallurgy and the physics of materials will be considered in detail. Topics include thermodynamics of solids, electronic structure of alloys, lattice stability, phase equilibria, diffusion, dislocation theory, deformation mechanisms and an introduction to the kinetics of phase transformations. The course is intended to show how the application of basic principles leads to clearer understanding and control of the behavior and properties of contemporary materials. Prerequisites: MS2201 and MS3202 or equivalent or consent of instructor.

MS3304 Corrosion and Marine Environmental Deterioration (3-2)

The fundamentals of corrosion science and the practice of corrosion engineering are discussed. The objectives include an appreciation of the varied causes, mechanisms and effects of corrosion. Fundamental topics such as basic electrochemistry, polarization and passivity are covered. A primary goal of the course is the development of skill in the recognition and prevention of a wide variety of types of corrosion. Standard methods of corrosion control are discussed, including cathodic protection, coatings, alloy selection and inhibitors. Prerequisites: MS2201 or equivalent or consent of instructor.

MS3606 Introduction to Welding and Joining Metallurgy (3-2)

Welding and joining are presented from the point of view of metallurgy. Topics include the nature and applications of welding and joining processes; the welding thermal cycle; metallurgical effects of the welding thermal cycle; welding and joining of steels, aluminum alloys, stainless steels and heat-resistant alloys. Also, weldment inspection and quality assurance are introduced. Prerequisites: MS2201 and MS3202 or consent of instructor.

MS4215 Phase Transformations (3-2)

The mechanisms and kinetics of structural changes in solid materials are considered in detail. A wide variety of transformation mechanisms are studied, including solidification, recrystallization, precipitation and martensitic transformation. The basic principles which govern these reactions are developed, including principles of nucleation and growth, diffusion and lattice distortion. The relevance of various transformations to practical heat treatment, thermomechanical processing, and technological advances is discussed. Microstructural recognition and methods of monitoring phase transformations are included. Changes in properties which result from phase transformations are given limited attention. Prerequisites: MS3214 or equivalent or consent of instructor.

MS4312 Characterization of Advanced Materials (3-2)

This course is structured to provide an insight into the various tools available for advanced physical examination of engineering materials. Topics covered include X-ray diffraction and optical, scanning, transmission and scanning transmission electron microscopies. Prerequisites: MS3202 or consent of instructor.

MS4410 Advanced Energy Materials (4-1)

The course was designed for military officers in situations where they are either directly involved in the use of batteries, fuel cells, or managing similar programs where such systems are designed, developed, or procured. Given the Navy's historic use of battery technology in submarines and aboard other platforms, the course provides both scientific understanding of key electrochemical concepts and expertise in evaluating energy storage technologies for military application. The course gives an overview on existing energy conversion and storage technologies, and provides a solid foundation in electrochemistry and chemical engineering. Lectures cover important energy concepts in thermodynamics, electrokinetics, and mass transport. The course then discusses the physics, chemistry, material requirements, performance, and operational aspects of a full range of energy conversation and storage technologies, including, but not limited to, primary and secondary batteries, fuel cells, supercapacitors, thermoelectric generators, photovoltaics, and biofuels. The reforming of natural gas, ethanol, and other carbon-based fuels into hydrogen for use in fuel cells will also be discussed, along with solid-state, pressurized-gas, and cryogenic hydrogen storage. Pertinent Navy-relevant examples are given, including the application of lithium ion battery technologies to autonomous underwater vehicles (AUVs), and use of fuel cell and solid-state hydrogen storage technologies in submarines with Air-Independent Propulsion (AIP). Prerequisites: MS3304.

MS4811 Mechanical Behavior of Engineering Materials (4-0)

The response of structural materials to stress is discussed, including elastic and plastic deformation and fracture. Topics include elastic response and the modules of elasticity; plasticity; deformation mechanisms and dislocation theory; strengthening mechanisms; and fatigue and fracture. Application to materials development is also considered. Prerequisites: MS3202, and MS3214 or consent of instructor.

MS4822 The Engineering and Science of Composite Materials (4-0)

This course focuses on the structure-property correlation in composites utilizing a multi-disciplinary approach, covering the areas of materials science and engineering and solid mechanics. Emphasis is given to the theoretical constitutive behavior at the micro- and macro-levels, as well as on how such behavior can be altered by processing and service variables. The course is divided into three broad parts: (1) Theoretical predictions of composite properties; (2) Materials issues (including processing) complicating accurate performance prediction; and (3) Thermo-mechanical behavior in actual service conditions. Prerequisites: ME3611, MS3202 or equivalent.

MX Courses

MX2001 Introduction to Physics-Based Modeling and Simulation (4-0)

This course is intended for DoD non-technical acquisition professionals who do not have engineering or science degrees so that they can obtain a general understanding of key M&S capabilities necessary for design, analysis, and maintenance of engineering systems. The course will introduce basic concepts in the modeling of engineering systems. The steps involved in the idealization of systems to produce a "computable" model will be discussed. Examples will involve structural, thermal, fluid, and electrical aspects. Fundamental physical quantities such as rates of change, (e.g. acceleration, stress) and force will defined heuristically. The simulation of simple physical processes (e.g. falling object) will described and simple simulation algorithms will be described. No computer programming is required. Spatial discretization, finite difference and finite element methods will be introduced. This course may not be used to fulfill ME/AE degree program requirements. Prerequisites: None.

MX3001 Basic Engineering Concepts in Modeling & Simulation I (4-0)

This course will provide introductory concepts of various engineering topics to DoD non-technical acquisition professionals who do not have engineering or science degrees so that they can obtain a general understanding of key M&S capabilities necessary for design, analysis, and maintenance of engineering systems. The topics covered in the course include structural mechanics, shock & vibrations, fluids, heat transfer & thermodynamics, dynamics and controls, and materials and fabrication. Upon completion, students should have basic understanding of the wide range of engineering concepts that are essential for physics-based engineering modeling and simulation. This course may not be used to fulfill ME/AE degree program requirements. Prerequisite: MX2001.

MX3002 Overview of Computers, Weapons Platforms and Electrical Systems (4-0)

This course will provide introductory concepts of various engineering topics to the DoD Modeling and Simulation workforce member supporting Defense Acquisition so that they can obtain a general understanding of key M&S capabilities necessary for design, analysis, and maintenance of computers, weapons platforms, and Electrical engineering systems. The topics covered in the course include wave propagation, modeling and simulation approaches to complex system design and assessment, fundamentals of computer software and its limitations, basic concepts in electrical engineering and electrical machinery, and the fundamental issues

involved in C4ISR systems. Upon completion, students should have basic understanding of the wide range of engineering concepts that are essential for physics-based engineering M&S. This course may not be used to fulfill ME/AE degree program requirements. Prerequisites: MX2001, MX3001.

MX4000 Selected Topics in the Application of Engineering Modeling & Simulation (4-0)
This course provides the DoD acquisition professional with an overview of how typical engineering modeling and simulation applications support the acquisition process. A systematic approach will be used to demonstrate the function of physics based modeling and simulation in the design, production, operation and maintenance of complex systems. The course is broken into four general topic areas that address specific engineering features related to land vehicle systems, sea based systems, aviation systems and space-satellite systems. Investigations into the feasibility, utility, and risk of engineering modeling and simulation in each of these focus areas will be highlighting through the use of engineering case studies. Upon completion of this course, students should have a general awareness of engineering modeling and simulation applications in support of the acquisition lifecycle. This course may not be used to fulfill ME/AE degree program requirements. Prerequisites: MX2001, MX3001, MX3002.

TS Courses

TS3000 Electrical Power Engineering (3-2)
An overview of the principles, concepts and trade-offs which form the foundation for shipboard electric power systems. The composition of electrical power systems for present and future Navy vessels is presented. Theory necessary to understand interactions among shipboard electric power system components is discussed. The interactions between the electric power system and the various types of loads is introduced. Prerequisites: None.

TS3001 Fundamental Principles of Naval Architecture (3-2)
The geometry, hydrostatics and hydrodynamics of monohull and other floating and submerged bodies; Froude similarity; wave and skin friction resistance; powering determination. Longitudinal and transverse stability of floating bodies. Hull girder strength. Introduction to seakeeping and passive survivability principles. Prerequisites: ME2201, ME2601 or consent of instructor.

TS3002 Principles of Ship Design and Case Studies (3-2)
Systems engineering in the design of complex systems; systems architecture and interface engineering and the Navy design environment. The systems development process, including need identification, requirements, feasibility determination, risk reduction, contract and detailed design. The iterative, multilevel ship design process, with affordability as a fundamental feature; modern ship design and construction methods, systems engineering techniques and tools. Case studies, ship design trends, design exercises and illustrations. Prerequisites: TS3001.

TS3003 Naval Combat System Elements (3-2)
This course will cover combat system detection and engagement elements. This includes radar, ESM, active and passive sonar, infrared, warheads, guns, missiles, torpedoes, fire control and countermeasures. The emphasis will be on what the elements contribute to a combat system, their basic principles of operation, their performance limitations, and their interfaces with the rest of the combat system. Details on specific elements and systems will be limited to those needed to illustrate basic principles and interactions

affecting systems engineering. Prerequisites: ME2503, or equivalent or consent of instructor.

TS4000 Naval Combat System Engineering (3-2)
Covers the definition and integration of naval combat systems. The emphasis will be on how the various detection, engagement, and control elements interact with each other and on how to combine them into an efficient and survivable combat system. Also addressed will be topside arrangements, signature reduction, readiness assessment, embedded training, and support system interfaces. Prerequisites: TS3000, TS3003.

TS4001 Integration of Naval Engineering Systems (3-2)
A system-oriented approach to integrating the principles of Naval Architecture and Marine Engineering in the design of ship subsystems. Lectures and projects exploring engineering design tools and analysis methods to meet specified systems requirements are used. Projects on hull, mechanical and electrical ship systems design are emphasized. The impact of systems design on other systems and subsystems and on the ship, including affordability, military effectiveness and survivability at the whole ship level are considered. Prerequisites: TS3000, TS3001, TS3002.

TS4002 Ship Design Integration (2-4)
The ship-impact of requirements/cost/performance tradeoffs within technical and acquisition constraints. Conversion of broad military requirements to mission-based ship requirements and specific tasks resulting from those requirements. Exploration of alternative methods of satisfying requirements, leading to combat systems (payload) definition. Conduct of feasibility studies to investigate whole-ship alternatives which meet requirements. Selection of a best design approach. Design considerations for unusual ship types and an assessment of future Navy ship and combat systems needs and trends. Prerequisites: TS4001 and TS4000.

TS4003 Total Ship Systems Engineering (2-4)
The design of a Naval vessel as a single engineering system satisfying mission requirements, with emphasis on affordability and survivability. The interaction and interfacing of various subsystems such as hull, propulsion, and combat systems will be explored through a joint ship "preliminary design" project to produce a balanced ship design based on the alternative chosen from feasibility studies conducted in TS4002. Concepts of design optimization within constraints. Prerequisites: TS4002.

Engineering Modeling and Simulation Certificate- Curriculum 279

Program Manager

Knox Millsaps
Watkins Hall, Room 338
(831) 656-3382, DSN 756-3382
millsaps@nps.edu

Brief Overview

The Engineering Modeling & Simulation certificate is comprised of four courses (MX-2001, MX-3001, MX-3002 and MX-4000). Upon completion of this certificate program, students will be awarded a certificate of completion from the Naval Postgraduate School. The

Engineering Modeling & Simulation Certificate program is targeted primarily at personnel in the DoD Acquisition Workforce but has great benefit for all students who seek further knowledge regarding the application of physics-based modeling and simulation in support of the acquisition lifecycle.

Requirements for Entry

For entry, the student must have a baccalaureate degree with a Minimum APC or 334.

Program Length

Four quarters.

Graduate Certificate Requirements

To earn the academic certificate students must pass all four courses with a C+ (2.3 Quality Point Rating (QPR)) or better in each course and an overall QPR of 3.0 or better. Students earning grades below these standards will need to retake the courses to bring their grades within standards or they will be withdrawn from the program.

Required Courses

Quarter 1

MX2001	(4-0)	Introduction to Physics- Based Modeling and Simulation

Quarter 2

MX3001	(4-0)	Basic Engineering Concepts in Modeling & Simulation I

Quarter 3

MX3002	(4-0)	Overview of Computers, Weapons Platforms and Electrical Systems

Quarter 4

MX4000	(4-0)	Selected Topics in the Application of Engineering Modeling & Simulation

Naval/Mechanical Engineering (Energy Focus) - Curriculum 563

Program Officer

Michael Porter, CDR, USN
Code 74, Watkins Hall, Room 107A

(831) 656-2033, DSN 756-2033
maporter1@nps.edu

Academic Associate

Joshua H. Gordis, Ph.D.
Code ME/Go, Watkins Hall, Room 313

(831) 656-2866, DSN 756-2866
jgordis@nps.edu

Brief Overview

The objective of this program is to provide graduate education, primarily in the field of Naval/Mechanical Engineering with a focus on Energy, including production, storage, and use. This program is designed to produce graduates with the technical competence to operate and maintain modern warships and naval systems. It establishes a broad background of basic engineering knowledge leading to advanced studies in heat transfer, fluid mechanics, control systems, solid mechanics and vibrations, material science, energy production, storage and usage. The graduate will be able to participate in technical aspects of naval systems acquisition for technological advances in naval ships and systems, particularly as they apply to energy. Through emphasis on the design aspect within the program, the graduate will be well prepared to apply these advances in technology to the warships of the future. An original research project focusing on either Energy, Power and Propulsion Systems or Energy Materials resulting in a satisfactory thesis is an integral part of the curriculum.

Requirements for Entry

A baccalaureate degree or its equivalent is required, preferably in an engineering discipline. A minimum academic profile code (APC) of 323 is required (334 with one quarter refresher). This equates to a minimum grade point average of 2.20, with mathematics through differential and integral calculus and one year of calculus-based physics as non-waiverable requirements. The program is open to naval officers in the rank of LTJG through LCDR and equivalent grade officers of other U.S. services and qualified foreign military officers. DoD civilian employees and DoD Contractors are also eligible.

Entry Date

Naval/Mechanical Engineering (Energy Specialty) is typically an eight-quarter program with preferred entry dates in March or September. For further information contact the Program Officer or the Academic Associate.

Degree

Requirements for the Master of Science in Mechanical Engineering degree, which is an ABET EAC accredited degree are met as a milestone en route to satisfying the educational skill requirements of the curricular program.

Subspecialty

Completion of this curriculum qualifies an officer as a Naval/Mechanical Engineering Specialist with a subspecialty code of 5603P. The curriculum sponsors are Naval Sea Systems Command and Navy Energy Coordination Office.

Typical Course of Study

Quarter 0

MA1113	(4-0)	Single Variable Calculus I
MA1114	(4-0)	Single Variable Calculus I w/Matrix Algebra
ME2501	(4-0)	Engineering Statics
AE2440	(3-2)	MATLAB
EN3000	(2-0)	**Defense Energy Seminar**

Quarter 1

MA1115	(4-0)	Multivariable Calculus
MA1116	(3-0)	Vector Calculus
ME2502	(5-0)	Engineering Dynamics
ME2101	(4-2)	Thermodynamics
NW3230	(4-0)	Maritime and Joint Strategic Planning
EN3000	(2-0)	**Defense Energy Seminar**

Quarter 2

MA2043	(4-0)	Linear Algebra
MA2121	(4-0)	Differential Equations
ME2601	(4-1)	Mechanics of Solids I
MS2201	(3-2)	Materials Science
EN3000	(2-0)	**Defense Energy Seminar**

Quarter 3

MA3132	(4-0)	Partial Differential Equations
MA3232	(4-0)	Numerical Analysis
ME3611	(4-0)	Mechanics of Solids II
ME2201	(3-2)	Fluid Mechanics I
PH3700	(4-0)	Fundamentals of Energy Technology
EN3000	(2-0)	**Defense Energy Seminar**

Quarter 4

EO2102	(4-2)	Intro to Circuit & Power Systems Analysis
ME3521	(3-2)	Mechanical Vibrations
ME3201	(4-1)	Applied Fluid Mechanics
ME3150	(4-1)	Heat Transfer
OS3007	(4-1)	Operations Research for Energy Systems Analysis
EN3000	(2-0)	**Defense Energy Seminar**

Quarter 5

ME2801	(3-2)	System Dynamics
ME3450	(3-2)	Computational Methods in Mechanical Engineering
ME3711	(4-1)	Machine Design
MS3202	(3-2)	Failure Analysis and Prevention
EN3000	(2-0)	**Defense Energy Seminar**

Quarter 6

ME3240	(4-2)	Marine Power and Propulsion
ME3712	(4-2)	Systems Design
ME3801	(3-2)	Dynamics and Control of Marine and Autonomous Vehicles I
ME4XXX	(V-V)	Energy Specialization Elective
EN3000	(2-0)	**Defense Energy Seminar**

Quarter 7

ME0810	(0-8)	Thesis Research (Energy)
ME0810	(0-8)	Thesis Research (Energy)
ME4XXX	(V-V)	Energy Specialization Elective
MS3304	(3-2)	Corrosion (can substitute MS3606 Welding)
EN3000	(2-0)	**Defense Energy Seminar**

Quarter 8

ME0810	(0-8)	Thesis Research
ME0810	(0-8)	Thesis Research
TS3001	(3-2)	Naval Architecture
ME4XXX	(V-V)	Energy Specialization Elective
EN3000	(2-0)	**Defense Energy Seminar**

Naval/Mechanical Engineering - Curriculum 570

Program Officer

Michael Porter, CDR, USN
Code 74, Watkins Hall, Room 107A

(831) 656-2033, DSN 756-2033
maporter1@nps.edu

Academic Associate

Joshua H. Gordis, Ph.D.
Code ME/Go, Watkins Hall, Room 313

(831) 656-2866, DSN 756-2866
jgordis@nps.edu

Brief Overview

The objective of this program is to provide graduate education, primarily in the field of Naval Mechanical Engineering, in order to produce graduates with the technical competence to operate and maintain modern warships and naval systems. It establishes a broad background of basic engineering knowledge leading to advanced studies in heat transfer, fluid mechanics, control systems, solid mechanics and vibrations and material science. The graduate will be able to participate in technical aspects of naval systems acquisition for technological advances in naval ships and systems. Through emphasis on the design aspect within the program, the graduate will be well prepared to apply these advances in technology to the warships of the future. An original research project resulting in a finished thesis is an integral part of the curriculum.

Requirements for Entry

A baccalaureate degree or its equivalent is required, preferably in an engineering discipline. A minimum academic profile code (APC) of 323 is required (334 with one quarter refresher). This equates to a minimum grade

point average of 2.20, with mathematics through differential and integral calculus and one year of calculus-based physics as non-waiverable requirements. The program is open to naval officers in the rank of LTJG through LCDR in the 11XX/14XX community, equivalent grade officers of other U.S. services and qualified foreign military officers. DoD employees are also eligible.

Entry Date

Naval/Mechanical Engineering is typically an eight-quarter program with preferred entry dates in January or June. Refresher quarters are offered in March and September and is recommended for non-engineering undergraduates and those out of school greater than 5 years. Time in residence may be reduced by course validations depending on the officer's specific academic background. If further information is needed, contact the Program Officer or the Academic Associate.

Degree

Requirements for the Master of Science in Mechanical Engineering degree are met as a milestone en route to satisfying the educational skill requirements of the curricular program.

Subspecialty

Completion of this curriculum qualifies an officer as a Naval/Mechanical Engineering Specialist with a subspecialty code of 5601P. The curriculum sponsor is Naval Sea Systems Command. A limited number of particularly well qualified students may be able to further their education beyond the master's degree and seek the degree of Mechanical Engineer and a 5601N Subspecialty Codes.

Typical Subspecialty Billets

Upon award of the 5601P/5602P subspecialty code, the officer becomes eligible for assignment to those billets identified as requiring graduate education in Naval/Mechanical Engineering. Typical of these billets are the following:

Industrial Activities - Shipyard, SUPSHIP, Ship Repair Facility, SIMA
Mechanical Engineering Instructor, USNA
Tender Repair Officer (Engineering Duty Officer)
Fleet/Type Commander Staff
Board of Inspection and Survey
Propulsion Examining Board
OPNAV/NAVSEA
Chief Engineer (Ships and Submarines)

Typical Course of Study

Quarter 1

MA1115	(4-0)	Multivariable Calculus
MA1116	(3-0)	Vector Calculus
ME2502	(4-1)	Dynamics
MS2201	(3-2)	Materials Science
NW3230	(4-2)	Strategy & Policy

Quarter 2

MA2043	(4-0)	Matrix and Linear Algebra
MA2121	(4-0)	Differential Equations
ME2101	(4-1)	Mechanics of Solids
ME2201	(3-2)	Materials Science
ME2801	(3-2)	System Dynamics

Quarter 3

MA3132	(4-0)	Partial Differential Equations
MA3232	(4-1)	Numerical Analysis
ME2601	(4-1)	Mechanics of Solids I
ME3801	(3-2)	Dynamics and Control of Marine and Autonomous Vehicles I
EO2102	(4-2)	Basic Electronics and Electrical Machines

Quarter 4

ME3711	(4-1)	Machine Design
ME2201	(3-2)	Introduction to Fluid Dynamics
MS3202	(3-2)	Failure Analysis and Prevention
ME3611	(4-0)	Mechanics of Solids II

Quarter 5

ME3151	(4-1)	Heat Transfer
ME3201	(4-1)	Applied Fluid Mechanics
ME3712	(4-2)	Systems Design

Quarter 6

MS3304	(3-2)	Corrosion
ME0810	(0-8)	Thesis Research
ME4XXX	(V-V)	Specialization Elective
ME4XXX	(V-V)	Specialization Elective

Quarter 7

ME0810	(0-8)	Thesis Research
TS3001	(3-2)	Naval Architecture
ME3521	(3-2)	Mechanical Vibrations
ME3240	(4-2)	Marine Power and Propulsion

Quarter 8

ME0810	(0-8)	Thesis Research
ME0810	(0-8)	Thesis Research
ME3450	(3-2)	Computational Methods in Mechanical Engineering
ME4XXX	(V-V)	Elective

Total Ship Systems Engineering (Under Department of Mechanical and Aerospace Engineering)

Program Director

Fotis A. Papoulias
Code ME/PA, Watkins Hall, Room 323

(831) 656-3381, DSN 756-3381
papoulias@nps.edu

Total Ship Systems Engineering

The objective of this program is to provide a broad-based, design-oriented education focusing on the warship as a total engineering system, including hull, mechanical, electrical and combat systems. The program is for selected Naval/Mechanical Engineering, Electrical Engineering, and Combat Systems Sciences and Engineering students and is structured to lead to the MSME, MSEE, or MS in Physics. Entry to the Total Ship Systems Engineering program is through the standard 533, 570, 590, 591 curricula.

Entry Date

Total Ship Systems Engineering will generally fit as part of an eight-or nine-quarter program, with TSSE elective commencing in October. The ease of accommodating TSSE in a student's program is influenced by the student's NPS entry quarter and undergraduate background and performance. Individuals interested in the program should explore the necessary course sequencing with the program officer or academic associate as early as possible.

Subspecialty

Completion of this program will contribute toward the graduates' subspecialty code within his/her designated curriculum. The student will also receive the 5602P subspecialty code for completion of the TSSE Program.

Typical Subspecialty Jobs

Upon award of the subspecialty code, a Naval officer would be eligible for assignments typical of the Navy P-Code. The expectation is that the combination of education and experience would lead to individuals qualified for assignment later in their career to more responsible positions in systems design and acquisition in NAVSEA, SPAWAR and OPNAV, and as Program Managers.

Typical Course of Study

Quarter 1

ME2101	(4-2)	Thermodynamics
MA2121	(4-0)	Differential Equations
ME2502	(4-1)	Dynamics
NW3230	(4-0)	Strategy & Policy
AE2440	(3-2)	Intro to Digital Computation

Quarter 2

MA2043	(4-0)	Matrix and Linear Algebra
ME2601	(4-1)	Mechanics of Solids I
MS2201	(3-2)	Materials Science

Quarter 3

ME2201	(3-2)	Fluid Mechanics I
ME3611	(4-0)	Mechanics of Solids II
MA3132	(4-0)	Partial Differential Equations and Integral Transforms
MA3232	(4-1)	Numerical Analysis

Quarter 4

TS3001	(3-2)	Fundamental Principles of Naval Architecture
ME3150	(4-1)	Heat Transfer
ME3201	(4-1)	Applied Fluid Mechanics
EO2102	(4-2)	Circuit and Power System Analysis
ME3521	(3-2)	Mechanical Vibrations

Quarter 5

TS3000	(3-2)	Electrical Power Engineering
ME2801	(3-2)	System Dynamics
ME3711	(4-1)	Design of Machine Elements
MS3202	(3-2)	Failure Analysis & Prevention

Quarter 6

SE3100	(3-2)	Fundamentals of Systems Engineering
TS3003	(3-2)	Naval Combat System Elements
ME3801	(3-2)	Dynamics and Control of Marine and Autonomous Vehicles I
ME4XXX	(V-V)	Specialization Elective

Quarter 7

TS4000	(3-2)	Naval Combat System Design
TS4001	(2-4)	Design of Naval Engineering Subsystems
ME3450	(3-2)	Computational Methods in Mechanical Engineering
ME4XXX	(V-V)	Specialization Elective

Quarter 8

TS4002	(2-4)	Ship Design Integration
ME3240	(4-2)	Marine Power and Propulsion
ME0810	(0-8)	Thesis Research
ME0810	(0-8)	Thesis Research

Quarter 9

TS4003	(2-4)	Total Ship Systems Engineering
MS3606	(3-2)	Introduction to Welding and Joining Metallurgy
ME0810	(0-8)	Thesis Research
ME0810	(0-8)	Thesis Research

Educational Skill Requirements (ESR)
Naval/Mechanical Engineering - Curriculum 570
Subspecialty Code: 5601P

Officers entering into the Naval/Mechanical Engineering curriculum will be offered the necessary preparatory level courses to enable them to satisfy the equivalent of a baccalaureate degree in Mechanical Engineering. They shall meet, as a minimum, the requirements set forth by the Engineering Accreditation Commission of ABET. At the graduate level, the officer will acquire the competence to participate in technical aspects of naval systems research, design, development, maintenance and acquisition. The background to deal with future advances is gained through the emphasis on design and a combination of the core

program requirements, specialization and thesis research. In pursuit of the above, the goal is for each officer to acquire a senior/upper division level physical and analytical understanding of the topics below. It is recognized that all students may not meet all ESRs, depending on individual circumstances determined by the Program Officer and the academic associate. However, each student will be exposed to fundamentals in all ESR areas.

1. **Thermodynamics and Heat Transfer**: Fundamentals of thermodynamics and heat transfer with applications to all marine engineering power cycles, as well as propulsion and auxiliary system cycle analysis and design.

2. **Fluid Mechanics**: Compressible and incompressible flow, both viscous and inviscid, with emphasis on propellers, cavitation, and design of shipboard fluid systems (e.g., fluid machinery, pumps, turbo-machinery).

3. **Dynamics and Control**: Kinematics and dynamics of particle, rigid-body and multi-body mechanical systems. Modeling and simulation of engineering systems with mechanical, electrical and hydraulic components. Feedback control concepts, both frequency response and time domain, with applications to the design of component, platform, and weapon systems. Control of systems with continuous, discrete and combined logic states. Navigation and control for single and network-centric systems. Design of intelligent systems for machinery monitoring and automation, as well as autonomous vehicle operations.

4. **Structural Mechanics and Vibration**: Statically determinant and indeterminate structural analysis, stress/strain analysis, buckling and fatigue. Shock and vibration response of marine structures, including surface ships and submarines.

5. **Materials and Fabrication**: Metallurgical processes and transformations; analytical approach to failure of materials in Naval Engineering use and a basic understanding of the materials technology associated with welding and marine corrosion; an introduction to the developing fields of composites and superconducting materials.

6. **Computers**: A basic understanding of computer system architecture, operating systems (such as UNIX), networking and introduction to engineering software design. Practical experience of structured programming languages (such as FORTRAN, C), and the use of integrated design tools for computational and symbolic manipulation (such as MATLAB and Maple). Use and application of mainframe, workstation and personal computers for the solution of naval engineering design and analysis tasks. Exposure

to finite element and finite difference tools and techniques, with application to the thermo-fluid and structural mechanics/dynamics areas, including experience with representative software packages.

7. **Mathematics**: Sufficient mathematics, including integral transforms and numerical analysis, to achieve the desired graduate education.

8. **Design/Synthesis**: Design synthesis and introduction to optimization techniques, with emphasis on the design of mechanical subsystems and their integration into the ship system.

9. **Electrical Engineering**: Electromagnetic and circuit theories, DC circuits, steady-state AC circuits, methods of circuit analysis, including Laplace transforms. Exposure to the construction and operating characteristics of rotating machinery, static converters, and power distribution systems and multiphased circuits.

10. **Naval Architecture**: Fundamentals of naval architecture including the geometry, hydrostatics and hydrodynamics of monohull floating and submerged structures. Wave and skin friction analysis, power requirements of particular designs. Longitudinal and transverse stability of floating and submerged bodies, hull girder strength requirements. Introduction to sea keeping and survivability principles.

11. **Specialization**: Through additional graduate level courses and their associated prerequisites, each officer will also acquire technical competence in one or more of the following areas: thermal/fluid sciences, solid and structural mechanics, dynamics and controls, material science, or total ship systems engineering.

12. **Joint and Maritime Strategic Planning**: American and world military history and joint and maritime planning, including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning, the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

13. **Thesis**: The graduate will demonstrate the ability to conduct independent research in the area of Naval/Mechanical Engineering, and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing appropriate to this curriculum.

Naval Reactors-Mechanical/Electrical Engineering Program - Curriculum 571

Primary Consultant

Ms. Becky Martini
Director, Management and Administration

Naval Sea Systems Command
NAVSEA 08B-MA Attn B. Martini
1240 Isaac Hull Ave SE Stop 8015
Washington Navy Yard, DC 20376-8015

(202) 781-6004

Academic Associate for Electrical Engineering

Monique P. Fargues, Ph.D.
Code EC/Fa, Spanagel Hall, Room 456

(831) 656-2859, DSN 756-2859
fargues@nps.edu

Academic Associate for Mechanical Engineering

Joshua H. Gordis, Ph.D.
Code ME/Go, Watkins Hall, Room 313

(831) 656-2866, DSN 756-2866, FAX (831) 656-2238
jgordis@nps.edu

Brief Overview

The objective of this special program is to provide both naval officers and civilian employees of Naval Reactors (NR), an advanced education leading to a Master of Science in Engineering Science with major in either Mechanical or Electrical Engineering. This is a non-thesis program for individuals who work as engineers and who wish to pursue a master's degree via Distance Learning. The program sponsor is NAVSEA and the subject matter expert is SEA-08.

Requirements for Entry

Entrance into this program is restricted to individuals who have successfully completed the Bettis Reactor Engineering School (BRES). Further requirements include an Academic Profile Code of 121. All entrants must be nominated for the program by the designated program coordinator and primary consultant for Naval Reactors. The nomination to the Director of Admissions must include original transcripts of the student's undergraduate and BRES records. The Director of Admissions will provide copies of all records to the Academic Associate in Mechanical or Electrical Engineering depending on the degree the student is pursuing.

Entry Date

Students usually enter this program at the beginning of the academic quarter following completion of the BRES. Application for entry is to be made through the program

coordinator and primary consultant for Naval Reactors. The program is also available to civilian employees of Naval Reactors who have completed BRES. For further information, contact the Academic Associate, or the Primary Consultant for this program.

Degree Requirements for Mechanical Engineering

The student must complete 20 hours of advanced graduate level (ME4XXX) NPS courses. This requirement may be met by completing a sequence of five courses via Distance Learning in a program approved by the Chairman of the Department of Mechanical and Aerospace Engineering. There are two (2) technical tracks, one in the Fluids, Thermal, and Propulsion area and the other in Solids, Structures, and Vibrations. A minimum of four (4) of the courses must be from one track or the other. This Master of Science in Engineering Science (Major in Mechanical Engineering) program may be completed in five academic quarters following completion of BRES.

Degree Requirements for Electrical Engineering

The student must complete 28 hours of graduate level (EC3XXX and EC4XXX) NPS courses. This requirement may be met by completing a sequence of seven courses via Distance Learning in a program approved by the Chairman of the Department of Electrical and Computer Engineering. This Master of Science in Engineering Science (Major in Electrical Engineering) program may be completed in seven academic quarters following completion of BRES.

Credit for Completion of BRES

This program is designed to build upon the BRES courses and the power plant design experience. The following BRES courses are considered as integral to this program and equivalent to 16 credit hours of ME3XXX level NPS courses:

· BRES 200 Mathematics
· BRES 340 Applied Structural Mechanics
· BRES 350 Heat Transfer and Fluid Flow
· BRES 360 Reactor Dynamics, Control and Safeguards

In addition, BRES 370 Reactor and Power Plant Design Project is considered partially in lieu of a thesis.

The NPS transcript will include 16 credits for the BRES program. The Quality Point Rating (QPR) for the NPS transcript will be computed based only on the NPS courses completed by the student.

Subspecialty

Graduates of BRES earn a Navy Subspecialty Code of 5200, which applies to their reactor design training. This Naval Postgraduate School curriculum will not affect that subspecialty code nor provide any additional subspecialty code(s).

Typical Course of Study

Upon entry into the program students will typically enroll in one course per quarter, to be taken via Distance Learning. All requirements must be completed within three calendar years from entry. Students will select a program of study from available courses and submit a program for approval by the Chairman of Mechanical or Electrical Engineering.

ME4161	(4-0)	Conduction Heat Transfer
ME4162	(4-0)	Convection Heat Transfer
ME4220	(4-0)	Viscous Flow
ME4522	(4-0)	Finite Element Methods in Structural Dynamics
ME4525	(4-0)	Ship Shock and Vibration
ME4550	(4-0)	Random Vibrations and Spectral Analysis
ME4612	(4-0)	Advanced Solid Mechanics
ME4613	(4-0)	The Finite Element Method
ME4731	(4-0)	Engineering Optimization

Educational Skill Requirements (ESRs)
Reactors - Mechanical or Electrical Engineering
Program - Curriculum 571
Subspecialty Code: None

The ESRs required by Naval Reactors are met upon completion of the BRES. This is a degree program only, leading to the Master of Science in Engineering Science with Major in Mechanical or Electrical Engineering.

Distance Learning Program in Mechanical Engineering for Nuclear Trained Officers - Curriculum 572

Primary Consultant

Ms. Becky Martini
Director, Management and Administration

Naval Sea Systems Command
NAVSEA 08B-MA Attn B. Martini
1240 Isaac Hull Ave SE Stop 8015
Washington Navy Yard, DC 20376-8015

(202) 781-6004

Academic Associate

Joshua H. Gordis, Ph.D.
Code ME/Go, Watkins Hall, Room 313

(831) 656-2866, DSN 756-2866, FAX (831) 656-2238
jgordis@nps.edu

NPS Distant Learning Office, PACNORWEST

2000 Thresher Ave., Room G-101
Silverdale, WA 98215
(360) 315-2803; FAX (360) 315-2516

msesmedl@nps.edu

Brief Overview

This special program provides the opportunity for nuclear trained naval officers (those who have successfully completed Naval Nuclear Power School, Officers Course) to obtain a Master of Science in Engineering Science with a major in Mechanical Engineering - MSES(ME), while on deployment. This is a non-thesis program, but a capstone research or design project is required, along with a presentation, which is generally done via VTC or Video. This is a distance learning program, with content offered via two-way video at the Trident Training Facility in Bangor, WA or via streaming video, selected courses are available as asynchronous packages, and other DL or resident courses available through partner institutions, as described below. For more information, see: www.nps.edu/mae/dl/nuc.

Requirements for Entry

Admission into this program is restricted to individuals who have successfully completed the Officer's Course at the Naval Nuclear Power School (NNPS). Further requirements include a minimum Academic Profile Code of 323 and a B.S. in Engineering . All entrants must be nominated by their commands. The nomination to the Director of Admissions must include original transcripts of the student's undergraduate records.

Entry Date

Students may enter this program in any quarter. However, specific courses are subject to availability.

Degree Requirements for Mechanical Engineering

NPS courses may be taken via VTC or streaming video, or special asynchronous courses packages have been develop so that this program may be completed while you are deployed. In addition up to twelve (12) equivalent quarter-credits can be obtained from a partner institution, which currently include the University of Washington (UWa) and Georgia Tech (GT). Graduate courses from GT/UWa are generally considered to be ME4000 level equivalents. The final two (2) quarters are devoted to a capstone research or design project and presentation, and the student must register for ME0810 during these quarters. A degree plan must be submitted and pre-approved by the Chairman of the Department of Mechanical and Aerospace Engineering. This special program fully considers the 28.5 quarter credits earned in NNPS, and therefore none of these credits may be used to fulfill the degree requirements. This program may be completed in two (2) years.

Subspecialty

This is a degree program only and does not provide an additional subspecialty code.

Typical Course of Study

Quarter 1
ME3201 (4-1) Applied Fluid Mechanics (Asynchronous)

Quarter 2
ME3150 (4-1) Heat Transfer (Asynchronous)

Quarter 3
ME4220 (4-0) Viscous Flow (Asynchronous)

Quarter 4
ME4162 (4-0) Convection Heat Transfer (Asynchronous)

Quarter 5
ME4161 (4-0) Conduction Heat Transfer (Asynchronous)

Quarter 6

ME 4420 (4-0) Marine Power and Propulsion (Asynchronous)

Quarter 7
ME0810 (0-8) Research/Design Paper

Quarter 8
ME0810 (0-8) Research/Design Paper

U.S. Naval Test Pilot School/Mechanical & Aerospace Engineering Program – Curriculum 613

Primary Consultant
Mr. John O'Connor
Chief of Academics

U.S. Naval Test Pilot School
22783 Cedar Point Rd., Unit 21
Naval Air Warfare Center Aircraft Division
Patuxent River, MD 20670-1160
(301) 757-5044

Academic Associate for Aerospace Engineering
Christopher M. Brophy, Ph.D.
Code MAE, Watkins Hall, Room 312

(831) 656-2699, DSN 756-2699
cmbrophy@nps.edu

Program Officer
Jason W. Pratt, CDR
Code 71, Bullard Hall, Room 203

(831) 656-7517, DSN 756-7517
jwpratt@nps.edu

Brief Overview

The objective of this special program is to provide an opportunity for graduates of the U.S. Naval Test Pilot School (USNTPS), who are trained in aircraft, rotorcraft, and airborne systems flight test, to obtain a Master of Science in Engineering Science with a major in Aerospace Engineering – MSES(AE). This is a distance learning program building upon the USNTPS academic and flight test instruction, with the student's USNTPS final flight test project and report serving in lieu of a thesis, and will provide advanced aerospace engineering knowledge to the test pilot and flight test engineer. NPS instruction will include advanced aerodynamics, aircraft structures, stability and control, and propulsion, and may also include systems engineering, autonomous vehicles, and air vehicle survivability. Instruction in flight system testing from the USNTPS as well as advanced graduate education in aerospace engineering topics from the NPS will qualify graduates of this program to participate in all technical aspects of naval air weapon systems acquisition.

Requirements for Entry

Entrance into this program is restricted to graduates of the U.S. Naval Test Pilot School (USNTPS) Main Curriculum, currently a 48-week program. Further requirements include an Academic Profile Code of 323. All entrants must be nominated for the program by the designated program coordinator and the primary consultant for USNTPS. The nomination to the Director of Admissions must include official transcripts from all undergraduate and graduate institutions attended plus USNTPS records. The Director of Admissions will provide copies of all records to the Academic Associate in Aerospace Engineering.

Entry Date

Students usually enter this program at the beginning of the academic quarter following graduation from USNTPS. Application for entry is to be made through the program coordinator and primary consultant for USNTPS. For further information, contact the Academic Associate, or the Primary Consultant for this program.

Degree Requirements for Aerospace Engineering

The student must complete 24 credit hours of advanced graduate level NPS (AE/ME/MS/SE 3000- and 4000-level) courses, with a minimum of 12 of the 24 hours at the 4000-level. This requirement may be met by completing a sequence of six courses via Distance Learning in a program approved by the Chairman of the Department of Mechanical and Aerospace Engineering. This Master of Science in Engineering Science (Major in Aerospace Engineering) program may be completed in six academic quarters following USNTPS graduation.

Credit for Completion of U.S. Naval Test Pilot School

This program is designed to build upon the USNTPS academic instruction and final flight test project and report. The following USNTPS courses are considered as integral to this program and equivalent to 6 credit hours of ME/AE 3000- level and 8 credit hours of ME/AE 4000- level NPS courses:

USNTPS MM503 Dynamic Systems Analysis Techniques

USNTPS PP501 Thermodynamics

USNTPS PP801 Propulsion Systems

USNTPS SC507 Airplane Stability and Control

USNTPS SC604 Airplane Dynamics

USNTPS SC502 Helicopter Rotor Systems

USNTPS AP501 Helicopter Performance and Aerodynamics

USNTPS SC506 Helicopter Stability and Control

USNTPS SY503 Airborne Navigation Systems

USNTPS SY601 Airborne Electro-optical Systems

In addition, the USNTPS DT-II flight test project and report is considered in lieu of a thesis. The NPS transcript will include 14 credits for the USNTPS program. The Quality Point Rating (QPR) for the NPS transcript will be computed based only on the NPS courses completed by the student.

Subspecialty

Graduates of USNTPS earn a Navy Subspecialty Code of 5403 which applies to their flight test training. This Naval Postgraduate School curriculum will not affect that subspecialty code nor provide any additional subspecialty code(s).

Typical Course of Study

Upon entry into the program students will typically enroll in one course per quarter to be taken via distance learning. All requirements must be completed within three calendar years from entry. The program of study for each student will be submitted for approval by the Chairman of Mechanical and Aerospace Engineering. A typical course sequence would include:

Core Courses:

AE4452	4-1	Advanced Missile Propulsion
ME3205	4-1	Missile Aerodynamics
ME3611	4-0	Mechanics of Solids II
ME4703	4-1	Missile Flight Dynamics and Control
ME4704	3-2	Missile Design

Other Courses:

SE3100	3-2	Fundamentals of Systems Engineering
ME4751	4-1	Combat Survivability, Reliability, and Systems Safety Engineering
ME3720	3-2	Introduction to Unmanned Systems
MS3202	3-2	Properties, Performance and Failure of Engineering Materials
MS3202	3-2	Properties, Performance and Failure of Engineering Materials

Educational Skill Requirements (ESRs)

USNTPS – Aerospace Engineering Program – Curriculum 613

Subspecialty Code: None

The ESRs required by the Naval Air Systems Command are met upon graduation from USNTPS. This is a degree program only, leading to the Master of Science in Engineering Science with Major in Aerospace Engineering.

Department of Meteorology

Chairman

Wendell A. Nuss, Ph.D.
Code MR/Nu, Root Hall, Room 273

(831) 656-2308, DSN 756-2308
nuss@nps.edu

Associate Chairman, Research

Qing Wang, Ph.D.
Code MR/Qg, Root Hall, Room 231

(831) 656-7716, DSN 756-7716
qwang@nps.edu

Associate Chairman, Curricular Matters

Patrick A. Harr, Ph.D.
Code MR/, Root Hall, Room 244

(831) 656-3787, DSN 756-3787
paharr@nps.edu

Michael M. Bell, Research Assistant Professor (2007)*; M.S., Colorado State University, 2006.

Hway-Jen Chen, Research Associate (2000); M.S., University of California - Los Angeles, 1993.

Chih-Pei Chang, Distinguished Professor (1972); Ph.D., University of Washington, 1972.

Philip A. Durkee, Professor (1984); Ph.D., Colorado State University, 1984.

Russell L. Elsberry, Distinguished Research Professor (1968); Ph.D., Colorado State University, 1968.

Paul A. Frederickson, Research Associate (1999); M.S., University of Maryland, 1989.

Peter S. Guest, Research Professor (1992); Ph.D., Naval Postgraduate School, 1992.

Joshua Hacker, Associate Professor (2009); Ph.D. University of British Columbia.

Patrick A. Harr, Professor (1989); M.S., Colorado State University, 1978; Ph.D. Naval Postgraduate School, 1993.

Mary S. Jordan, Research Associate (1999); M.S., Naval Postgraduate School, 1985.

Michael T. Montgomery, Professor (2006); Ph.D., Harvard, 1986.

Richard W. Moore, Research Assistant Professor (2008); Ph.D., Colorado State University, 2004.

James T. Murphree, Research Associate Professor (1991); Ph.D., University of California at Davis, 1989.

Kurt E. Nielsen, Research Associate (1999); M.S., University of Oklahoma, 1988.

Wendell A. Nuss, Professor and Associate Chair for Curricular Matters (1986); Ph.D., University of Washington, 1986.

Andrew Penny, Research Associate (2009); M.S. University of Arizona.

Qing Wang, Professor and Associate Chair for Research (1995); Ph.D., Pennsylvania State University, 1993.

Professors Emeriti:

Kenneth L. Davidson, Professor (1970); Ph.D., University of Michigan, 1970.

Russell L. Elsberry, Distinguished Professor (1968); Ph.D., Colorado State University, 1968.

Robert L. Haney, Professor Emeritus (1970); Ph.D., University of California at Los Angeles, 1971.

Robert J. Renard, Distinguished Professor Emeritus (1952); Ph.D., Florida State University, 1970.

Carlyle H. Wash, Professor (1980); Ph.D., University of Wisconsin, 1978.

Forest Williams, Senior Lecturer Emeritus (1975); M.S., Naval Postgraduate School, 1962; M.S., Massachusetts Institute of Technology, 1972.

Roger T. Williams, Professor (1968); Ph.D., University of California at Los Angeles, 1963.

Willem van der Bijl, Professor , Ph.D. (1961), State University, Utrecht, Netherlands, 1952

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

Brief Overview

The Department of Meteorology's history dates back to the 1940s when it was part of the Postgraduate Department at the Naval Academy. The department's academic function is interdisciplinary in nature in that it supports separate Master of Science Degree programs: Meteorology, Meteorology and Physical Oceanography, and Oceanography; and, provides courses for the Space Systems, Undersea Warfare, Information/Electronic Warfare, and Joint Command, Control, Communications, Computers and Intelligence (C4I) curricula. Offerings in the Special Operations and Joint Warfare Analysis are under development.

Department academic strengths include air/ocean dynamics and numerical modeling and prediction, structure and dynamics of the atmospheric boundary layer, satellite remote sensing and its applications and synoptic meteorology, including analysis and prediction in tropical, mid-latitude, and polar regions in both hemispheres. More than forty courses are offered in meteorology, primarily at the graduate level. The department has Nineteen faculty (8 tenure track, 11 non-tenure track, two military, and five emeritus), with graduate student participation as research-team members through the M.S. thesis and Ph.D. dissertation process. The current areas of research concentration encompass numerical and analytic air/ocean modeling and prediction, tropical meteorology (including monsoon circulations and tropical cyclone dynamics and forecasting), coastal meteorology and oceanography, climate dynamics, marine boundary layer studies with emphasis on air/sea interactions and electromagnetic/optic propagation, remote sensing/satellite meteorology and a wide range of synoptic studies (e.g., regional studies, maritime cyclogenesis, short range forecasting, and numerical-model verification). The Ph.D. program in the department is active with Navy officers, Air Force officers, DoD civilians and international officers among its recent graduates.

Degree

A student is able to earn an academic degree listed below while enrolled in Meteorology (Curriculum 372) and Meteorology and Oceanography (Curriculum 373).

Master of Science in Meteorology

Entrance to a program leading to a Master of Science in Meteorology degree requires a baccalaureate degree with completion of mathematics through differential and

integral calculus and a minimum of one year of college physics.

The Master of Science in Meteorology degree requires completion of:

1. Necessary prerequisite courses in mathematics (through partial differential equations) and meteorology,
2. The sequence of core courses in the fields of dynamical, numerical, physical and synoptic meteorology,
3. An approved selection of graduate elective courses,
4. An acceptable thesis.

The total number of quarter-hours in (2) and (3) above must be at least 36. These 36 hours must include 18 quarter-hours at the 4000 level in courses other than directed study.

Master of Science in Meteorology and Physical Oceanography

Direct entrance to a program leading to the Master of Science in Meteorology and Physical Oceanography degree requires a baccalaureate degree in one of the physical sciences, mathematics or engineering. This normally permits the validation of a number of required undergraduate courses such as physics, differential equations, linear algebra, vector analysis, and various courses in meteorology and/or oceanography which are prerequisites to the graduate program. These prerequisites may be taken at the Naval Postgraduate School; however, in that event, the program may be lengthened by one or more quarters.

The Master of Science in Meteorology and Physical Oceanography degree requires completion of:

1. Necessary prerequisite courses in mathematics (through partial differential equations), meteorology, and physical oceanography,
2. The sequence of core courses in the fields of dynamical, numerical, physical and synoptic meteorology and oceanography,
3. An approved selection of graduate elective courses in meteorology and oceanography,
4. A significant educational experience in the field using instruments.
5. An acceptable thesis on a topic approved by the department.

The total number of quarter-hours in (2) and (3) above must be at least 48. These 48 hours must include 20 hours at the 4000 level in courses other than directed study, and they should show an approximate balance between the disciplines of meteorology and oceanography.

Dual Degree in Meteorology and Physical Oceanography

The Meteorology and Oceanography Departments have adopted a policy to not recommend the award of dual master's degrees in Meteorology and Physical Oceanography.

Doctor of Philosophy

The Ph.D. program is offered in the Department of Meteorology in the following areas of study: numerical weather prediction, geophysical fluid dynamics, boundary-layer meteorology, analysis of atmospheric systems and tropical meteorology.

The requirements for the degree are grouped into three categories: course work, research in conjunction with an approved dissertation and examination in both the major and, if elected, a minor field. The minor field is usually in physical oceanography, mathematics or physics.

The Department of Meteorology also may require a preliminary examination to show evidence of acceptability as a doctoral student.

Prospective students should consult with the Chairman of the Department of Meteorology for further guidance regarding doctoral programs.

Laboratories

As described below, the department is served by four major laboratory facilities: An interactive computer lab, a synoptic meteorology lab, a meteorological measurements lab, and a tactical applications lab.

The Interactive Digital Environmental Analysis (IDEA) Laboratory, which is shared with Oceanography, provides real-time acquisition and analysis of conventional and remotely-sensed data in support of the synoptic and physical meteorology and oceanography programs. The laboratory consists of 32 image analysis and graphics workstations. The laboratory accesses real-time GOES, NOAA, Navy (FNMOC), and DMSP data for use in instruction and research.

The department has developed a modern Synoptic Analysis and Forecasting Laboratory which receives environmental products and observations for instruction on the preparation of real-time weather analyses and forecasts. Fleet Numerical Meteorology and Oceanography Center (FNMOC) and the National Center for Environmental Prediction (NCEP) weather analysis and forecast products are received through a variety of channels that include the Navy Oceanographic Data Distribution System (NODDS), UNIDATA, GOESTAP, PC-based DIFAX facsimile, and the World-Wide Web. UNIX workstations and PC-based systems provide multiple software capabilities for displaying, animating, and visualizing current weather observations, satellite images, radar

observations, and numerical model products obtained from FNMOC, NCEP or generated locally.

The Marine Atmospheric Measurements Laboratory utilizes in-situ and remote sensing instrumentation systems for both teaching and research. Instrumentation includes: A 405 MHz and 915 MHz Doppler radar wind profiler with radio acoustic sounding system (RASS); rawinsonde systems with GPS and LORAN navigational aids; a laser ceilometer; and a fully instrumented surface weather station. Access to other instrumentation (measuring turbulent fluxes, aerosols, etc.), measuring platforms (research vessel, buoys, and remotely piloted aircraft) and data from a variety of networked local measurement sites enables the laboratory to provide near "real-time" data from the coastal region.

Meteorology Course Descriptions

MR Courses

MR0001 Meteorology and Oceanography Colloquium (0-1) As Required

(No credit.) Departmental lecture series covering topics of current interest by NPS and outside guest speakers. Graded pass/fail. Prerequisites: none.

MRR210 Refresher, Introduction to Meteorology/Lab (No Credit) Meets last six weeks of quarter (4-2) As Required

An introductory course that treats the composition and structure of the atmosphere, thermodynamic processes, forces and related small- and large-scale motions, air masses fronts, tropical cyclones, solar and terrestrial radiation, general circulation and weather forecasting. Additionally, laboratory periods are included to illustrate lecture material, including surface and airways communication codes, pressure and streamline/ isotach analyses, introduction to mid-latitude and tropical analyses by the Navy Operational Global Atmospheric Prediction System (NOGAPS) over oceanic regions, plus satellite interpretation.

MR0810 Thesis Research (0-8) As Required

Every student conducting thesis research will enroll in this course.

MR0999 Seminar in Meteorology (No Credit) (2-0) As Required

Students present results of thesis or other approved research investigation. Prerequisites: Concurrent preparation of thesis or other acceptable research paper.

MR2020 Computer Computations in Air-Ocean Sciences (2-2) As Required

Introduction to the programming languages, operating systems, and computing facilities which METOC students use in MR and OC courses. Laboratory assignments are elementary problems in oceanography and meteorology. Prerequisites: Calculus and college physics.

MR2200 Introduction to Meteorology (4-0) As Required

An introductory course that treats the composition and structure of the atmosphere, thermodynamic processes, forces and related small-and large-scale motions, air masses, fronts, tropical cyclones, solar and terrestrial radiation, general circulation and weather forecasting. Prerequisites: Department approval.

MR2210 Introduction to Meteorology/Laboratory (4-2) As Required

Same course as MR2200 plus laboratory periods illustrating lecture material, including Navy Operational Global Atmospheric Prediction System (NOGAPS) analysis over oceanic areas, plus satellite imagery interpretation. Prerequisites: Department approval.

MR2230 Meteorology, Oceanography, and Military Operations (4-0) As Required

This course is an introduction to meteorology and oceanography (METOC) from a military operations perspective. The course examines the basic patterns and processes of the atmosphere and ocean, and their impacts on the planning and conducts of military.

MR2262 Elements of Weather Forecasting (1-2) As Required

Survey of subjective and objective methods of atmospheric prognosis. Weather briefings illustrate applications of forecasting principles and use of satellite imagery. Prerequisites: MR3222, MR3230 or consent of instructor.

MR2416 Meteorology for Electronic Warfare (2-0) As Required

A survey of environmental factors affecting the propagation and attenuation of electromagnetic waves. Synoptic and climatological conditions associated with anomalous refraction are studied. Ionospheric phenomena associated with longer wavelength (Hf) propagation. Layers associated with high aerosol concentration and optical turbulence are identified. Hands-on experience with existing environmental effects assessment models. Prerequisites: Differential and integral calculus (may be taken concurrently).

MR2520 Survey of Air-Ocean Remote Sensing (3-0) As Required

Overview of systems for remote sensing of the atmosphere and oceans from space, and operational applications. Prerequisites: Undergraduate physics and calculus or consent of instructor.

MR3140 Probability and Statistics for Air-Ocean Science (3-2) Spring/Fall

Basic probability and statistics, in the air-ocean science context with emphasis on techniques of statistical data analysis. Histograms, boxplots, empirical distributions and associated characteristics such as moments and percentiles. Structure of a probability model, density distribution function, expectation and variance. Binomial, Poisson and Gaussian distributions. Conditional probability and independence. Joint distributions, covariance and central limit theorem. Standard tests of hypotheses and confidence intervals for both one-and two-parameter situations. Regression analysis as related to least squares estimation. Prerequisites: Calculus.

MR3150 Analysis of Air/Ocean Time Series (3-2) As Required

Analysis methods for atmospheric and oceanic time series. Fourier transforms applied to linear systems and discrete data. Correlation functions, power density spectra and cospectra. Optimal design of air-ocean data networks. Laboratory work involves analysis of actual atmospheric and oceanic time series using principles developed in class. Prerequisites: A probability and statistics course.

MR3212 Polar Meteorology/Oceanography (4-0) Winter

Operational aspects of arctic and antarctic meteorology. Polar oceanography. Sea-ice: amount, its seasonal distribution, melting and freezing processes, physical and mechanical properties, drift

and predictions. Prerequisites: OC3240, MR3222 or consent of instructor.

MR3220 Meteorological Analysis (4-0) Spring/Fall

Techniques of evaluation, interpretation and analysis of pressure, wind, temperature and moisture data, including weather satellite observations, with emphasis on the low and middle troposphere. Synoptic models of extratropical vortices, waves and frontal systems, with emphasis on three-dimensional space structure and time continuity, including isentropic surfaces and vertical cross-section analysis. Introduction to analysis in the troposphere and low stratosphere, including daily exposure to Navy Operational Global Atmospheric Prediction System (NOGAPS) analysis, and satellite imagery interpretation. Prerequisites: MR3420 or MR3480, MR/OC3321.

MR3222 Meteorological Analysis/Laboratory (4-3) Spring/Fall

Same as MR3220, plus laboratory sessions in the IDEA lab on the concepts considered in the lectures, with emphasis on the analysis of the low and middle troposphere, streamline and isotach analysis techniques, satellite interpretation, and vertical cross-section analyses. Prerequisites: MR3420 or MR3480, MR/OC3321.

MR3230 Tropospheric and Stratospheric Meteorology (4-0) Summer/Winter

Development and application of conceptual models of the evolution of various tropospheric and stratospheric circulation systems. Extratropical cyclones, jet streams and fronts are examined through application of dynamical concepts with particular emphasis on aspects associated with the marine environment. Prerequisites: MR3222, MR4322 (may be taken concurrently).

MR3234 Tropospheric and Stratospheric Meteorology/Laboratory (4-4) Summer

Same as MR3230 plus laboratory sessions utilizing the IDEA Lab to facilitate the physical understanding of dynamical relationships inherent to the conceptual models of the various weather systems. Exercises utilize various case studies including material from recent marine cyclogenesis field experiments. Prerequisites: MR3222, MR4322, (may be taken concurrently).

MR3240 Radar Meteorology (3-0) As Required

Principles of radar meteorology. Topics covered include radar systems, meteorological radar equation, doppler radar basics, propagation, attenuation, precipitation and velocity estimation, and characteristic echoes. Prerequisites: MR3222 and MR3522.

MR3250 Tropical Meteorology (3-0) Summer/Winter

Structure and mechanisms of synoptic-scale wave disturbances, cloud clusters, upper-tropospheric systems, the intertropical convergence zone; structure, development and motion of tropical cyclones; monsoon circulations. Emphasis on analysis and energetics. Prerequisites: MR4322 and MR3230 or MR3234 (may be taken concurrently).

MR3252 Tropical Meteorology/Laboratory (3-4) Summer/Winter

Same as MR3250 plus laboratory sessions on analysis of tropical systems emphasizing streamline and isotach analysis and incorporating aircraft and satellite observations. Exercises stress tropical cyclone regimes. Satellite imagery is used as an analysis tool and also in forecasting tropical cyclone intensity. A track forecasting exercise provides an exposure to the use of various dynamic, climatological and statistical forecast models.

Prerequisites: MR4322 and MR3230 or MR3234 (may be taken concurrently).

MR3260 Operational Atmospheric Prediction (3-0) Fall/Winter

Subjective and objective methods of atmospheric prognosis and techniques for forecasting operationally-important weather elements from surface to 100 mb. Interpretation, use and systematic errors of computer-generated products. Weather satellite briefs and applications of forecasting principles to current situations. Prerequisites: MR3230, or MR3234; MR/OC4323 may be taken concurrently.

MR3262 Operational Atmospheric Prediction/Laboratory (3-5) Fall/Winter

Same as MR3260 plus laboratory sessions on the application of lecture material. Also, practice in weather briefing, including diagnosis and forecasting of current weather briefing, including diagnosis and forecasting of current weather situations using weather satellite observations, and Fleet Numerical Oceanography Center and National Meteorological Center products. Prerequisites: MR3230 or MR3234; MR/OC4323 may be taken concurrently.

MR3321 Air-Ocean Fluid Dynamics (4-0) Winter

A foundation course for studies of atmospheric and oceanographic motions. The governing dynamical equations for rotating stratified fluids are derived from fundamental physical laws. Topics include: the continuum hypothesis, real and apparent forces, derivations and applications of the governing equations, coordinate systems, scale analysis, simple balanced flows, boundary conditions, thermal wind, barotropic and baroclinic conditions, circulation, vorticity, and divergence. Prerequisites: Multivariable calculus and vectors; ordinary differential equations (may be taken concurrently).

MR3413 Boundary Layer Meteorology (3-0) Spring

This course covers the basic concepts, description, and quantification of the main features of the atmospheric boundary layer (ABL) and atmospheric dispersion. The characteristics of turbulent flow will be introduced at the beginning of the course followed by a detailed discussion of the flux-profile relationship and the bulk aerodynamics surface flux parameterization for the surface layer. The course also covers the main features and dominant physical processes in the stable, clear, and convective boundary layers and an overview of the surface energy budget over various surface types. For dispersion modeling, the basic concepts of dispersion modeling and the Gaussian plume and puff models will be introduced. During the course, the statistical and dimensional analysis methods, which are the main tools to analyze the ABL observational and numerical modeling data, are introduced and used to reveal the characteristics and structure of the ABL. Prerequisites: MR3222 and MR3480.

MR3419 Assessment of Atmospheric Factors in EM/EO Propagation (2-1) As Required

The course addresses atmospheric parameters and their distribution that affect propagation of electromagnetic and Electro-optical (EM/EO) waves and describes their assessment with in situ and satellite borne sensors. It relates propagation phenomena to wavelength-dependent controlling atmospheric influences. Students receive demonstrations of obtaining web-site available atmospheric descriptions. There are demonstrations and exercises with computer-based assessment codes that relate EM/EO propagation to measured and predicted atmospheric properties: PROPHET (HF), AREPS (UHF VHF-SHF),

EOTDA&NOVAM (IR). Discussions will occur on display/distribution of global atmospheric and oceanic conditions supporting specific operational systems. Satellite sensor retrieval procedures will be described and demonstrated. Prerequisites: Curricula; Calculus based physics and math through multivariable calculus; Enrollment in International Electronic Warfare and Electronics/Communication.

MR3420 Atmospheric Thermodynamics (3-0) Spring/Summer/Fall/Winter
The physical variables; the equation of state; the first law of thermodynamics and its application to the atmosphere; meteorological thermodynamic diagrams; adiabatic processes and potential temperatures; moist air processes; hydrostatic equilibrium, vertical motion in the atmosphere, stability methods and criteria. Prerequisites: Multivariable calculus.

MR3421 Cloud Physics (3-0) Spring
Basic principles of cloud and precipitation physics and application to cloud formation and optical properties. Prerequisites: MR3420 or MR3480.

MR3445 Oceanic and Atmospheric Observational Systems (2-2) As Required
Principles of measurement: sensors, data acquisition systems, calibration, etc. Methods of measurement for thermodynamic and dynamic variables in the ocean and atmosphere, including acoustics and optics. Prerequisites: OC3230 and MR3420, MR/OC3150 or consent of instructor.

MR3455 Measurement Systems for the Marine and Coastal Atmospheric Boundary Layer (2-2) As Required
The course treats a broad spectrum of measurement techniques for atmospheric dynamic and thermodynamic variables. Laboratory sessions provide hands-on experience with various state-of-the-art sensing systems, including NPS' Doppler Radar Wind Profiler. Topics include sensor static and dynamic characteristics; calibration; in situ measurements of wind, pressure, temperature, humidity, aerosols and radiation on the surface, on balloon-borne sounding systems and on aircraft; and surface-based remote sensing systems, including wind profilers, SODAR and LIDAR. Prerequisites: MR3150 and MR3222 or consent of instructor.

MR3480 Atmospheric Thermodynamics and Radiative Processes (4-1) As Required
The physical variables; the equation of state; the first law of thermodynamics and its application to the atmosphere; meteorological thermodynamic diagrams; adiabatic processes and potential temperatures; moist air process; hydrostatic equilibrium, vertical motion in the atmosphere, stability methods and criteria. Basic radiative transfer including absorption and scattering by atmospheric constituents; solar and terrestrial radiative heating; radiative energy budgets; climate change; radiative effects of clouds and aerosols; optical phenomena. Prerequisites: Single variable calculus.

MR3520 Remote Sensing of the Atmosphere and Ocean (4-0) Winter
Principles of radiative transfer and satellite sensors and systems; visual, infrared and microwave radiometry and radar systems; application of satellite remotely-sensed data in the measurement of atmospheric and oceanic properties. Prerequisites: Undergraduate physics and differential/integral calculus, ordinary differential equations and MR3480, or consent of instructor.

MR3522 Remote Sensing of the Atmosphere and Ocean/Laboratory (4-2) Winter
Same as MR3520 plus laboratory sessions on the concepts considered in the lecture series. Prerequisites: Same as MR3520.

MR3540 Radiative Processes in the Atmosphere (3-0) Spring/Fall
Applications of radiation theory to atmospheric energy budgets, general circulation and anthropogenic climate changes. Radiational imbalance at the surface leading to heat fluxes and temperature changes in atmosphere and earth. Upper atmosphere phenomena (ozonosphere and ionosphere). Radiative effects of clouds and aerosols, and optical phenomena. Prerequisites: MR3420, MR3520 or MR3522.

MR3570 Operational Oceanography and Meteorology (2-4) Spring/Summer
Experience in the field acquiring and analyzing oceanographic and atmospheric data using state-of-the-art instrumentation. Integration of satellite remote sensing and other operational products with in situ data. Includes survey of instrumentation, pre-cruise planning, operations the field and post-cruise analysis. Prerequisites: OC3240, MR3220, or consent of instructor.

MR3571 Operational Oceanography and Meteorology Lecture (2-0) As Required
Introduction to the core oceanographic and atmospheric instruments used in support of environmental monitoring and modeling. Principles of instrument design and sampling protocols will be covered. Emphasis will be placed on the capabilities and limitation of autonomous platforms, on aircraft- and shore-based remote sensing, and on the major systems in place to organize and distribute environmental data. A brief introduction to data assimilation will be included to illustrate the critical link between observations and oceanic and atmospheric circulation models. Prerequisite: OC3230 or consent of instructor.

MR3572 Operational Oceanography and Meteorology Lab (0-4) As Required
This course is intended to insure a flexible hands-on experience deploying equipment in a realistic environment. Students will be required to design their individual field programs working with the instructor and the curriculum's program officer. Approved programs include: 1) design and implementation of coastal ocean or atmosphere sampling protocols using unmanned vehicles, 2) design and implementation of monitoring plans for the surf zone or estuarine environments (in this case OC4210 may be taken as an alternative), 3) design and implementation of sampling protocols for the atmosphere using fixed-location or aircraft-based sensors, 4) design of and participation in upper-ocean or lower-atmosphere sampling protocols at polar ice camps, and 5) design of and participation in deep-water surveys onboard ocean-going research vessels using NPS vessel time or faculty-mentored cruises of opportunity. Prerequisite: MR3571 (may be taken concurrently) or consent of instructor.

MR3610 Modern Climatology (4-0) Summer
An introduction to physical climatology and its applications. This course examines Earth's climate system, especially major long-term global and regional patterns, and the physical processes that create them, with focus on the application of physical climatology to solve operational DoD problems and analyze and forecast climate variations at intraseasonal and longer time scales. Emphasis placed on support of military operations, past, present and future. Prerequisites: MR2200, MR/OC3321 and MR3480.

MR4234 Advanced Topics in Mid-Latitude Weather Systems (4-0) Spring

The course examines the classic conceptual models of mid-latitude weather systems and their associated dynamics. From this classic perspective, recent advances in our theoretical and observational understanding of cyclones and fronts are examined to extend our conceptual models of mid-latitude weather systems over a broad range of scales. It is expected that students have a working knowledge of the quasigeostrophic dynamics of cyclones, fronts, and jet streaks as taught in MR3234 (Trop and Strat) and MR4322 (Dynamic Met) or their equivalents. Prerequisites: MR3234 and MR4322 or similar undergraduate course on mid-latitude weather systems.

MR4240 Coastal Meteorology (3-1) As Required

Mesoscale circulations of the coastal atmosphere are examined from theoretical, observational, and model perspectives. Thermally-driven circulations, orographically-driven circulations and mesoscale circulations due to the interaction of synoptic-scale weather systems with coastlines are studied to develop useful conceptual models of coastal meteorological phenomena. Prerequisites: MR4322, MR3234 taken concurrently or consent of instructor.

MR4241 Mesoscale Meteorology (3-0) Spring/Fall

Descriptive and physical understanding of subsynoptic-scale weather systems including fronts, squall lines, mesoscale convective systems, tornadoes, etc., and their relation to the synoptic-scale environment. Applications to short-range and local-area forecasting utilizing satellite and numerical-model products relevant to mesoscale weather phenomena. Prerequisites: MR3230, MR4322 with consent of instructor.

MR4242 Advanced Tropical Meteorology (3-0) Summer

Theories and observations of tropical motion systems. Equatorial wave theory; stratospheric biennial oscillation; tropical intraseasonal oscillations; monsoon circulations; tropospheric biennial oscillation; El Nino and Southern Oscillation; other climate variations. Tropical cyclone dynamics; influence of environmental flow on formation and motion; advanced models and forecasting of tropical motion. Emphases among these topics will depend on the interest of the students. Prerequisites: MR3252 or consent of instructor.

MR4250 Atmospheric General Circulation (3-0) Spring

The observed circulation. Zonal mean and eddy motions. Balances of momentum, heat and moisture. Energetics. Maintenance of circulation. Zonally asymmetric circulations. Other selected topics of the general circulation of the atmosphere. Prerequisites: MR4322 and consent of instructor.

MR4262 Advanced Meteorological Prediction (3-2) Fall

The course requires previous weather forecast experience and covers advanced forecasting topics. A sample of topics covered include dust forecasting, orographic precipitation, mountain waves and downslope winds, cold-air damming and coastal frontogenesis, marine fog and stratus, ocean wind waves and swell, thunderstorms, and others. The focus is on the mesoscale aspects of forecasting and how to appropriately use observational and model tools for short-range to longer range forecasts of these phenomena. Hands-on practical forecast labs and briefings are used to demonstrate and practice the theory and techniques covered in the lectures. Prerequisites: Experience equivalent to completion of MR3262, MR3234 and MR3522.

MR4322 Dynamic Meteorology (4-0) Spring/Fall

Pressure coordinates, quasi-geostrophic scale analysis, perturbation method; solutions of equations of motion for sound, gravity and synoptic waves; baroclinic and barotropic instability; energetics; geostrophic adjustment. Prerequisites: MR3420, MR/OC3321, calculus and ordinary differential equations.

MR4323 Numerical Air and Ocean Modeling (4-2) Spring/Fall

Numerical models of atmospheric and oceanic phenomena. Finite difference techniques for solving hyperbolic, parabolic and elliptic equations, linear and nonlinear computational instability. Spectral and finite element models. Filtered and primitive equation prediction models. Sigma coordinates. Objective analysis and initialization. Moisture and heating as time permits. Prerequisites: MR4322, OC4211, partial differential equation, MA3232 desirable.

MR4324 Ensemble Prediction Systems (2-2) Summer

Operational weather prediction is evolving from a deterministic forecasting focus, based on single-solution numerical weather prediction (NWP) output, to a focus on ensemble-based forecasting. This course introduces the fundamentals of chaos theory (as the scientific basis for ensemble forecasting), describes the behavior of an ideal vs. a practical ensemble, and covers details of the various components of an ensemble prediction system (EPS). The course goal is to develop weather officers knowledgeable in EPS capabilities, strengths, weaknesses, etc., so that the DOD can effectively incorporate the technology into its weather support process. Prerequisites: MR4323 or similar undergraduate course in numerical weather prediction.

MR4325 METOC for Warfighter Decision Making (3-2) Fall

This course introduces decision science in the context of utilizing deterministic vs. stochastic meteorological and oceanographic forecasts to improve strategic, operational, and tactical planning. Various aspects of generating, communicating, and applying stochastic forecasts for optimal decision making under uncertainty are explored. Prerequisites: MR/OC3140 or similar course on statistics. MR/OC4323 and MR4324 are recommended but not required.

MR4331 Advanced Geophysical Fluid Dynamics I (3-0) Summer

Advanced topics in the dynamics of the atmosphere and the oceans including scale analysis; geostrophic adjustment; dispersion, and barotropic and baroclinic instabilities. Prerequisites: Consent of instructor.

MR4332 Advanced Geophysical Fluid Dynamics II (3-0) As Required

Normal mode and baroclinic instability; frontogenesis; boundary layer analysis with application; finite amplitude baroclinic waves; symmetric instability. Prerequisites: Consent of instructor.

MR4413 Air-Sea Interaction (4-0) Spring

Fundamental concepts in turbulence. The atmospheric planetary boundary layer, including surface layer and bulk formula for estimating air-sea fluxes. The oceanic planetary boundary layer including the dynamics of the well-mixed surface layer. Recent papers in air-sea interaction. Prerequisites: MR/OC3150 and OC3240 or MR4322, or consent of instructor.

MR4414 Advanced Air/Sea Interaction (3-0) As Required
Advanced topics in the dynamics of the atmospheric and oceanic planetary boundary layers. Prerequisites: MR/OC4413 or consent of instructor.

MR4415 Atmospheric Turbulence (3-0) Spring
Approaches for defining the structure of the turbulent atmospheric boundary layer. Review of statistical descriptions of atmospheric turbulence; averaging, moments, joint moments, spectral representation. Equations for turbulent regime in a stratified, shear flow. Scaling parameters and similarity theories for surface layer profiles, spectra; Kolmogorov hypotheses, Monin-Obukhov similarity theory. Measurement of atmospheric turbulence. Examination of observed spectra and scales of atmospheric turbulence. Prerequisites: MR/OC3150 or consent of instructor.

MR4416 Atmospheric Factors in Electromagnetic and Optical Propagation (3-0) Spring/Fall
Principles of microwave and optical wave propagation in the atmosphere. Effects of surface and boundary layers on propagation: refraction, scattering, attenuation, ducting, etc. Addresses existing environmental effects assessment models. Prerequisites: MR/OC4413 or MR4415 (may be taken concurrently).

MR4520 Topics in Satellite Remote Sensing (3-0) Summer
Selected topics in the advanced application of satellite remote sensing to the measurement of atmospheric and oceanic variables. Prerequisites: MR/OC3522.

MR4800 Advanced Topics in Meteorology (Variable Credit 1-0 to 4-0) (V-0) As Required
Advanced topics in various aspects of meteorology. Topics not covered in regularly offered courses. The course may be repeated for credit as topics change. Prerequisites: Consent of instructor and Department Chairman.

MR4900 Directed Study in Meteorology (Variable Credit 1-0 to 4-0) Spring/Summer/Fall/Winter
Directed study of selected areas of meteorology to meet the needs of the individual student. Prerequisites: Consent of instructor and Department Chairman. Graded on Pass/Fail basis only.

MR5810 Dissertation Research (0-8) As Required
Dissertation research for doctoral studies. Required in the quarter following advancement to candidacy and then continuously each quarter until dissertation is approved by the Academic Council.

Meteorology - Curriculum 372

Program Officer

William (Bill) Sommer, CDR, USN
Code 75, Spanagel Hall, Room 304

(831) 656-2045, DSN 756-2045
wlsommer@nps.edu

Academic Associate

Patrick A. Harr, Ph.D.
Code MR, Root Hall, Room 244

(831) 656-3787, DSN 756-3787
paharr@nps.edu

Brief Overview

This curriculum will provide qualified personnel with a sound understanding of the science of meteorology. The program is designed to provide the student with:

- A thorough understanding of the principles governing the physical and dynamic properties of the atmosphere.
- The ability to observe, assimilate, analyze, interpret, and predict atmospheric parameters and conditions using field experimentation, direct and remote sensing observational techniques, statistical analyses and numerical models.
- A thorough understanding of the effects of atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting military warfare.
- A meteorological research experience germane to military warfare, culminating in a thesis of professional quality.

Requirements for Entry

The master's program is open to International Officers, officers from other services, and DoD civilians. It is open to METOC (1800) officers of the U.S. Navy and officers from other services as a Ph.D. program. Students in the USAF Basic Meteorology Program (BMP) are also listed in this curriculum. The remainder of this section applies to the MS degree program.

For the master's program, a baccalaureate degree with completion of mathematics through differential and integral calculus and a minimum of one year of college physics is required. An APC of 323 is required for direct entry. A refresher quarter is available for candidates who do not meet all admission requirements for direct entry and is normally offered in the Summer quarter prior to 372 enrollment.

Entry Date

Meteorology is a six-quarter course of study with a normal entry date in the Fall quarter. For further information contact the Program Officer. Academic questions may be referred directly to the Academic Associate.

Degree

Master of Science in Meteorology.

Typical Course of Study

Quarter 1

MA1115 (6wks)	(4-0)	Multi-Variable Calculus
MA1116 (6wks)	(4-0)	Vector Calculus
MR2020	(2-2)	Computer Computations in Air-Ocean Sciences
MR3140	(3-2)	Probability and Statistics for Air-Ocean Science

MR3252	(3-4)	Tropical Meteorology/Laboratory

Quarter 2

MA3132	(4-0)	Partial Differential Equations and Fourier Analysis
MR3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Lab
MR4322	(4-0)	Dynamic Meteorology
MR4413	(4-2)	Air-Sea Interaction

Quarter 3

MR3610	(4-0)	Modern Climatology
MR4234	(4-0)	Advanced Topics in Mid-Latitude Weather Systems
MR4323	(4-2)	Numerical Air and Ocean Modeling
MR4900	(3-0)	Directed Study in Meteorology

Quarter 4

MR4241	(3-0)	Mesoscale Meteorology
MR4800	(3-0)	Elective in Meteorology
MR0810	(0-8)	Thesis Research
MR0810	(0-8)	Thesis Research

Quarter 5

MR4262	(3-2)	Advanced Weather Forecasting
MR4800	(3-0)	Elective in Meteorology
MR0810	(0-8)	Thesis Research
MR0810	(0-8)	Thesis Research

Quarter 6

MR4800	(3-0)	Elective in Meteorology
MR0810	(4-0)	Thesis Research
MR0810	(0-8)	Thesis Research
MR0999	(2-0)	Thesis Presentation

Educational Skill Requirements (ESR) Meteorology (Masters) - Curriculum 372 Subspecialty Code: Not Applicable for MS Degree

Note –This program primarily supports USAF and International graduate education, thus there is no Navy p-code or subspecialty associated with this master's program, and no official ESRs . This list describes the skills this program will provide students upon successful completion.

This curriculum will provide qualified personnel with a sound understanding of the science of meteorology. The program is designed to provide the student with:

1. A thorough understanding of the principles governing the physical and dynamic properties of the atmosphere.
2. The ability to observe, assimilate, analyze, interpret, and predict atmospheric parameters and conditions using field experimentation, direct and remote sensing observational techniques, statistical analyses and numerical models.

3. A thorough understanding of the effects of atmospheric properties and conditions on weapon, sensor and platform performance, while conducting and supporting military warfare.
4. A meteorological research experience germane to military warfare, culminating in a thesis of professional quality.

Educational Skill Requirements (ESR) Meteorology (Ph.D.) - Curriculum 372 Subspecialty Code: 6403D

The officer must have a thorough theoretical and functional knowledge (obtained at the doctorate level) of the principles of meteorology and its effects on naval warfare and weapons systems.

Meteorology and Oceanography (METOC) - Curriculum 373 (Under Department of Meteorology)

Program Officer
William (Bill) Sommer, CDR, USN
Code 75, Spanagel Hall, Room 304

(831) 656-2045, DSN 756-2045
wlsommer@nps.edu

Academic Associates
Ching-Sang Chiu, Ph.D. (Oceanography)
Spanagel Hall, Room 313

(831) 656-3239, DSN 756-3239
chiu@nps.edu

Patt Harr, Ph.D. (Meteorology)
Root Hall, Room 244

(831) 656-3787
paharr@nps.edu

Brief Overview

This curriculum in meteorology and oceanography involves approximately 110 quarter-hours of classroom lectures, supplemented by an additional 37 quarter-hours of laboratory exercises. This program is designed to provide the student with:

· A thorough understanding of the principles governing the physical and dynamic properties of the oceans and atmosphere.
· The ability to observe, assimilate, analyze, interpret, and predict oceanic and atmospheric parameters and conditions using field experimentation, direct and remote sensing observational techniques, statistical analyses, and numerical models.

· A thorough understanding of the effects of oceanic and atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting naval warfare, with particular emphasis on ocean acoustics and electromagnetic/optical propagation.

· An oceanographic or meteorological research experience germane to naval warfare culminating in a thesis of professional quality.

· A knowledge of Joint and Maritime Strategic Planning.

This education will enhance performance in all duties throughout a career, including operational billets, technical management assignments and policy making positions. Students will develop graduate-level technical ability based upon scientific principles, acquire diverse professional knowledge, and develop analytical ability for practical problem solving.

Requirements for Entry

This program is open to METOC (1800) Officers, officers from other services, International Officers and DoD civilians.

A baccalaureate degree in the physical sciences, mathematics or engineering is required. Completion of mathematics through differential and integral calculus and one year of calculus-based college physics are required. An APC of 323 is required for direct entry.

Entry Date

METOC curriculum is a nine quarter course of study with entry dates in September and March. If further information is needed, contact the Program Officer. Academic questions may be referred directly to either of the Academic Associates.

Degree

Master of Science in Meteorology and Physical Oceanography.

Subspecialty

Completion of this curriculum qualifies an officer as a METOC Subspecialist with a subspecialty code of 6401P. The Curriculum Sponsor is the Oceanographer of the Navy (CNO N2/N6E).

Typical Subspecialty Jobs

METOC Officer aboard CV(N)/LHD
Submarine Group Staff
Numbered Fleet Staff
CARSTRKGRU Staff
OIC Naval Meteorology and Oceanography Command Detachment
NAVMETOCCOM Mobile Warfare Teams

National Geospatial Agency
Office of Naval Research

Typical Course of Study - Fall Start

Quarter 1

OC3230	(3-1)	Descriptive Physical Oceanography
MA1115	(4-0)	Multi-variable Calculus
MA1116	(4-0)	Vector Calculus
MA2121	(4-0)	Ordinary Differential Equations
MR/OC0001	(0-1)	METOC Seminar

Quarter 2

MR3480	(4-1)	Atmos. Thermodynamics & Radiative Processes
MR/OC3321	(4-0)	Fluid Dynamics
MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA3132	(4-0)	Partial Differential Equations and Integral Transforms
MR/OC3140	(3-2)	Probability and Statistics
MR/OC0001	(0-1)	METOC Seminar

Quarter 3

MR3222	(4-3)	Meteorological Analysis/Lab
MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
OC3260	(4-1)	Fund. of Ocean Acoustics
OC3240	(4-2)	Ocean Circulation Analysis
MR/OC0001	(0-1)	METOC Seminar

Quarter 4

MR4322	(4-0)	Dynamic Meteorology
MR/OC4413	(4-0)	Air-Sea Interaction
MR/OC3522	(4-2)	Remote Sensing
OC4211	(4-0)	Ocean Waves
MR/OC0001	(0-1)	METOC Seminar

Quarter 5

MR/OC4323	(4-2)	Numerical Air & Ocean Modeling
MR3234	(4-4)	Tropospheric & Stratospheric Meteorology/Lab
OC4800	(4-0)	Coast/Nearshore Course (Dept Scheduled)
OC3212	(4-0)	Polar Met & Ocean
MR/OC0001	(0-1)	METOC Seminar

Quarter 6

MR3252	(4-4)	Tropical Meteorology/Laboratory
MR/OC4800	(4-0)	Elective
MR/OC3571	(2-0)	Operational Ocean and Met./Instruments and Observations
OC4210	(2-4)	Littoral Field Studies

| MR/OC4900 | (V-0) | Directed Study in Meteorology/ Oceanography |
| MR/OC0001 | (0-1) | METOC Seminar |

Quarter 7

MR4220	(3-1)	Coastal Meteorology
MR4416	(0-4)	Atmos. Factors in EM/EO Propagation
NW3230	(4-2)	Strategy and Policy
MR/OC0810	(0-8)	Thesis Research
MR/OC0001	(0-1)	METOC Seminar

Quarter 8

OC4270	(3-4)	Tactical Oceanography
OC4335	(4-0)	METOC Decision Theory
MR/OC0810	(0-8)	Thesis Research
MR/OC0810	(0-8)	Thesis Research
MR/OC0001	(0-1)	METOC Seminar

Quarter 9

MR3262	(4-0)	Operational Atmospheric Prediction/Laboratory
MR/OC0001	(0-1)	METOC Seminar
MR/OC0810	(0-8)	Thesis Research
MR/OC0810	(0-8)	Thesis Research
MR/OC0999	(2-0)	Theses Presentation

Typical Course of Study-Spring Start

Quarter 1

OC3230	(3-1)	Descriptive Physical Oceanography
MA1115	(4-0)	Multi-variable Calculus
MA1116	(3-0)	Vector Analysis
MA2121	(4-0)	Ordinary Differential Equations
MR/OC0001	(0-1)	METOC Seminar

Quarter 2

MR3480	(4-1)	Atmos. Thermodynamics & Radiative Processes
MR/OC3321	(4-0)	Fluid Dynamics
MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA3132	(4-0)	Partial Differential Equations and Integral Transforms
MR/OC3140	(3-2)	Probability and Statistics
MR/OC0001	(0-1)	METOC Seminar

Quarter 3

MR3222	(4-3)	Meteorological Analysis/Lab
MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
OC3260	(4-1)	Fund. of Ocean Acoustics
OC3240	(4-2)	Ocean Circulation Analysis
MR/OC0001	(0-1)	METOC Seminar

Quarter 4

MR4322	(4-0)	Dynamic Meteorology
MR/OC4413	(4-0)	Air-Sea Interaction
MR/OC3522	(4-2)	Remote Sensing
OC4211	(4-0)	Ocean Waves
MR/OC0001	(0-1)	METOC Seminar

Quarter 5

MR/OC4323	(4-2)	Numerical Air & Ocean Modeling
MR3234	(4-4)	Tropospheric & Stratospheric Meteorology/Lab
OC4800	(4-0)	Coast/Nearshore Course (Dept Scheduled)
MR4416	(3-0)	Atmos. Factors in EM/EO Propagation
MR/OC0001	(0-1)	METOC Seminar

Quarter 6

MR3252	(4-4)	Tropical Meteorology/Laboratory
MR/OC4800	(4-0)	Elective
MR/OC3571	(2-0)	Operational Ocean and Met./ Instruments and Observations
OC4210	(2-4)	Littoral Field Studies
MR/OC4900	(V-0)	Directed Study in Meteorology/ Oceanography
MR/OC0001	(0-1)	METOC Seminar

Quarter 7

MR3262	(3-1)	Operational Atmospheric Prediction/Laboratory
OC3212	(4-0)	Polar Met & Ocean
NW3230	(4-2)	Strategy and Policy
MR/OC0810	(0-8)	Thesis Research
MR/OC0001	(0-1)	METOC Seminar

Quarter 8

OC4270	(3-4)	Tactical Oceanography
MR4325	(4-0)	METOC Decision Theory
MR/OC0810	(0-8)	Thesis Research
MR/OC0810	(0-8)	Thesis Research
MR/OC0001	(0-1)	METOC Seminar

Quarter 9

MR4240	(3-1)	Coastal Meteorology
MR/OC0810	(0-8)	Thesis Research
MR/OC0810	(0-8)	Thesis Research
MR/OC0999	(2-0)	Theses Presentation
MR/OC0001	(0-1)	METOC Seminar

Educational Skill Requirements (ESR)
Meteorology & Oceanography (METOC) - Curriculum 373
Subspecialty Code: 6401P

1. Integration of Oceanic & Atmospheric Parameters: The officer must be able to observe, assimilate, analyze, and predict oceanic and littoral water conditions, and atmospheric conditions using direct and remote sensing observation techniques, statistical analysis, and numerical models. The officer will have a sound understanding of polar, mid-latitude and tropical atmospheric and oceanographic dynamics, including the impact of these region's conditions on military operations and systems.

2. Numerical Prediction Systems: The officer will have a thorough understanding of numerical prediction systems as it applies to the physics and dynamics of the ocean and the atmosphere. This understanding should include a broad understanding of the modeling systems to include strengths, weaknesses, and vulnerabilities; the state of current models and techniques; and appropriate applications of deterministic and stochastic techniques.

3. Ocean/Atmosphere Problem Solving: The officer must develop critical thinking skills and conduct independent analyses to solve environmentally challenging problems in the fields of Physical Oceanography and/or Meteorology as they apply to Naval/Joint operations, using modern scientific research techniques, field experience, tools, and equipment.

4. Decision Superiority: The officer must have a thorough understanding of open-ocean and near-shore oceanographic and atmospheric dynamics and properties. The officer must have the ability to apply this knowledge to warfighter decisions using sound decision theory, taking into account available courses of action, assessments of vulnerability, uncertainty, and risk.

5. Other NPS Requirements: The officer must successfully complete all NPS requirements for the Master's Degree in Meteorology and Physical Oceanography.

Department of Oceanography

Chair
Peter C. Chu, Ph.D.
Code OC/CU, Spanagel Hall, Room 324

(831) 656-2673, DSN 756-2673
pcchu@nps.edu

Associate Chair, Instruction
Ching-Sang Chiu, Ph.D.
Spanagel Hall, Room 313
(831) 656-3239, DSN 756-3239

chiu@nps.edu

Associate Chair, Research

Thomas H. Herbers, Ph.D.

Code OC, Spanagel Hall, Room 331B

(831) 656-2917, DSN 756- 2917
thherber@nps.edu

Associate Chair, Operations
Keir D. Stahlhut, MS, LCDR
(831) 656-7712, DSN 756-7712
kdstahlh@nps.edu

Mary Louise Batteen, Professor (1985)*; Ph.D., Oregon State University, 1984.

Ching-Sang Chiu, Distinguished Professor and Associate Chair, Instruction (1988); Sc.D, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, 1985.

Peter C. Chu, Distinguished Professor and Chair(1986); Ph.D., University of Chicago, 1985.

Jacqueline L Clement-Kinny, Research Assistant Professor(2002); Ph.D., Naval Postgraduate School, 2011.

John A. Colosi, Professor and Associate Chair of Research (2005); Ph.D., University of California, Santa Cruz, 1993.

Arlene A. Guest, Senior Lecturer, (1999); M.S., Florida State University, 1981.

Thomas H.C. Herbers, Professor and Associate Chair, Research (1993); Ph.D., University of California, San Diego, 1990.

Leonid Ivanov, Research Associate Professor (2012); Ph.D., Marine Hydrophysical Institute of the Ukrain Academy of Sciences, 1983.

James MacMahan, Associate Professor (2007), Ph.D., University of Florida, 2003.

Wieslaw Maslowski, Research Associate Professor (1994); Ph.D., University of Alaska-Fairbanks, 1994.

Jeffrey Dean Paduan, Professor (1991); Ph.D., Oregon State University, 1987.

Timour Radko, Associate Professor (2004); Ph.D., Florida State University, 1997.

D. Benjamin Reeder, (2011); Ph.D., Massachusetts Institute of Technology/Woods Hole Oceanographic Institution Joint Program, 2002.

Andrew F. Roberts, (2011); Ph.D., University of Tasmania, 2005.

Leslie K. Rosenfeld, Research Associate Professor (1989); Ph.D., Woods Hole Oceanographic Institution, 1987.

William J. Shaw, Research Assistant Professor (2005); Ph.D., Woods Hole Oceanographic Institution, 2000.

Keir D. Stahlhut, Military Instructor (2010), M.S., Naval Postgraduate School, 2006.

Timothy Peter Stanton, Research Associate Professor and Associate Chair for Research (1978); M.S., University of Auckland, 1977.

Rebecca E. Stone, Permanent Military Professor (2004); Ph.D., Naval Postgraduate School, 1999.

Robin T. Tokmakian, Research Associate Professor (1997); Ph.D., Naval Postgraduate School, 1997.

Research Associates And Assistants:

Chenwu Fan, Research Associate(2012); M.S., China Textile University, 1982

Benjamine Haffa, Research Assistant (2010); B.S., University of California, Irvine, 2010.

John E. Joseph, Research Associate (2005); M.S., Naval Postgraduate School, 1991

Tetyana Margolina, Research Associate (2011); Ph.D. Marine Hydrophysical Institute of the Ukraine Academy of Sciences, 2001.

Eli Michael, Research Associate (2012); M.S. Stanford University, 2012.

Christopher W. Miller, Research Associate (1992); M.S., Naval Postgraduate School, 1998

Mark D. Orzech, Research Associate (2001); M.S., University of Delaware, 1997

Professors Emeriti:

Robert Hathaway Bourke, Professor Emeritus (1971); Ph.D., Oregon State University, 1972.

Curtis Allan Collins, Professor Emeritus (1987); Ph.D., Oregon State University, 1967.

Roland William Garwood, Professor Emeritus, (1976); Ph.D., University of Washington, 1976.

Glenn Harold Jung, Professor Emeritus (1958); Ph.D., Texas A & M University, 1955, 1950.

Albert Julius Semtner, Jr., Professor Emeritus(1986); Ph.D., Princeton University, 1973

Eugene Dewees Traganza, Professor Emeritus (1970); Ph.D., University of Miami, 1966.

Stevens Parrington Tucker, Professor Emeritus (1968), Ph.D., Oregon State University, 1972.

Joseph John von Schwind, Professor Emeritus (1967); Ph.D., Texas A & M University, 1968.

Distinguished Professor Emeritus:

Eugene C. Haderlie, Distinguished Professor Emeritus, ()Ph.D.; University of California - Berkeley, 1950.

Edward Bennett Thornton, Distinguished Professor Emeritus , (1969); Ph.D., University of Florida, 1970.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

Brief Overview

Founded as a separate department in 1968, the Oceanography Department supports curricula sponsored by the Oceanographer of the Navy: #372 Meteorology #373 Air-Ocean Science, #374 Operational Oceanography, #440 Oceanography. The department also offers the MS in Physical Oceanography to Undersea Warfare curricula #525 (USN) and #526 (international).

The department focuses primarily on Physical Oceanography, Ocean Acoustics and Acoustical Oceanography, Numerical Modeling, Air-Sea Interactions, and Nearshore and Coastal/Littoral Oceanography, and has strong interests in remote sensing and geospatial information systems.

Topics include ocean dynamics, numerical ocean prediction and simulation, satellite remote sensing of the ocean, air-sea interaction, polar oceanography, upper ocean dynamics and thermodynamics, near-shore processes, wave and surf forecasting, mesoscale dynamics, coastal ocean circulation, tactical oceanography and environmental acoustics. The department also provides core courses for Undersea Warfare and the Space Systems curricula.

Degree

A student is able to earn an academic degree listed below while enrolled in Meteorology and Oceanography (Curriculum 373), Operational Oceanography (Curriculum 374), Oceanography (Curriculum 440), and Undersea Warfare (Curriculum 525).

Master of Science in Physical Oceanography

Entrance to a program leading to the Master of Science in Physical Oceanography degree requires a baccalaureate degree. Minimal requirements include mathematics through differential and integral calculus and one year of calculus-based physics.

The Master of Science in Physical Oceanography degree requires:

·   Completion of at least eight physical oceanography graduate courses with at least four courses in the OC4000 series. The sequence of core courses in physical oceanography encompasses the fields of dynamic, acoustical, and coastal/littoral oceanography. The entire sequence of courses selected must be approved by the Department of Oceanography. Significant experience in the field using instruments is required for the degree. (OC3570 satisfies this requirement).
·   Completion of an acceptable thesis on a topic approved by the Department of Oceanography.

Master of Science in Meteorology and Physical Oceanography

Direct entrance to a program leading to the Master of Science in Meteorology and Physical Oceanography degree requires a baccalaureate degree in one of the physical sciences, mathematics, or engineering. This normally permits the validation of a number of required undergraduate courses such as physics, differential equations, linear algebra, vector analysis and various courses in meteorology and/or oceanography, which are prerequisites to the graduate program. These prerequisites may be taken at the Naval Postgraduate School; however, in that event, the program may be lengthened by one or more quarters.

The Master of Science in Meteorology and Physical Oceanography degree requires:

1. Necessary prerequisite courses in mathematics (through partial differential equations), meteorology and physical oceanography.
2. The sequence of core courses in meteorology and oceanography in the fields of dynamical, numerical and physical and synoptic meteorology and oceanography.
3. An approved selection of graduate elective courses in oceanography and meteorology.

4. Significant experience in the field using instruments.
5. An acceptable thesis on a topic approved by either department.

The total number of quarter-hours in (2) and (3) above must be at least 48. These 48 hours must include 20 hours at the 4000 level in courses other than directed study and they should show an approximate balance between the disciplines of Meteorology and Physical Oceanography.

Dual Degree in Meteorology and Physical Oceanography

The Meteorology and Oceanography Departments have adopted a policy to not recommend its award of dual master's degrees in Meteorology and Physical Oceanography

Doctor of Philosophy

Department of Oceanography admission requirements for the Doctor of Philosophy degree include:

A bachelor's degree with a high QPR or a highly successful first graduate year in a master's program, with clear evidence of research ability.

A master's degree may be required before admission to candidacy.

The Ph.D. program is in Physical Oceanography, including areas of study in ocean circulation theory, air-sea interaction, ocean acoustics, nearshore, and coastal/littoral oceanography among others. An applicant to the Ph.D. program who is not already at NPS should submit transcripts of previous academic and professional work, plus results of a current Graduate Record Examination (GRE) general test, to the Director of Admissions, Code 01C3, Naval Postgraduate School, Monterey, California 93943-5100.

Oceanographic Laboratories

NPS is a member of UNOLS (University National Oceanography Laboratory System), CENCAL (Central California Cooperative), UCAR (University Corporation for Atmosphere Research), MBCORC (Monterey Bay Crescent Ocean Research Consortium), CeNCOOS (Central and Northern California Ocean Observing Systems and CORE (Consortium for Oceanographic Research and Education). In 2007, CORE Joined with JOI (Joint Oceanographic Institutions) to become CoOL (Consortium for Ocean Leadership). UNOLS operates the nation's academic oceanographic research fleet, while CENCAL promotes and coordinates research vessel operations between several academic institutions in central California. The nearby Moss Landing Marine Laboratory operates the NSF-owned, 135-foot R/V POINT SUR for the benefit of CENCAL.

The Rapid Environmental Assessment Laboratory (REAL) consists of moored-equipment in Monterey Bay, the R/V POINT SUR, and the former PT SUR SOSUS underwater acoustic array provides for instruction in the practical design, deployment and collection of state-of-the-art oceanographic data. Real-time observations of currents, temperature, salinity and sound speed structure in a variety of oceanic regimes are analyzed and modeled, applying theoretical and mathematical techniques learned in the classroom to Naval Oceanography problems.

The Oceanography Department operates a graphics laboratory that is equipped with networked workstations for the analysis of numerical model output, geospatial information system (GIS) exercises, satellite imagery, acoustical data and other digital fields from REAL. Smart classrooms enable data to be brought into the classroom in real time to demonstrate signal processing, rapid environmental assessment and other state-of-the-art oceanographic and tactical decision aids.

The department is organized around thematic laboratories, each containing faculty, staff and student offices, computing facilities and special laboratory equipment. Thematic laboratories exist for Oceanic Planetary, Polar, Nearshore, Acoustics, Coastal /Littoral Modeling, Global and Polar Ocean/Sea Ice Modeling, GI&S, Naval Ocean Analysis and Prediction, Ocean Turbulence, Ocean Waves, Radar and Drifter, and Tactical Environmental Support.

Oceanography Course Descriptions

OC Courses

OC0001 Meteorology and Oceanography Colloquium (0-1) Every Quarter

(No credit.) Departmental lecture series covering topics of current interest by NPS and outside guest speakers. Graded pass/fail. Prerequisites: none.

OC0810 Thesis Research (0-8) Every Quarter

Every student conducting research in oceanography will enroll in this course.

OC0999 Thesis Seminars (No Credit) (2-0) Every Quarter

Students in the various oceanography curricula present their thesis research. Prerequisites: Preparation of a thesis.

OC2020 Computer Computations in Air-Ocean Sciences (2-2) Spring

Introduction to the programming languages, operating systems, and computing facilities which METOC students use in MR and OC courses. Laboratory assignments are elementary problems in oceanography and meteorology. Prerequisites: Calculus and college physics.

OC2022 Scientific Fortran Programming (2-2) As Required

Structured Fortran programming as applied to elementary problems including oceanography and meteorology. Prerequisites: Calculus.

OC2902 Fundamentals of Geospatial Information and Services (3-0) As Required

This course will give the student an appreciation for the important facts about precision location today, from the true physical shape of the earth to the fusion of geographically labeled data in modern electronic databases. Today's military officer needs to know the fundamentals of precision location systems to operate in the battlespace of the twenty-first century. We have come from precise position being 60 nautical miles in the 1700s to a few meters in the 2000s. We have gone from dead reckoning on paper charts to GPS positions fed to fully automated navigation and weapons systems. The entire process of producing modern geospatially tagged items will be reviewed. This will include the scientific background of the processes and the advantages and limitations of the steps. Prerequisites: Students will need to have a basic understanding of algebra, geometry and trigonometry. A basic course in physics or equivalent that covers vector, conservation of energy and forces is needed. The student needs to be familiar with basic computer skills including the storage of data in arrays (spreadsheets work is sufficient for example).

OC2910 Use of U.S. Navy Operational Ocean Circulation and Tide Models (3-2) As Required

This course aims to provide Navy users with the information necessary to make informed and intelligent use of the Navy's operational ocean circulation and tide models. The course assumes some familiarity with physical oceanography, and experience working with output from atmospheric and/or oceanographic models. Basic concepts in physical oceanography and numerical modeling will be covered as introduction to more detailed descriptions of each of the Navy operational models and their capabilities. Students will work with output from the Navy models, and perform some model runs themselves. Evaluation of student learning will be in the form of exercises where students will be presented with several hypothetical (or real) operational scenarios and have to choose which model products to use in preparing a forecast or analysis, justify their choices, and interpret the products.

OC2930 Oceanography for Undersea Warfare (3-0) Summer

An introduction to ocean processes and phenomena with applications to Undersea Warfare. Prerequisites: None.

OC3030 Oceanographic Computing and Data Display (2-2) As Required

Course emphasizes the use of the computer as a tool in oceanography problem-solving. Use of various software packages for graphics, scientific visualization, statistics and numerical computation. Prerequisites: OC/MR2020, OC3240 or MR/OC3522, or the consent of instructor. Graded: Pass/Fail.

OC3120 Biogeochemical Processes in the Ocean (4-3) As Required

Basic biological, geological, and chemical processes in the ocean. Bioacoustics, deep scattering layers, and bio-deterioration. Geomorphic features of the ocean floor; kinds and distribution of ocean bottom features. Chemical composition of the ocean. Prerequisites: None.

OC3140 Probability and Statistics for Air-Ocean Science (3-2) Spring

Basic probability and statistics, in the air-ocean science context. Techniques of statistical data analysis. Structure of a probability model, density distribution function, expectation, and variance. Binomial, Poisson and Gaussian distributions. Conditional probability and independence. Joint distributions, covariance and

central limit theorem. Transformations of random variables. Histograms and empirical distributions and associated characteristics such as moments and percentiles. Standard tests of hypotheses and confidence intervals for both one-and two-parameter situations. Regression analysis as related to least squares estimation. Prerequisites: Calculus.

OC3150 Analysis of Air Ocean Time Series (3-2) Winter, Summer

Analysis methods for atmospheric and oceanic time series. Fourier transforms applied to linear systems and discrete data. Correlation functions, power density spectra and cross-spectrum. Optimal design of air-ocean data network. Laboratory work involves analysis of actual atmospheric and ocean time series using principles developed in class. Prerequisites: A probability and statistics course.

OC3210 Polar Oceanography (3-0) Summer

Covers the ice characteristics and physical oceanography of polar seas. Sea ice: types, physical and mechanical properties, heat flux, temporal and spatial distribution, melting and freezing processes, forecasting models, and remote sensing of ice/snow covered surfaces. Physical oceanography of currents and water masses, deep and bottom water formation, fronts and eddies, polynya processes, and underwater acoustics. Discuss naval and research operations in polar warfare. Prerequisites: OC3240.

OC3212 Polar Meteorology/Oceanography (4-0) Summer

Operational aspects of Arctic and Antarctic meteorology, including polar lows, boundary layer and marginal ice zone influences. Polar oceanography. Sea ice amount, seasonal distribution, melting and freezing processes, physical and mechanical properties, drift and predictions. Physical oceanography of currents and water masses, deep and bottom water formation, fronts and eddies, polynya processes. Prerequisites: MR3222 and OC3240 or consent of instructor.

OC3230 Descriptive Physical Oceanography (3-1) Winter, Summer

Physical properties of seawater. Processes influencing the distribution of heat, salt and density in the ocean. Static stability in the ocean. Circulation and water masses in the ocean. Laboratory work involves collection and analysis of actual data using principles developed in class.

OC3231 Descriptive Regional Oceanography (4-0) As Required

Overview of basic concepts. Water masses and regional circulation including littoral regions and marginal seas. Recent developments dealing with ocean circulation, sea level, climate, El Nino, ocean resources and pollution, and modern observational techniques. Prerequisites: OC3230 or the equivalent.

OC3240 Ocean Circulation Analysis (4-2) Winter, Summer

Application of dynamic concepts of ocean circulation, including conservation of mass, momentum and energy. Oceanic currents without friction: inertial and geostrophic flows. Frictional currents: Reynolds equations, Ekman and wind-driven flows. Vorticity balance: Sverdrup transport, potential vorticity, topographic steering, western intensification and Rossby waves. Thermohaline effects and thermocline theory. Prerequisites: OC3230 and OC3321 or the equivalent.

OC3260 Fundamentals of Ocean Acoustics (4-1) Spring, Fall

The fundamentals of ocean acoustics, including the acoustic wave equation, ray theory, acoustic arrays and filters, ambient noise, scattering, absorption, an introduction to normal mode theory, and sonar equations. Laboratory emphasizes acoustic signal processing techniques. Prerequisites: OC3230, partial differential equations or equivalent.

OC3300 Ocean Policy (3-1) As Required

Students will study ocean policy issues as they relate to the use and restriction of use of waters, both international and national, by the U.S. Navy and joint forces. The course will include an introduction to the institutions and players involved in the policy formulation; the policy making process; implementation, enforcement, and compliance; and consequences and effectiveness. Several questions relevant to Navy operations will be addressed: What are the consequences of the current policy structure (protected areas, impeded exercises, etc.)? How do we operate under these policies? What alternatives exist? How do we influence the policies? Students will become familiar with current issues for the Navy Environmental Readiness staff (OPNAV N45), current policy issues for the Oceanographer of the Navy staff (OPNAV N84), with current Navy guidance on environmental programs and protections, and with the reports and recommendations of the several national-level commissions on the ocean. Prerequisites: None.

OC3321 Air-Ocean Fluid Dynamics (4-0) Fall

A foundation course for studies of atmospheric and oceanographic motions. The governing dynamical equations for rotating stratified fluid are derived from fundamental physical laws. Topics include the continuum hypothesis, real and apparent forces, derivations and applications of the governing equations, coordinate systems, scale analysis, simple balanced flows, boundary conditions, thermal wind, barotropic and baroclinic conditions, circulation, vorticity, and divergence. Prerequisites: Multi-variable calculus, vectors, and ordinary differential equations (may be taken concurrently).

OC3325 Marine Geophysics (3-0) As Required

Theory and methods of marine geophysics surveys, and emphasis on gravity, magnetism, seismic and acoustic wave propagation; geophysical anomalies associated with major sea floor features; marine geodesy. Prerequisites: OC3120 (may be taken concurrently).

OC3445 Oceanic and Atmospheric Observational Systems (2-2) As Required

Principles of measurement; sensors, data acquisition systems, calibration, etc. Methods of measurement for thermodynamic and dynamic variables in the ocean and atmosphere, including acoustics and optics. Prerequisites: OC3230 and MR3420, MR/OC3150 or consent of instructor.

OC3520 Remote Sensing of the Atmosphere and Ocean (4-0) As Required

Principles of radiative transfer and satellite sensors and systems; visual, infrared and microwave radiometry, and radar systems; application of satellite remotely-sensed data in the measurement of atmospheric and oceanic variability. Prerequisites: Undergraduate physics and differential/integral calculus; ordinary differential equations and MR3480 or consent of instructor.

OC3522 Remote Sensing of the Atmosphere and Ocean/Laboratory (4-2) As Required
Same as OC3520 plus laboratory sessions on the concepts considered in the lecture series. Prerequisites: Same as OC3520.

OC3570 Operational Oceanography and Meteorology (2-4) As Required
Experience at sea acquiring and analyzing oceanographic and atmospheric data using state-of-the-art instrumentation. Integration of satellite remote sensing and other operational products with in-situ data. Includes survey of instrumentation, pre-cruise planning, operations at sea, and post-cruise analysis. Prerequisites: OC3240, MR3220, or consent of instructor.

OC3571 Instruments and Observations (2-0) Winter/Summer
Introduction to the core oceanographic and atmospheric instruments used in support of environmental monitoring and modeling. Principles of instrument design and sampling protocols will be covered. Emphasis will be placed on the capabilities and limitation of autonomous platforms, on aircraft- and shore-based remote sensing, and on the major systems in place to organize and distribute environmental data. A brief introduction to data assimilation will be included to illustrate the critical link between observations and oceanic and atmospheric circulation models. Prerequisite: OC3230 or consent of instructor.

OC3572 Operational Oceanography and Meteorology Lab (0-4) Winter/Summer
This course is intended to insure a flexible hands-on experience deploying equipment in a realistic environment. Students will be required to design their individual field programs working with the instructor and the curriculum's program officer. Approved programs include: 1) design and implementation of coastal ocean or atmosphere sampling protocols using unmanned vehicles, 2) design and implementation of monitoring plans for the surf zone or estuarine environments (in this case OC4210 may be taken as an alternative), 3) design and implementation of sampling protocols for the atmosphere using fixed-location or aircraft-based sensors, 4) design of and participation in upper-ocean or lower-atmosphere sampling protocols at polar ice camps, and 5) design of and participation in deep-water surveys onboard ocean-going research vessels using NPS vessel time or faculty-mentored cruises of opportunity. Prerequisite: OC3571 (may be taken concurrently) or consent of instructor.

OC3750 Naval Astronomy and Precise Time (2-0) As Required
Positional astronomy. Coordinate systems. Solar system dynamics. Astrometry (measurements of positions and motion of stars). Time, earth rotation and atomic clocks. Naval applications of astronomy. Overview of astrophysics and cosmology. Prerequisites: College physics and calculus.

OC3902 Fundamentals of Mapping, Charting and Geodesy (3-2) As Required
Basics of map/chart generation and scientific basis for their accuracy and precision. Ellipsoids, latitudes, longitudes, datums, datum transformations, map projections, geoid and heights. Map/chart generation process including satellite surveying. Use of map/charts with modern navigation systems, including GPS. Digital map characteristics. Prerequisites: Vector analysis, probability and statistics or consent of instructor.

OC3903 Electronic Surveying and Navigation (3-0) As Required
Introduction to the theory and practice of electronic navigation including principles of electronics, geometry, and error propagation. Covers ground-based and satellite systems. The global positioning system is covered in detail. Prerequisites: Consent of instructor.

OC4210 Littoral Field Studies (2-4) As Required
Employs the scientific method for studying nearshore and wave processes using field observations in littoral battlespace environments. Monterey Bay, CA will be used as a natural laboratory for studying a plethora of littoral related topics. Students will design a small nearshore field experiment or set of experiments, deploy state-of-the-art instrumentation, and analyze data to test relevant nearshore hypotheses. Students will write a mini-proposal with budget focused on their scientific hypothesis, experiment, and analysis, and write a scientific final report. Introductions and limitations of instrumentation will be discussed and integrated into the field design, which will include deployment schemes and subsequent analyses. Data quality control and analysis techniques will be described and implemented. In particular, tidal harmonic analysis will be introduced and performed. The course is divided into 1) in-class discussions (instrumentation, deployment schemes, and data analysis techniques), and 2) field exercises that require student participation in performing the proposed small experiments. There is a high probability that students will get wet, but it is not a requirement. Prerequisites: OC3140; OC3150; Matlab familiarity; or consent of instructor.

OC4211 Ocean Waves (4-0) Fall/Spring
Linear theory of surface, internal, inertial-internal and Rossby waves, barotropic and baroclinic instabilities. Coastal and equatorial trapped waves. Prerequisites: Partial differential equations and OC3240.

OC4212 Tides (4-0) As Required
Development of the theory of tides including the tide-producing forces, equilibrium tides, and the dynamic theory of tides; harmonic analysis and prediction of tides; tidal datum planes and their relationship with geodetic datum planes, short-term and secular changes in sea level. Prerequisites: OC4211.

OC4213 Nearshore and Wave Processes (3-1) Fall
Shoal-water wave processes, breakers and surf; nearshore water circulation; beach characteristics; littoral drift; coastal hydraulics; storm surge. Prerequisites: OC4211 or consent of instructor.

OC4220 Coastal Circulation (4-1) Spring
Coastal ocean physical processes. Dynamics and models of coastal ocean circulations driven by wind, thermohaline, tidal, boundary currents, and ocean eddy forces. Recent papers on coastal ocean circulation. Laboratory sessions on computing properties of tides, coastal trapped waves and wind-driven motions over the shelf and slope. Prerequisites: OC4211 (may be taken concurrently).

OC4230 Physical Oceanography of Monterey Bay (3-0) As Required
Monterey Bay will be used as a case study for various processes affecting the physical oceanography of coastal environments. Topics to include coastal upwelling, flow in and around submarine canyons, internal waves, air-sea interactions, and tides and seiches. Historical, recent, and ongoing studies in and around the bay will be considered. Prerequisites: OC3240 or consent of instructor.

OC4250 General Circulation of the Atmosphere and Oceans (3-0) As Required

Selected topics on the general circulation of the atmosphere (e.g. heat, momentum and moisture fluxes; energetics) and ocean (e.g. linear and non-linear theories of the wind-driven ocean circulation); coupled ocean-atmosphere general circulation models. Prerequisites: Consent of instructor.

OC4262 Theories & Models in Underwater Acoustics (3-0) As Required

Development of the underlying theories and algorithms of ray, normal mode, and parabolic equation acoustic models for both range independent and dependent environments. Examination of the strengths and weaknesses of and similarities between the various models. Prerequisites: OC3260 and partial differential equations or equivalent.

OC4267 Ocean Acoustic Variability and Uncertainty (4-0) As Required

Examines sound speed profiles (time and space variability), ambient noise, absorption, and reflection and scattering from the sea surface and bottom as they affect sound propagation in the ocean. Synoptic prediction techniques for ambient noise and transmission loss are reviewed. Environmental data input and computational approximations for acoustic models are evaluated against observed signal fluctuations and transmission loss. The course is designed for the Air-Ocean Science, Operational Oceanography, and USW Curricula. Prerequisites: OC3230 and OC3260 or equivalent.

OC4270 Tactical Oceanography (3-4) Winter/Summer

Course emphasizes the tactical use of the environment and battlespace characterization as a force multiplier in naval operations including acoustic undersea warfare, special operations, amphibious warfare, and mine warfare. Using tailored lectures, students will examine oceanographic conditions and the ability for naval forces to exploit them in nearshore, coastal and deep ocean settings. Current acoustic prediction models, remote sensing, tactical decision aids and Geographic Information Systems (GIS) will be utilized by students as they explore a broad spectrum of environmental conditions and methods for exploitation by naval forces. Students will also utilize the R/V PT SUR to perform experiments and analyze data relating to acoustic propagation and the ocean. Prerequisites: For Meteorology and Oceanography students: OC3260, OC4267 (concurrent), or consent of instructor. For USW students: OC3260 and EC4450 (concurrent), or consent of instructor. Classification: SECRET Clearance and U.S. Citizenship is required. Lecture series is UNCLASSIFIED.

OC4271 Topics in Tactical Oceanography (3-0) Winter/Summer

Course emphasizes the tactical use of the environment and battlespace characterization as a force multiplier in naval operations, including acoustic undersea warfare, special operations, amphibious warfare, and mine warfare. Using tailored lectures, students will examine oceanographic conditions and the ability for naval forces to exploit them in nearshore, coastal and deep ocean settings. Prerequisites: For International Meteorology and Oceanography students: OC3260, OC4267 (concurrent), or consent of instructor. For International USW students: OC3260 and EC4450 (concurrent), or consent of instructor.

OC4323 Numerical Air and Ocean Modeling (4-2) Spring

Numerical models of atmospheric and oceanic phenomena. Finite difference techniques for solving elliptic and hyperbolic equations, linear and non-linear computational instability. Spectral and finite element models. Filtered and primitive equation prediction models. Sigma coordinates. Objective analysis and initialization. Moisture and heating as time permits. Prerequisites: MR4322 or OC4211, partial differential equations; numerical analysis desirable.

OC4324 Advanced Numerical Ocean Modeling (3-0) As Required

Advanced techniques for simulating and predicting ocean circulation, including recent modeling results. Topics to include multi-layer guasi-geotrophic models, multi-level primitive equation models, treatment of irregular geometry and open boundary conditions, satellite data assimilation and computer technology considerations. Prerequisites: MR/OC4323.

OC4325 METOC for Warfighter Decision Making (3-2) Fall

This course introduces decision science in the context of utilizing deterministic vs. stochastic meteorological and oceanographic forecasts to improve strategic, operational, and tactical planning. Various aspects of generating, communicating, and applying stochastic forecasts for optimal decision making under uncertainty are explored. Prerequisites: MR/OC3140 or similar course on statistics. MR/OC4323 and MR4324 are recommended but not required.

OC4331 Ocean Variability (4-0) As Required

Contemporary knowledge of ocean mesoscale eddies, fronts, meandering currents; baroclinic and barotropic instabilities; kinematics, dynamics and energetics for observations, theories and models. Prerequisites: OC4211 or equivalent.

OC4335 Naval Ocean Analysis and Prediction (3-2)Summer

Advanced knowledge of the U.S. Navy ocean analysis and prediction systems, including the Naval Ocean Modeling Program (NOMP), naval ocean data systems, atmospheric forcing systems, data assimilation systems, Optimal Thermal Interpolation System (OTIS), Thermal Ocean Prediction Systems (TOPS), the global ocean circulation prediction system, Shallow Water Analysis and Forecast System (SWAFS), Polar Ice Prediction System (PIPS), and global wave prediction system (WAM). Prerequisites: OC4211 and MR/OC4323 (may be taken concurrently).

OC4413 Air/Sea Interaction (4-0) Summer

Fundamental concepts in turbulence. The atmospheric planetary boundary layer, including surface layer, and bulk formulae for estimating air-sea fluxes. The oceanic planetary boundary layer including the dynamics of the well-mixed surface layer. Recent papers on large-scale air-sea interaction. Prerequisites: MR/OC3150, and OC3240 or MR3240 or consent of instructor.

OC4414 Advanced Air/Sea Interaction (3-0) As Required

Advanced topics in the dynamics of the atmospheric and oceanic planetary boundary layers. Prerequisites: MR/OC4413 or consent of instructor.

OC4415 Ocean Turbulence (3-0) As Required

Advanced topics in the dynamics of ocean turbulence, wakes and microstructure. Prerequisites: MR/OC4413 or consent of instructor.

OC4490 Ocean Acoustic Tomography (Same as EC4490) (3-0) As Required

An introduction to Ocean Tomography, an underwater acoustic inverse technique for mapping ocean sound speed and current fields. Covers the major aspects of Ocean Acoustic Tomography, including the underlying concepts, the design and transmission of tomographic signals, and linear inverse methods for the

reconstruction of ocean fields. Prerequisites: OC3260 or EC3450 or PH4453 or equivalent; linear algebra, partial differential equations or equivalent.

OC4520 Topics in Satellite Remote Sensing (3-0) As Required

Selected topics in the advanced application of satellite remote sensing to the measurement of atmospheric and oceanic variables. Prerequisites: MR/OC3522.

OC4610 Wave and Surf Forecasting (2-2) Fall. Spring

Theory and prediction of wind-generated ocean waves. Spectral transformation of waves from deep to shallow water. Prediction of surf and wave related influences on operations. Prerequisites: OC3150, OC4211.

OC4800 Advanced Courses in Oceanography (Variable hours 1-0 to 4-0) As Required

Advanced courses in various aspects of oceanography. Typically these are advanced topics not covered in regularly offered courses. The course may be repeated for credit as topics change. Prerequisites: Consent of instructor and the Department Chairman.

OC4900 Directed Study in Oceanography (V-0) Every Quarter

Independent study of advanced topics in oceanography. Prerequisites: Consent of instructor and the Department Chairman. Graded on Pass/Fail basis only.

OC5810 Dissertation Research (0-8) Every Quarter

Dissertation research for doctoral studies. Required in the quarter following advancement to candidacy and then continuously each quarter until dissertation is approved by the Academic Council.

Meteorology and Oceanography (METOC) - Curriculum 373 (Under Department of Oceanography)

Program Officer

William (Bill) Sommer, CDR, USN
Code 75, Spanagel Hall, Room 304

(831) 656-2045, DSN 756-2045
wlsommer@nps.edu

Academic Associate:

Ching-Sang Chiu, Ph.D.
Spanagel Hall, Room 313

(831) 656-3239, DSN 756-3239
chiu@nps.edu

Brief Overview

This curriculum in meteorology and oceanography involves approximately 110 quarter-hours of classroom lectures, supplemented by an additional 37 quarter-hours of laboratory exercises. This program is designed to provide the student with:

· A thorough understanding of the principles governing the physical and dynamic properties of the oceans and atmosphere.

· The ability to observe, assimilate, analyze, interpret, and predict oceanic and atmospheric parameters and conditions using field experimentation, direct and remote sensing observational techniques, statistical analyses, and numerical models.

· A thorough understanding of the effects of oceanic and atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting naval warfare, with particular emphasis on ocean acoustics and electromagnetic/optical propagation.

· An oceanographic or meteorological research experience germane to naval warfare culminating in a thesis of professional quality.

· A knowledge of Joint and Maritime Strategic Planning.

This education will enhance performance in all duties throughout a career, including operational billets, technical management assignments and policy making positions. Students will develop graduate-level technical ability based upon scientific principles, acquire diverse professional knowledge, and develop analytical ability for practical problem solving.

Requirements for Entry

This program is open to METOC (1800) Officers, officers from other services, International Officers and DoD civilians.

A baccalaureate degree in the physical sciences, mathematics or engineering is required. Completion of mathematics through differential and integral calculus and one year of calculus-based college physics are required. An APC of 323 is required for direct entry.

Entry Date

METOC curriculum is a nine quarter course of study with entry dates in September and March. If further information is needed, contact the Program Officer. Academic questions may be referred directly to either of the Academic Associates.

Degree

Master of Science in Meteorology and Physical Oceanography.

Subspecialty

Completion of this curriculum qualifies an officer as a METOC Subspecialist with a subspecialty code of 6401P. The Curriculum Sponsor is the Oceanographer of the Navy (CNO N2/N6E).

Typical Subspecialty Jobs

METOC Officer aboard CV(N)/LHD
Submarine Group Staff

Numbered Fleet Staff
CARSRTKGRU Staff
OIC Naval Meteorology and Oceanography Command
  Detachment
NAVMETOCCOM Mobile Warfare Teams
National Geospatial Agency
Office of Naval Research

Typical Course of Study

Quarter 1

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1113	(4-0)	Single variable Calculus
MA1114	(4-0)	Single Variable Calculus W/Matrix Algebra
MR/OC3140	(3-2)	Probability and Statistics
MR/OC0001	(0-1)	METOC Seminar

Quarter 2

OC3230	(3-1)	Descriptive Physical Oceanography
MA1115	(4-0)	Multi-variable Calculus
MA1116	(4-0)	Vector Calculus
MA2121	(4-0)	Ordinary Differential Equations
MR/OC0001	(0-1)	METOC Seminar

Quarter 3

MR3420	(3-0)	Atmospheric Thermodynamic
MR3540	(3-0)	Radiative Processes
MA3132	(4-0)	Partial Differential Equations
NW3230	(4-2)	Strategy and War
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
MR/OC0001	(0-1)	METOC Seminar

Quarter 4

MR/OC3150	(4-2)	Time Series
MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
MR3222	(4-3)	Met Analysis/Lab
OC3240	(4-2)	Ocean Circulation Dynamics
MR/OC0001	(0-1)	METOC Seminar

Quarter 5

OC3260	(4-1)	Fund. of ocean Acoustics
MR/OC4322	(4-2)	Dynamic Meteorology
OC4211	(4-0)	Ocean Waves
OC4XXX	(4-0)	Coastal Ocean Elective
MR/OC0001	(0-1)	METOC Seminar

Quarter 6

MR3234	(4-4)	Tropospheric and Stratospheric Meteorology/Lab
MR/OC4413	(4-0)	Air Sea Interaction
MR/OC3571	(2-0)	Operational Ocean and Met./ Instruments and Observations
MR/OC4325	(3-2)	METOC for Warfighter Decision Making
MR/OC4900	(V-0)	Directed Study in Meteorology/ Oceanography
MR/OC0001	(0-1)	METOC Seminar

Quarter 7

MR3252	(3-4)	Tropical Meteorology/Laboratory
MR/OC3572	(0-4)	Operational Ocean and Met. Lab
MR4323	(4-2)	Numeric Modeling
MR/OC4XXX	(4-0)	Advanced MR or OC elective
MR/OC0810	(0-8)	Thesis Research
MR/OC0001	(0-1)	METOC Seminar

Quarter 8

OC4270	(3-4)	Tactical Oceanography
MR/OC4XXX	(3-0)	Ocean Variability
MR/OC0810	(0-8)	Thesis Research
MR/OC0810	(0-8)	Thesis Research
MR/OC0001	(0-1)	METOC Seminar

Quarter 9

MR3262	(4-0)	Operational Atmospheric Prediction/Laboratory
MR/OC4XXX	(4-0)	Specialization Course
MR/OC0810	(0-8)	Thesis Research
MR/OC0810	(0-8)	Thesis Research
MR/OC0999	(2-0)	Theses Presentation

Educational Skill Requirements (ESR) Meteorology & Oceanography (METOC) - Curriculum 373
Subspecialty Code: 6401P

1. Weapon & Sensor Performance: The officer must have an understanding of the effects of open-ocean and near-shore ocean and atmospheric properties on weapons, sensors, and platform performance. The officer must have the ability to translate this knowledge into warfighter decision recommendations based on sound decision theory, taking into account available courses of action, assessments of vulnerability, uncertainty, and risk as indicated on performance surfaces.

2. Integration of Oceanic & Atmospheric Parameters: The officer must be able to observe, assimilate, analyze, and predict oceanic and littoral water conditions, and atmospheric conditions using direct and remote sensing observation techniques, statistical analysis, and numerical models. The officer will have a sound understanding of polar, mid-latitude and tropical atmospheric and oceanographic dynamics, including the impact of regional conditions on military operations and systems.

3. Numerical Processing: The officer will have a thorough understanding of numerical modeling/processing as it applies to the physics and dynamics of the ocean and the atmosphere. This understanding should include a broad understanding of the modeling process itself to include strengths, weaknesses, and vulnerabilities; the state of current models and techniques; and appropriate applications of deterministic and stochastic techniques.

4. Ocean/Atmosphere Problem Solving: The officer must develop critical thinking skills and conduct independent analyses to solve environmentally challenging problems in the fields of Physical Oceanography and/or Meteorology as they apply to Naval/Joint operations, using modern scientific research techniques, field experience, tools, and equipment. The officer should understand the concept of developing and producing a performance surface.

5. Other NPS Requirements: The officer must successfully complete all NPS requirements for the Master's Degree in Meteorology and Physical Oceanography.

Operational Oceanography - Curriculum 374

Program Officer
William (Bill) Sommer, CDR, USN
Code 75, Spanagel Hall, Room 304

(831) 656-2045, DSN 756-2045
wlsommer@nps.edu

Academic Associate
Ching-Sang Chiu, Ph.D.
Spanagel Hall, Room 313

(831) 656-3239, DSN 756-3239
chiu@nps.edu

Brief Overview

This flexible oceanography curriculum involves approximately 100 quarter-hours of classroom lectures, supplemented by an additional 20 quarter-hours of laboratory exercises. This program is designed to provide the student with:

- A thorough understanding of the principles governing the physical and dynamic properties of the oceans.
- An understanding of the analysis and prediction of oceanic and atmospheric parameters and conditions using direct and remote sensing observational techniques, statistical analyses, and numerical models.
- An understanding of the effects of oceanic and atmospheric properties and conditions on weapon, sensor, and platform performance, while conducting and supporting naval warfare with particular emphasis on ocean acoustics.
- An educationally significant oceanographic experience at sea.
- An oceanographic or meteorological research experience germane to naval warfare culminating in a thesis of professional quality.
- A knowledge of Joint Maritime Strategic Planning.

This curriculum is designed to allow the student to meet all of the requirements for Navy PME (as established by the Chief of Naval Operations) and for Joint PME (as established by the Chairman, Joint Chiefs of Staff) for Intermediate Level Professional Military Education.

The Operational Oceanography Curriculum has a physical oceanography and ocean acoustics base. It is a very flexible program allowing students to examine oceanographic topics relevant to their warfare specialization areas, such as antisubmarine warfare, amphibious warfare, mine warfare, anti-air warfare, strike warfare and special warfare. This program is open to Unrestricted Line Officers (1110, 1120, 1310, 1320), officers from other services, International Officers and DoD civilians.

Requirements for Entry

A baccalaureate degree in the physical sciences, mathematics or engineering is desirable. Completion of mathematics through differential and integral calculus and one year of calculus-based college physics are required. An APC of 323 is required for direct entry. A refresher quarter is available for candidates who do not meet all admission requirements for direct entry and is offered in the Spring or Fall quarter prior to 374 enrollment.

Entry Date

Operational Oceanography is an eight-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate or the Program Officer for this curriculum.

Degree

Master of Science in Physical Oceanography.

Subspecialty

Completion of this curriculum qualifies an officer as an Operational Oceanography Subspecialist with a subspecialty code of 6402P. The curriculum sponsor is the Oceanographer of the Navy (CNO N2/N6F5).

Typical Subspecialty Jobs

CV ASW Module
CARGRU Staff
ASW Operations Center
Navy Laboratories
Office of Naval Research
Patrol Wing Detachments
Naval Academy Instructor
NIMA
Naval Oceanographic Office

Typical Course of Study - Winter

Quarter 1 (Winter)

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1115 (1st 6wks)	(4-0)	Multi-variable Calculus
MA1116 (2nd 6wks)	(4-0)	Vector Calculus
MA2121	(4-0)	Differential Equations
OC3230	(3-1)	Descriptive Physical Oceanography

Quarter 2 (Spring)

MA3132	(4-0)	Partial Differential Equations and Fourier Analysis
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
NW3230	(4-2)	Strategy and Policy
NW3285	(3-0)	National Strategy Decision Making

Quarter 3 (Summer)

MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
OC3240	(4-2)	Ocean Circulation Analysis
NW3275	(2-0)	Joint Maritime Operations (Part 1)
OC3260	(4-1)	Fundamentals of Ocean Acoustics

Quarter 4 (Fall)

OC3902	(3-2)	Fundamentals of GI&S
OC4211	(4-0)	Ocean Waves
MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
NW3276	(2-0)	Joint Maritime Operations (Part 2)

Quarter 5 (Winter)

OC4267	(4-0)	Ocean Acoustic Variability and Uncertainty
MR/OC3570	(2-4)	Operational Oceanography and Meteorology
OC4610	(2-2)	Wave and Surf Forecasting
OC4900	(V-0)	Directed Study in Oceanography

Quarter 6 (Spring)

OC4220	(4-1)	Coastal Circulation
OC4213	(3-1)	Nearshore and Wave Processes
MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes
OC0810	(0-8)	Thesis Research

Quarter 7 (Summer)

OC4270	(3-4)	Tactical Oceanography
MR/OC4413	(4-0)	Air Sea Interaction
MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
OC0810	(0-8)	Thesis Research

Quarter 8 (Fall)

OC4331	(4-0)	Ocean Variability
MR/OC4323	(4-0)	Numerical Modeling (or elective)
OC0810	(2-0)	Thesis Research
OC0999	(0-8)	Thesis Presentation

Typical Course of Study - Summer Input

Quarter 1 (Summer)

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1115 (1st 6wks)	(4-0)	Multi-variable Calculus
MA1116 (2nd 6wks)	(4-0)	Vector Calculus
MA2121	(4-0)	Differential Equations
OC3230	(3-1)	Descriptive Physical Oceanography

Quarter 2 (Fall)

MA3132	(4-0)	Partial Differential Equations and Fourier Analysis
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
NW3230	(4-2)	Strategy and Policy
NW3285	(3-0)	National Strategy Decision Making

Quarter 3 (Winter)

MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
OC3240	(4-2)	Ocean Circulation Analysis
NW3275	(2-0)	Joint Maritime Operations (Part 1)
OC3260	(4-1)	Fundamentals of Ocean Acoustics

Quarter 4 (Spring)

MR3480	(4-1)	Atmospheric

		Thermodynamics and Radiative Processes
OC4211	(4-0)	Ocean Waves
MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
NW3276	(2-0)	Joint Maritime Operations (Part 2)

Quarter 5 (Summer)

OC4267	(4-0)	Ocean Acoustic Variability and Uncertainty
MR/OC3570	(2-4)	Operational Oceanography and Meteorology
MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
OC4900	(V-0)	Directed Study in Oceanography

Quarter 6 (Fall)

OC4331	(4-0)	Ocean Variability
MR/OC4323	(4-0)	Numerical Modeling (or elective)
OC3902	(3-2)	Fundamentals of GI&S
OC0810	(0-8)	Thesis Research

Quarter 7 (Winter)

OC4270	(3-4)	Tactical Oceanography
MR/OC4413	(4-0)	Air Sea Interaction
OC4610	(2-2)	Wave and Surf Forecasting
OC0810	(0-8)	Thesis Research

Quarter 8 (Spring)

OC4220	(4-1)	Coastal Circulation
OC4213	(3-1)	Nearshore and Wave Processes
OC0810	(2-0)	Thesis Research
OC0999	(0-8)	Thesis Presentation

Educational Skill Requirements (ESR) Operational Oceanography- Curriculum 374 Subspecialty Code: 6402P

1. Weapon & Sensor Performance: The officer must have an understanding of the effects of open-ocean and near-shore ocean on weapons, sensors, and platform performance. The officer must have the ability to translate this knowledge into warfighter decision recommendations, taking into account available courses of action, assessments of vulnerability, uncertainty, and risk.

2. Integration of Oceanic Parameters: The officer must be able to observe, assimilate, analyze, and predict oceanic and littoral water conditions using direct and remote sensing observation techniques, statistical analysis, and numerical models. The officer will have a sound understanding of polar, mid-latitude oceanographic dynamics, including the impact of regional conditions on military operations and systems.

3. Numerical Processing: The officer will have a thorough understanding of numerical modeling/processing as it applies to the physics and dynamics of the ocean. This understanding should include a broad understanding of the modeling process itself to include strengths, weaknesses, and vulnerabilities; the state of current models and techniques; and appropriate applications of deterministic and stochastic techniques.

4. Ocean Problem Solving: The officer must develop critical thinking skills and conduct independent analyses to solve environmentally challenging problems in the field of Physical Oceanography as it applies to Naval/Joint operations, using modern scientific research techniques, field experience, tools, and equipment.

5. Other NPS Requirements: The officer must successfully complete all NPS requirements for the Master's Degree in Physical Oceanography.

Oceanography - Curriculum 440

Program Officer
William (Bill) Sommer, CDR, USN
Code 75, Spanagel Hall, Room 304

(831) 656-2045, DSN 756-2045
wlsommer@nps.edu

Academic Associate
Mary Batteen, Ph.D.
Code OC, Spanagel Hall, Room 346

(831) 656-3265, DSN 756-3265

mlbattee@nps.edu

Brief Overview

The Oceanography Curriculum provides students with a sound understanding of the science of oceanography. The student develops the technical expertise to provide and use oceanographic and acoustical data and models in support of all aspects of at-sea operations. The graduate will be able to:

· Interpret and predict oceanic and air-ocean interface conditions.
· Operate modern oceanographic data management, archival and communications systems.
· Plan, conduct, interpret and present results of research activities.

This education further enhances performance in operational billets, technical management assignments and policy-making positions. Students will develop a sound,

graduate-level, technical ability based on scientific principles.

Requirements for Entry

This program is open to International Officers, officers from other services and DoD civilians. It is open to METOC (1800) officers as a Ph.D. program.

A baccalaureate degree in the physical sciences, mathematics or engineering is required. Completion of mathematics through differential and integral calculus and one year of calculus-based college physics are required. An APC of 323 is required for direct entry. A refresher quarter is available for candidates who do not meet all admission requirements for direct entry, and is offered in the Spring or Fall quarter prior to 440 enrollment.

Entry Date

Oceanography is a 6-8 quarter course of study with entry dates in January and July. If further information is needed, contact the Program Officer for this curriculum. Academic questions may be referred directly to the Academic Associate.

Degree

Master of Science in Physical Oceanography.

Typical Course of Study - Winter

Quarter 1 (Winter)

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1115 (1st 6wks)	(4-0)	Multi-variable Calculus
MA1116 (2nd 6wks)	(4-0)	Vector Calculus
MA2121	(4-0)	Differential Equations
OC3230	(3-1)	Descriptive Physical Oceanography

Quarter 2 (Spring)

MA3132	(4-0)	Partial Differential Equations and Fourier Analysis
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
OC3902	(3-2)	Fundamental of GI&S (or Elective)
MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes

Quarter 3 (Summer)

MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
OC3260	(4-1)	Fundamentals of Ocean Acoustics
OC3240	(4-2)	Ocean Circulation Analysis I

Quarter 4 (Fall)

OC4211	(4-0)	Ocean Waves
MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
IT1600	(3-0)	Communication Skills for International Officers (or Elective)
IT1700	(2-0)	Academic Writing for International Officers (or Elective)

Quarter 5 (Winter)

OC4900	(V-0)	Directed Study in Oceanography
MR/OC3570	(2-4)	Operational Oceanography and Meteorology
OC4267	(4-0)	Ocean Acoustic Variability and Uncertainty
OC4610	(2-2)	Wave and Surf Forecasting

Quarter 6 (Spring)

MR/OC4323	(4-2)	Numerical Air and Ocean Modeling
OC0810	(4-0)	Thesis Research
OC4220	(4-1)	Coastal Circulation
OC4213	(3-1)	Nearshore and Wave Processes

Quarter 7 (Summer)

OC4271	(3-0)	Tactical Oceanography
MR/OC4413	(4-0)	Air Sea Interaction
OC0810	(0-8)	Thesis Research
OC0810	(0-8)	Thesis Research

Quarter 8 (Fall)

OC4331	(3-1)	Ocean Variability
OC0810	(0-8)	Thesis Research
OC0999	(2-0)	Thesis Presentation
OCXXXX	(4-0)	Elective

Typical Course of Study - Summer

Quarter 1 (Summer)

MR/OC2020	(2-2)	Computer Computations in Air-Ocean Sciences
MA1115 (1ˢᵗ 6wks)	(4-0)	Multi-variable Calculus
MA1116 (2ⁿᵈ 6wks)	(4-0)	Vector Calculus
MA2121	(4-0)	Differential Equations
OC3230	(3-1)	Descriptive Physical Oceanography

Quarter 2 (Fall)

MA3132	(4-0)	Partial Differential Equations and Fourier Analysis
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
OC3902	(3-2)	Fundamental of GI&S (or Elective)
MR3480	(4-1)	Atmospheric Thermodynamics and

		Radiative Processes

Quarter 3 (Winter)

MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
OC3260	(4-1)	Fundamentals of Ocean Acoustics
OC3240	(4-2)	Ocean Dynamics I

Quarter 4 (Spring)

OC4211	(4-0)	Ocean Dynamics II
MR/OC3150	(3-2)	Analysis of Air/Ocean Time Series
OC4220	(4-1)	Coastal Circulation
IT1600	(3-0)	Communication Skills for International Officers (or Elective)

Quarter 5 (Summer)

MR/OC4413	(4-0)	Air Sea Interaction
OC4900	(V-0)	Directed Study in Oceanography
OC4267	(4-0)	Ocean Acoustic Prediction
IT1700	(2-0)	Academic Writing for International Officers (or Elective)

Quarter 6 (Fall)

MR/OC4323	(4-2)	Numerical Air and Ocean Modeling
OC0810	(4-0)	Thesis Research
OC4331	(3-1)	Mesoscale Ocean Variability
OCXXXX	(4-0)	Elective

Quarter 7 (Winter)

OC0810	(0-8)	Thesis Research
OC4271	(3-0)	Tactical Oceanography
OC3570	(2-4)	Operational Oceanography and Meteorology
OC4610	(2-2)	Wave and Surf Forecasting

Quarter 8 (Spring)

OC4213	(3-1)	Nearshore and Wave Processes
OC0810	(0-8)	Thesis Research
OC0810	(0-8)	Thesis Research
OC0999	(2-0)	Thesis Presentation

Educational Skill Requirements (ESR) Oceanography (Masters) - Curriculum 440 Subspecialty Code: Not Applicable For MS Degree

Note – there is no p-code associated with this program, thus there are no official ESRs. This list describes the skills that this program will provide students upon successful completion of the program.

This curriculum provides students with a sound understanding of the science of oceanography. The student develops the technical expertise to provide and use oceanographic and acoustical data and models in support of all aspects of at-sea operations. The graduate will be able to:

1. Interpret and predict oceanic and air-ocean interface conditions.
2. Operate modern oceanographic data management, archival and communications systems.
3. Plan, conduct, interpret and present results of research activities.

This education further enhances performance in operational billets, technical management assignments and policy-making positions. Students will develop a sound, graduate-level, technical ability based on scientific principles.

Educational Skill Requirements (ESR) Oceanography (Ph.D.) - Curriculum 440 Subspecialty Code: 6402D

The officer must have a thorough theoretical and functional knowledge (obtained at the doctorate level) of the principles of oceanography and its effects on naval warfare and weapons systems.

Department of Physics

Chairman

Andres Larraza, Ph.D.
Code PH/La, Spanagel Hall, Room 200

(831) 656-2896, DSN 756-2896
larraza@nps.edu

Associate Chairman, Instruction and Administration

Richard Harkins, MS
Code PH/Hr, Spanagel Hall
Room 142A

(831) 656-2828, DSN 756-2828
rharkins@nps.edu

Associate Chairman, Research

Kevin Smith, Ph.D.
Code PH/Sk, Spanagel Hall
Room 114

(831) 656-2107, DSN 756-2107
kbsmith@nps.edu

Steven Richard Baker, Associate Professor (1985); Ph.D., University of California at Los Angeles, 1985.

Joseph Blau, Research Associate Professor (1989); Ph.D., Naval Postgraduate School, 2002.

Brett Borden, Professor (2002); Ph.D., University of Texas at Austin, 1986.

Ronald E. Brown, Research Professor (2002); Ph.D., University of Southern California, 1972.

William Boniface Colson, Distinguished Professor (1989); Ph.D., Stanford University, 1977.

Keith Cohn, Research Assistant Professor (2009); Ph.D., Stanford University, 2007.

Peter P. Crooker, Senior Lecturer (2001); Ph.D., Naval Postgraduate School, 1967.

David Scott Davis, Associate Professor (1989); Ph.D., Purdue University, 1976.

Bruce C. Denardo, Associate Professor (1998); Ph.D., University of California at Los Angeles, 1990.

Dragoslav Grbovic, Assistant Professor (2010), Ph.D., University of Tennessee-Knoxville, 2007.

Nancy M. Haegel, Distinguished Professor (2003); Ph.D., University of California at Berkeley, 1985.

Richard M. Harkins, Senior Lecturer (2000); MS, Naval Postgraduate School, 1988, MA Naval War College.1993.

Joseph Hooper, Assistant Professor (2011); Ph. D., Tulane University, 2006.

Daphne Kapolka, Senior Lecturer (2000); Ph.D., Naval Postgraduate School, 1997.

Gamani Karunasiri, Professor (2000); Ph.D., University of Pittsburgh, 1984.

Fred Kruse, Research Professor (2009), Ph.D., Colorado School of Mines, 1987.

Andres Larraza, Associate Professor and Chairman (1994); Ph.D., University of California at Los Angeles, 1987.

James H. Luscombe, Professor (1994); Ph.D., University of Chicago, 1983.

Richard Christopher Olsen, Professor (1987); Ph.D., University of California at San Diego, 1980.

Sebastian Osswald, Assistant Professor (2008); Ph. D., Drexel University/Ilmenau University of Technology, 2008.

Jonathan Phillips, Research Professor (2012); Ph.D., University of Madison Wisconsin, 1982

Joseph A. Rice, Research Professor (2007); MS, University of California at San Diego, 1990.

Craig F. Smith, Research Professor (2004); Ph.D., University of California at Los Angeles, 1975.

Kevin B. Smith, Professor (1995); Ph.D., University of Miami, 1991.

Christopher Smithtro, Col, USAF, Associate Dean of GSEAS, Ph.D., Utah State University, 2004.

David M. Trask, Col, USAF (Ret.), MASINT Chair (2001); M.B.A., Embry-Riddle University, 1991.

Professors Emeriti:

Robert Louis Armstead, Associate Professor Emeritus (1964)*; Ph.D., University of California at Berkeley, 1964.

Fred Raymond Buskirk, Professor Emeritus (1960); Ph.D., Case Institute of Technology, 1958.

Alfred William Madison Cooper, Professor Emeritus (1957); Ph.D., The Queens University of Belfast, 1961

Harry Handler, Professor Emeritus (1958); Ph.D., University of California at Los Angeles, 1955.

Otto Heinz, Professor Emeritus (1962); Ph.D., University of California at Berkeley, 1954.

Xavier K Maruyama, Professor Emeritus (1987); Ph.D., Massachusetts Institute of Technology, 1971.

James Vincent Sanders, Professor Emeritus (1961); Ph.D., Cornell University, 1961.

Gordon Everett Schacher, Professor Emeritus (1964); Ph.D., Rutgers, 1961.

Fred Schwirzke, Emeritus Professor (1967); Ph.D., University of Karlsruhe, 1959.

Donald Lee Walters, Emeritus Professor (1983); Ph.D., Kansas State University, 1971.

Karlheinz Edgar Woehler, Professor Emeritus (1962); Ph.D., University of Munich, 1962.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

Current expertise in the Department of Physics includes the following specializations:
Optical and Electromagnetic Signal Propagation, Detection and Sensor Systems.
Underwater Acoustics
Conventional weapons and their effects
Explosives and high strain rate deformation of materials
Free-Electron Laser Physics.
Directed Energy Weapons Physics.
Physical Acoustics.
Condensed-Matter, Device and Sensor Physics.
Micro-Electrical and Mechanical Systems (MEMS)
Autonomous Systems and Sensors
Energy

All of these specializations are of relevance to modern and future weapons technologies. The faculty supports an ongoing research program in these areas and student thesis topics are available in all of them.

Degree Requirements

The Department of Physics offers the Master of Science and the Ph.D. degrees in Physics and in Applied Physics. Upon approval by the department, courses taken at other institutions may be applied toward satisfying degree requirements to the extent allowed by the general Postgraduate School regulations.

Degree

A student is able to earn an academic degree listed below while enrolled in Combat Systems Science & Engineering (Curriculum 533), and Space Systems Engineering (Curriculum 591).

Master of Science in Physics

A candidate for the Master of Science in Physics degree must satisfactorily complete a program of study that includes a minimum of 30 quarter-hours of physics courses (not including thesis) distributed among courses at the graduate (3000 or 4000) level; of these 30 hours at least 15 hours must be at the 4000 level. Upon approval of the Chairman of the Physics Department, a maximum of 4 hours of courses taken in another department may be applied toward satisfying the above requirements. In lieu of the preceding requirements, students who are qualified to pursue graduate courses in physics when they arrive at the Naval Postgraduate School may complete a minimum of 20 hours entirely of 4000 level physics courses. In addition, all students must satisfy the general Postgraduate School minimum requirements for the master's degree and present an acceptable thesis advised by a member of the Physics Department.

The following specific course requirements (or equivalent) must be successfully completed for a student to earn the Master of Science in Physics degree:
1. PH3152: Analytical Mechanics
   PH3360: Electromagnetic Waves
   PH3991: Theoretical Physics
   PH3782: Thermodynamics and Statistical Physics.
   PH4353: Topics in Advanced Electricity and Magnetism
   PH4656: Quantum Mechanics
2. In addition to the above, a graduate sequence containing at least two physics courses, at least one of which must be at the 4000 level.

All programs leading to the degree Master of Science in Physics must be approved by the Chairman of the Department of Physics.

Master of Science in Applied Physics

To be awarded the Master of Science in Applied Physics degree, a student must complete a program that includes at least 20 quarter-hours of Physics courses at the graduate level, including 12 at the 4000 level. The total graduate hours in Physics, Mathematics, and Engineering must be at least 32, including 20 at the 4000 level.

The program must include at least one graduate level course in each of the following areas: mechanics, electromagnetism, and quantum physics. Students will demonstrate additional breadth by taking at least one 4000 level physics course outside their concentration area.

In addition to the above required courses, a student's program must include an area of concentration containing a four-course sequence of graduate-level courses, at least two at the 4000 level, in an area related to applied physics and approved by the Chairman of the Department of Physics. A list of courses and concentrations meeting the above requirements is available from the Chairman of the Physics Department.

All programs leading to the Master of Science in Applied Physics degree must satisfy the general Postgraduate School requirements for the master's degree, must include

a thesis advised or coadvised by a member of the Physics Department, and must be approved by the Chairman of the Department of Physics.

Master of Science in Combat Systems Technology

A candidate for the Master of Science in Combat Systems Technology degree must complete satisfactorily a program of study that includes a minimum of 32 quarter-hours of graduate work in Physics, Mathematics, and Engineering, with at least 18 quarter-hours at the 4000 level. Included in these hours must be at least 20 quarter-hours of graduate-level physics, including 12 quarter-hours at the 4000 level.

The program must include two approved sequences of courses related to combat systems technology. Each sequence must consist of at least four graduate-level courses with at least two courses at the 4000 level. A list of approved sequences is available from the Chairperson of the Department of Physics.

All programs leading to the Master of Science in Combat Systems Technology degree must satisfy the general Postgraduate School requirements for the master's degree, must include a thesis advised or coadvised by a member of the Physics Department, and must be approved by the Chairperson of the Physics Department.

Doctor of Philosophy

The Department of Physics offers the Ph.D. in several areas of specialization which currently include acoustics, electro-optics, free electron lasers, space physics, and theoretical physics.

Requirements for the degree may be grouped into three categories: courses, dissertation research, and examinations.

The required examinations are outlined under the general school requirements for the Ph.D. In particular, the department requires a preliminary examination to show evidence of acceptability as a doctoral student. This examination may be taken before or after commencement of graduate studies at NPS.

The department offers two options for the Ph.D.: major in Physics or major in Applied Physics. For the major in Physics, a minimum of 40 credit hours of physics courses at the 4000 level is required. The major in Applied Physics also requires 40 credit hours of 4000 level courses, but a portion of these hours may be taken in other departments in technical subjects related to physics.

A more detailed description of departmental requirements for the Ph.D. is contained in the booklet "Doctoral Study in Physics or in Applied Physics at the Naval Postgraduate School," available from the Academic Associate.

An applicant to the Ph.D. program who is not already a student at NPS should submit transcripts of previous academic and professional work, plus results of a current Graduate Record Examination (GRE) general test, to the Director of Admissions, Code 01C3, Naval Postgraduate School, Monterey, California 93943-5100.

Doctor of Philosophy in Engineering Acoustics or Doctor of Engineering

The Department of Electrical and Computer Engineering and the Department of Physics jointly sponsor an interdisciplinary program in Engineering Acoustics leading to either the Doctor of Philosophy or Doctor of Engineering degree. Areas of special strength in the departments are physical acoustics, underwater acoustics, acoustic signal processing, and acoustic communications. A noteworthy feature of this program is that a portion of the student's research may be conducted away from the Naval Postgraduate School at a cooperating laboratory or other federal government installation. The degree requirements and examinations are as outlined under the general school requirements for the doctorate degree. In addition to the school requirements, the departments require a preliminary examination to show evidence of acceptability as a doctoral student.

Physics Laboratories

The physics laboratories are equipped to carry on instruction and research work in acoustics, atomic and molecular physics, electro-optics, spectroscopy, laser physics, computational physics, optical propagation, and sensor physics.

The Optical Physics and Sensors Laboratory uses imaging, spectroscopic and sensing systems from far infrared to ultraviolet wavelengths, including instrumentation for seagoing, airborne and ground-based measurements.

The Acoustics Laboratory equipment includes a large anechoic chamber, a small reverberation chamber and a multiple-unit acoustics laboratory for student experimentation in acoustics in air. Sonar equipment, test and wave tanks and instrumentation for investigation in underwater sound comprise the Underwater Acoustics Laboratory. Also available is scale-model shallow-water waveguide. The Physical Acoustics Laboratories are equipped with a variety of modern data collection and processing equipment.

The Sensor Research Laboratory is capable of design, packaging and characterization of optical and infrared detectors using I-V measurement, Fourier transform spectroscopy and variable temperature photocurrent spectroscopy. Facilities exist for advanced microcharacterization, including cathodoluminescence, EBIC, X-ray analysis, and transport imaging in a scanning electron microscope with variable temperature capability.

Physics Course Descriptions

PC Courses

PC2013 Introductory Applied Physics Laboratory (3-4) As Required

This course is an introduction to basic electronic test instrumentation and basic passive and active circuit components, with emphasis on extensive, practical hands-on exposure to laboratory hardware and devices. Included are the measurement and signal processing of analog signals and analog sensors/transducers. Operational amplifiers are introduced as building blocks of analog systems. Passive LRC filters and active filters are studied with an emphasis on applications. Some background in laboratory instrumentation and simple DC and AC circuit elements is assumed. Prerequisites: College-level basic physics and mathematics, plus simple electrical circuits (e.g., PH1322)

PC2911 Introduction to Computational Physics (3-2) As Required

An introduction to the role of computation in physics, with emphasis on the programming of current nonlinear physics problems. Assumes no prior programming experience. Includes a tutorial on the C programming language and Matlab, as well as an introduction to numerical integration methods. Computer graphics are used to present the results of physics simulations. Prerequisites: None.

PC3014 Intermediate Applied Physics Laboratory (3-4) Spring/Fall

This course continues with the instrumentation and signal processing topics begun in PC2013. Included are: controllable oscillators and RF modulation/demodulation techniques, basic electrical noise sources, device damage and failure modes, elementary digital logic gates and ICs. Also included are an overview of relevant microcomputer topics, such as digital encoding schemes, analog and digital interfacing, and serial communications and networking. At the discretion of the instructor, hands-on projects incorporating the course material may be assigned. Typical projects are: in-air sonar systems, radio receivers and transmitters, and opto-electronic communications links. Prerequisites: PC2013 and PC2911 or permission of instructor.

PC3172 Physics of Weapons Systems: Fluid Dynamics of Weapons, Shock Waves, Explosions (4-2) Winter/Summer

This course provides the basic physical principles applicable to air-borne and water-borne missiles, as well as the fluid dynamics of shocks and explosions. Topics include: Elements of thermodynamics, ideal fluid flow, elementary viscous flows, similitude and scaling laws, laminar and turbulent boundary layers, underwater vehicles, classical airfoil theory, supersonic flow, drag and lift of supersonic airfoils with applications to missiles, fluid dynamics of combustion, underwater explosions. Prerequisites: PH2151 and PH3991.

PC3200 Physics of Electromagnetic Sensors and Photonic Devices (4-1) Fall

An introductory survey of the physics of active and passive electromagnetic detection systems, primarily for Combat Systems students who do not elect to follow the Electromagnetic Sensors specialization track. Basic radiometry. Introduction to radar: ranging, pulse rate and range ambiguity, Doppler measurements, radar equation, target cross-sections, antenna beam patterns and phased arrays. Optoelectronic displays: CRTs, LEDs, LCDs, plasma displays. Introduction to lasers: transitions, population inversion, gain, resonators, longitudinal and transverse resonator modes, Q-switching, mode-locking, laser applications. Photodetection basics: noise and its characterization, photovoltaic, photoconductive and photoemissive detectors, image intensifiers, CCDs, night vision systems. Introduction to optical fibers and their applications. Prerequisites: PH2652, PH3292 and PH3352, or equivalent(s), or by permission of instructor.

PC3400 Survey of Underwater Acoustics (4-2) Spring

The physics of the generation, propagation, and detection of sound in the ocean. Topics include the acoustic wave equation and its limitations in fluids; plane, cylindrical, and spherical waves; the ray approximation; reflection of planes waves from plane boundaries; radiation of sound from circular piston, continuous line source, and linear array; speed of sound and absorption in the ocean; active and passive sonar equations; transmission-loss and detection-threshold models; normal mode propagation in the ocean; the parabolic equation approximation. Laboratory experiments include surface interference, noise analysis, normal modes, and acoustic waveguides. Prerequisites: PH2151 and PH3991.

PC3800 Survey of the Effects of Weapons (4-0) Spring

Physics of high-velocity impact including the dynamical behavior of ductile and brittle materials and shock waves in solids. Physics of projectile penetration at high velocities. Shaped charges. Nuclear weapons effects including blast and shock thermal radiation, X-rays, neutron flux, electromagnetic pulse, and radioactive fallout. Biological and chemical weapons effects, deployment, detection and countermeasures. Directed energy weapons and effects. Prerequisites: PC3172 and PH2652.

PC4015 Advanced Applied Physics Laboratory (3-4) Summer/ Winter

Students must integrate the material that they learned in the previous two courses (PC2013 and PC3014PC3014), along with additional material on embedded microprocessors and controls. A working introduction to control systems theory is provided and incorporated into an autonomous weapon system or "robot." Collaborative and autonomous engagement of the robots will be performed with RF modems and Ethernet communications. The principles of cooperative engagement will be emphasized. For the final exam, teams will compete in 2-on-1 or 2-on-2 engagement contests. These contests will test the students' assimilation of both the formal and the practical aspects of the course material. Prerequisites: PC2911 or other C/C++ programming course, plus PC2013 and PC3014.

PC4022 Combat Systems Capabilities (3-0) Spring

An advanced study of the technical capabilities of current acquisition programs within DoD. The course begins with an overview of the Navy acquisition community and the acquisition process. This is followed by weekly presentations by program managers and their technical experts. Overviews of each program are followed by an in-depth analysis of the critical physics and engineering issues, design trade-offs, risk areas, reliability issues, use of simulation and modeling, testing and evaluation rationale, interoperability concerns, software development issues, interfacing issues, etc. Topics of the course are dictated by the availability of program office personnel. Prerequisites: None. Classification: SECRET.

PC4860 Advanced Weapon Concepts (4-1) Spring/Fall

This course is a comprehensive overview of the components and underlying technologies of modern missile technologies. The

course gives an introduction to missile guidance, missile aerodynamic design considerations, and missile propulsion technologies, followed by an introduction to the physics of modern conventional warhead designs for missile intercept and lethality and survivability considerations. Prerequisites: PC3172 and good comprehension of all aspects of mechanics and electromagnetics.

PH Courses

PH0810 Thesis Research (0-8) Spring/Summer/Fall/Winter
Every student conducting thesis research will enroll in this course.

PH0820 Integrating Project (0-12) Spring/Winter
The Naval Postgraduate School provides many opportunities for students to participate in campus-wide interdisciplinary projects. These projects encourage students to conceptualize systems which respond to current and future operational requirements. An integral part of the project involves working with other groups to understand and resolve issues involved with system integration. This course is available to students in the Combat Systems Science and Technology Curriculum who are participating in a campus-wide integrated project. Prerequisites: Consent of instructor.

PH0999 Physics Colloquium (No Credit) (0-1) Spring/Summer/Fall/Winter
Discussion of topics of current interest by NPS and outside guest speakers.

PH1000 The Nature and Structure of Physics (4-2) As Required
The concepts and laws of physics are explored from the ancient science of Aristotle and Ptolemy through the beginnings of classical physics with Galileo and Newton through the modern quantum and relativity physics of Schrodinger and Einstein to the physics of quarks and neutrino oscillations. Physics concepts are explored and their relevance to every day and military technologies is highlighted. The course is designed for students who will not take a physics based curriculum, but will encounter technologies impacted by physical concepts. The goal in this course is to convey an appreciation for physics as an intellectual endeavor and an understanding of the principles underlying modern technology. Prerequisites: None.

PH1001 Fundamentals of Physics I (4-2) As Required
This course meets for twelve hours per week for the first five and one-half weeks of the quarter. Topics covered are the fundamentals of calculus-based mechanics: Kinematics and dynamics of particles, statics of rigid bodies, work, energy, systems of particles, collisions, rotations of rigid bodies, angular momentum and torque, mechanical properties of solids, elasticity, harmonic motion, sound, fluids. Mathematical methods are reviewed as required. Prerequisites: Calculus with a passing grade.

PH1002 Fundamentals of Physics Ii (4-2) As Required
This course meets for twelve hours per week for the second five and one-half weeks of the quarter and covers electromagnetism: electric charge, electric and magnetic fields, forces on charges in fields, electric potential, Gauss' law, Ampere's law, Faraday's law, resistance, capacitance, inductance, DC circuits, magnetic properties of matter, transient currents in circuits, complex AC circuits analysis, Maxwell's equations. Mathematical methods are reviewed as required. Prerequisites: PH1001 or equivalent.

PH1121 Mechanics (4-2) Summer/Winter
This course covers the fundamentals of calculus-based mechanics: Kinematics and dynamics of particles, statics of rigid bodies, work,

energy, systems of particles, collisions, rotations of rigid bodies, angular momentum and torque, mechanical properties of solids, elasticity, harmonic motion, fluids. Prerequisites: A course in calculus or concurrent registration in a calculus course and consent of instructor.

PH1322 Electromagnetism (4-2) Spring/Fall
Basic electromagnetism: electric charge, electric and magnetic fields, forces on charges in fields, electric potential, Gauss's law, Ampere's law, Faraday's law, resistance, capacitance, inductance, DC and AC circuits, magnetic properties of matter, transient currents in circuits, Maxwell's equations, electromagnetic waves. Prerequisites: PH1121 or consent of instructor.

PH1623 Thermodynamics and Wave Phenomena (4-2) As Required
An introduction to thermodynamics and wave phenomena. The Laws of Thermodynamics, calorimetry, thermal effects, kinetic theory of gases, heat transfer, the Carnot cycle, heat engine and refrigerator efficiency are studied followed by the general properties of wave phenomena, vibrations, acoustics, and geometrical and physical optics. Prerequisites: PH1121, PH1322 or consent of instructor.

PH1992-1998 Special Topics in Elementary Physics (V-0) As Required
Study in one of the fields of elementary physics selected to meet the needs of students without sufficient undergraduate physics to meet the prerequisites of their curriculum. The course may be conducted either as a lecture course or as supervised reading. Prerequisites: Consent of the Department Chairman.

PH2001 Research Seminar in Physics (1-0) Spring/Fall
This course will present the research expertise of the physics faculty. The course is designed to support Combat Systems Science and Technology students in their second quarter in the selection of their concentration and area for thesis research. The course is given in the Pass/Fail mode. Prerequisites: CSS&T students in their second quarter or consent of the Academic Associate.

PH2151 Particle Mechanics (4-1) Spring/Fall
After a review of the fundamental concepts of kinematics and dynamics, this course concentrates on those two areas of dynamics of simple bodies which are most relevant to applications in Combat Systems: vibrations and projectile motion. Topics include: damped and driven oscillations, projectile motion with atmospheric friction, satellite orbits, and rotating coordinate systems. Prerequisites: PH1121 or equivalent; MA2121 or equivalent course in ordinary differential equations (may be taken concurrently).

PH2203 Topics in Basic Physics: Waves and Optics (4-0) Fall
A course to provide the physical background to wave motion and optics for students in the Information Warfare and Electronic Warfare curricula, and to provide applications of analytical techniques to physical problems. Areas covered are harmonic motion— differential equations, complex notation, damped vibration and resonance; wave motion—properties of waves, electromagnetic waves, light waves; geometrical and wave optics. Prerequisites: MA1115, MA1116, MA2121.

PH2351 Electromagnetism (4-1) Summer/Winter
Electrostatic fields in vacuum and dielectrics, electrostatic energy and capacitors. The magnetic field of steady currents, Biot-Savart and Ampere's Laws, vector potential, magnetic properties of matter. Faraday's law. Magnetic energy. Maxwell's Equations. Prerequisites: PH1322, MA1116, MA2121.

PH2514 Introduction to the Space Environment (4-0) As Required
Plasma concepts. Solar structure and magnetic field, particle and electromagnetic emissions from the sun, the geomagnetic field, and the magnetosphere, radiation belts, structure and properties of the earth's upper atmosphere, ionosphere, implications of environmental factors for spacecraft design. Prerequisites: A course in basic electricity and magnetism.

PH2652 Modern Physics (4-1) Winter/Summer (Fall for SE Students)
An introduction to modern physics. Theory of relativity; blackbody radiation; photoelectric effect; matter waves; atomic spectral lines; Bohr model of the atom; uncertainty relations (position-momentum and time-energy); the Schrödinger equation (time dependent and independent); probability interpretation; infinite, finite and parabolic potential wells; tunneling (single and double barriers); electron spin and exclusion principle; the periodic table; molecular energy levels; quantum statistics (Bose-Einstein, Fermi-Dirac). Prerequisites: PH1623.

PH2724 Thermodynamics (4-0) Winter/Summer
Equations of state; the concepts of temperature, heat and work; the first law of thermodynamics; heat engines and refrigerators; entropy and the second law of thermodynamics; thermodynamic potentials; phase equilibrium; kinetic theory; equipartition theorem; transport phenomena. Prerequisites: PH1121, PH1322, MA1116.

PH3002 Non-Acoustic Sensor Systems (4-0) Fall
This course covers the physical principles underlying the operation of a number of operational and proposed non-acoustic sensor systems. Geomagnetism, magnetometers and gradiometers, MAD signatures, optical and IR transmission in the atmosphere and in sea water. Image Converter, FLIR and radar systems for USW. Exotic detection schemes. Prerequisites: PH1322.

PH3052 Physics of Space and Airborne Sensor Systems (4-0) As Required
This interdisciplinary course explores the physical principles underlying the sensor systems needed for satellites and tactical aircraft, as well as limitations imposed by the atmosphere and operating environment on these systems and their communication links. Topics include: satellite orbits, the satellite environment, ionospheric interactions and atmospheric propagation, phased array and pulsed compressed radars, imaging synthetic aperture and inverse synthetic aperture radars, noise resources, thermal radiation, principles of semiconductor devices, optical and infrared imaging detector systems, and their resolution limitations and bandwidth requirements. Prerequisites: Basic physics class. Must be familiar with the concepts of energy and wave motion.

PH3119 Oscillation and Waves (4-2) Summer
An introductory course designed to present mechanics to students studying acoustics. Kinematics, dynamics, and work and energy consideration for the free, damped, and driven oscillators. The wave equation for transverse vibration of a string, ideal and realistic boundary conditions, and normal modes. Longitudinal and transverse waves in bars. Transverse waves on rectangular and circular membranes. Vibrations of plates. Laboratory periods include problem sessions and experiments on introduction to experimental techniques and handling of data; the simple harmonic oscillator analog; transverse waves on a string; and transverse, longitudinal, and torsional waves on a bar. Prerequisites: PH3991 or equivalent.

PH3152 Analytical Mechanics (4-0) Summer/Winter
Dynamics of systems of particles, including rockets. Hamilton's principle, Lagrangian dynamics, and the role of physical symmetry. Velocity-dependent potentials. The inertia tensor and rotational dynamics of rigid bodies. Small-amplitude oscillations of systems of particles, and normal modes. Prerequisites: PH2151.

PH3204 Electro-Optic Principles and Devices (4-2) As Required
The first course of a two-course sequence for the Information Warfare/Electronic Warfare Curricula. This course treats the principles and capabilities of military electro-optic and infrared systems in a Range Equation context. Topics include: target signatures and backgrounds, optical transmitter and receiver characteristics, MTF and OTF, atmospheric propagation and propagation codes, laser radiation and types, fiber optics, detectors, focal plane arrays, D* and NET, principles of imaging, and sensor performance parameters. Laboratory work provides hands-on familiarity with modem infrared devices. Prerequisites: PH1322, MA3139 or equivalent.

PH3280 Introduction to MEMS Design (3-3) As Required
This is a 4.5 credit hour class introducing the students to Micro Electro Mechanical Systems (MEMS). Topics include material considerations for MEMS and microfabrication fundamentals. Surface, bulk and non-silicon micromachining. Forces and transduction; forces in micro-nano-domains and actuation techniques. Case studies of MEMS based microsensor, microactuator and microfluidic devices. The laboratory work includes computer aided design (CAD) of MEMS devices and small group design project. Prerequisites: basic understanding of electrical and mechanical structures: EC2200 or MS2201 or PH1322 or consent of instructor.

PH3292 Applied Optics (4-2) Spring
An intermediate-level course in optics. Review of basic geometric and physical optics concepts. Laws of reflection and refraction at interfaces. Imaging systems and aberrations. Polarization; Jones matrix methods; electro-optical modulation. Matrix methods for paraxial ray tracing and optical systems analysis. Two-beam and multiple-beam interference; Young's double slit experiment, multiple-slit systems and diffraction gratings; Michelson's interferometer; Fabry-Perot interferometer. Huygens-Fresnel principle; Fraunhofer diffraction; Fresnel diffraction. Prerequisites: PH3352.

PH3352 Electromagnetic Waves (4-0)
Maxwell's equations, energy density and Poynting vector, boundary conditions. Polarization. Propagation of uniform plane waves in vacuum, dielectrics, conducting media (with emphasis on sea water) and low-density neutral plasmas. Reflection and refraction at plane dielectric and conducting boundaries, at normal and oblique incidence. Rectangular waveguides. Prerequisites: PH2351.

PH3360 Electromagnetic Wave Propagation (4-1) Summer/Winter
Introduction to vector fields and the physical basis of Maxwell's equations. Wave propagation in a vacuum, in dielectrics and conductors, and in the ionosphere. Reflection and refraction at the interface between media. Guided waves. Radiation from a dipole.

Prerequisites: MA2121 and a course in basic electricity and magnetism.

PH3401 Introduction to the Sonar Equations (3-0) Spring/Fall

A discussion of the fundamental principles behind each term of the sonar equations. Starting with the acoustic wave equation and the basic properties of sound waves, topics include ray acoustics, normal mode theory, simple transmission loss models, coherent and incoherent sound, directivity, beamforming, scattering, noise sources and properties, and the detection threshold. This course can be taken online as part of the ASW Certificate program. Prerequisites: Single-variable calculus.

PH3451 Fundamental Acoustics (4-2) Fall

Development of, and solutions to, the acoustic wave equation in fluids; propagation of plane, spherical and cylindrical waves in fluids; sound pressure level, intensity, and specific acoustic impedance; normal and oblique incidence reflection and transmission from plane boundaries; transmission through a layer; image theory and surface interference; sound absorption and dispersion for classical and relaxing fluids; acoustic behavior of sources and arrays, acoustical reciprocity, continuous line source, plane circular piston, radiation impedance, and the steered line array; transducer properties, sensitivities, and calibration. Laboratory experiments include longitudinal waves in an air-filled tube, surface interference, properties of underwater transducers, three-element array, speed of sound in water, and absorption in gases. Prerequisites: PH3119 and PH3991 or equivalent.

PH3452 Underwater Acoustics (4-2) Winter

This course is a continuation of PH3451. Lumped acoustic elements and the resonant bubble; introduction to simple transducers; normal modes in rectangular and cylindrical enclosures; steady-state response of acoustic waveguides of constant cross section, propagating evanescent modes, and group and phase speeds; transmission of sound in the ocean, the Eikonal Equation and necessary space conditions for ray theory, and refraction and ray diagrams; sound propagation in the mixed layer, the convergence zone, and the deep sound channel; passive sonar equation, ambient noise and doppler effect and bandwidth considerations; active sonar equations, target strength and reverberation. Laboratory experiments include Helmholtz resonators, normal modes in rectangular, cylindrical, and spherical enclosures, water-filled waveguide, noise analysis, impedance of a loudspeaker. Prerequisites: PH3451.

PH3458 Noise, Shock and Vibration Control (4-2) As Required

The application of the principles of acoustics and mechanics to the problems of controlling noise, vibration and mechanical shock. Topics include linear mechanical vibrations; introduction to vibrations of nonlinear systems; damping mechanisms; vibration and shock isolation; noise generation and control; effects of noise on man; application to problems of naval interest, such as ship quieting and industrial noise control. Prerequisites: A course in acoustics.

PH3479 Physics of Underwater Weapons (4-0) Spring

Navier-Stokes Equations and their exact solutions; Reynolds and other numbers and dynamic similarity. Incompressible inviscid hydrodynamics including flow about a circular cylinder and airfoil theory. Prandtl's boundary layer theory: the laminar boundary layer on a flat plate; effects of pressure gradients; separation of a laminar boundary; streamline bodies. Hydrodynamics stability and transition to a turbulent boundary layer; velocity profile in the turbulent boundary layer; drag on a flat plate. Blunt bodies. Drag reduction. Supercavitation. Torpedoes: drag and lift; dynamics of a straight-running torpedo; power plants; propulsors. Review of thermodynamics. Subsonic and supersonic flows. The converging-diverging nozzle. Shock waves: Rankine-Hugoniot equations; stationary normal shocks in air and water. Underwater explosions: detonation; scaling laws for the shock wave; the bubble and it interaction with surfaces. Shaped charges. Prerequisite: MA3139 or equivalent.

PH3655 Semiconductor Device Physics (4-0) Spring/Fall

Formation of solids, crystal structure of semiconductors, X-ray diffraction, lattice vibrations, defects, electrical and thermal properties, free electron model, Seebeck effect, thermionic emission, photoemission, effects of periodic potential, formation of energy bands, E-k relation, band structure of Si and GaAs, electrons and holes, doping and impurity levels, mobility, diffusion, continuity equation, Schottky and ohmic contacts, optical properties, Formation of p-n junction, I-V characteristics, bipolar and field effect transistors, fabrication technology, semiconductor alloys, quantum effect devices, fundamental limits to semiconductor device technology. Prerequisites: PH2652.

PH3700 Fundamentals of Energy (4-0) Winter

This course provides a study of the underlying science of all aspects of energy, including energy availability, production, conversion, storage, and delivery. Topics covered will emphasize basic physics and chemistry of: work, power, units and unit conversion; fossil fuels, heat engines and power plants; solar thermal and solar voltaic sources; wind, hydro, and tidal power; geothermal and biomass energy; transportation, including electric and hybrid vehicles, batteries and fuel cells; nuclear energy; and energy conservation. Quantitative problem solving will be emphasized, including development of tools for energy systems analysis. Student will present briefs addressing energy topics with DoD/Don relevance at the end of the course. Prerequisite: Introductory physics at the algebra/trigonometry level.

PH3782 Thermodynamics and Statistical Physics (4-0) As Required

Entropy, temperature, Boltzmann factor and Gibbs factor are developed from a quantum point of view. Blackbody radiation, chemical potential, partition function, Gibbs sum and applications to an ideal gas are covered. Fermi-Dirac and Bose-Einstein statistics and applications to degenerate systems; Gibbs free energy, Helmholtz free energy, enthalpy, kinetic theory, phase transformations, chemical reactions. Prerequisites: PH2724 and PH2652.

PH3855 Nuclear Physics (4-0) As Required

This is the first in a sequence of graduate specialization courses on nuclear weapons and their effects. This course deals with the underlying principles of nuclear physics, including nuclear forces, models, stability, reactions and decay processes, and interaction of high energy particles with matter. Prerequisites: PH3152, PH3360, and PH2652 or equivalents.

PH3858 Railgun Technology (2-0) As Required

This course provides a basic introduction to the fundamentals of railgun theory, design, and practice. Requirements for both the Army and Navy applications are discussed. Acceleration of projectiles, pulsed power sources for the railgun, barrel life, mechanical stress, projectile design, and thermal considerations will be discussed

PH3991 Theoretical Physics (4-1) Spring/Fall
Discussion of heat flow, electromagnetic waves, elastic waves, and quantum-mechanical waves; applications of orthogonal functions to electromagnetic multipoles, angular momentum in quantum mechanics, and to normal modes on acoustic and electromagnetic systems. Applications of complex analysis to Green Function in quantum mechanics and electromagnetism. Application of Fourier series and transforms to resonant systems. Applications of partial differential equation techniques to equation of physics. Prerequisites: Basic physics, multivariable calculus, vector analysis, Fourier series, complex numbers, and ordinary differential equations.

PH3992-3998 Special Topics in Intermediate Physics (Variable Hours 1-0 to 4-0.) (V-0) As Required
Study in one of the fields of intermediate physics and related applied areas selected to meet special needs or interests of students. The course may be conducted as a seminar or supervised reading in different topics. Prerequisites: A 2000 level course appropriate to the subject to be studied, and consent of the Department Chairman. The course may also be taken on a Pass/Fail basis, provided the student has requested so at the time of enrollment.

PH4001 Physics Thesis Presentation (1-0) As Required
This course provides students with the opportunity to develop the ability to deliver a briefing on a technical subject by presenting their thesis to other students and faculty. This course is required of all students working for a degree from the Physics Department and of all Combat Systems students not presenting their thesis in some other department. Prerequisites: At least two quarters of thesis research.

PH4055 Free Electron Laser Physics (3-0) As Required
The physical principles describing free electron lasers are explained with applications to ship defense from sea-skimming missiles, and to new radiation sources for scientific research. Theory is applied to experimental facilities around the world. Topics include optical resonator design, general laser concepts, laser beam propagation, relativistic electron dynamics, phase-space analysis, and numerical simulation. Prerequisites: PH4353, E&M.

PH4056 Radiofrequency Weapons, High Power Microwaves, and Ultrawide Band Systems (4-0) As Required
This course outlines High-Power Microwave (HPM) and radiofrequency (RF) weapons technology, design, and progress including sources, systems integration, and effects of these emerging capabilities at the SECRET/U.S. ONLY level. Definitions and terminology, and calculations concerning the effects upon electronics, such as burnout and upset; narrowband and wideband modulation; and RF radiation, propagation, and coupling will be presented. The generation of high-power electromagnetic fields in compact sources, testing, EMI/EMC fratricide/suicide issues, and transition to employment as operational systems in a variety of applications will be described. Intelligence concerning the growing RF weapons threat is analyzed with particular attention paid to IW, terrorism, and asymmetrical threat aspects of these developments. Prerequisites: PH3352, EC3600, or EO3602. Classification: SECRET/U.S. only.

PH4153 Advanced Classical Mechanics I (4-1) As Required
The first course in a two-course sequence covering classical mechanics at the advanced graduate level. Newtonian mechanics of single-particle and two-body central force systems, including orbital motion and scattering. Constraints, Lagrangian dynamics and generalized coordinates. Euler's formulation of rigid body mechanics. Small oscillations and systems of coupled oscillators. Prerequisites: PH3152 and PH3991 or equivalents.

PH4154 Advanced Classical Mechanics II (4-1) As Required
The second course in a two-course sequence covering classical mechanics at the advanced graduate level. Kinematics and dynamics of relativistic systems from the Lagrangian perspective. Hamilton's equations of motion and conservation laws. Poison brackets and commutation. Hamilton-Jacobi formulation of mechanics and action-angle variables. Introduction to nonlinear dynamics and chaotic systems. Introduction to classical perturbation theory. Prerequisites: PH4153 or equivalent.

PH4162 Mechanics of Continua (3-0) As Required
The foundations of fluid mechanics presented in the tensor formulation. Scalars, vectors, and tensors; tensor differential and integral calculus; the stress tensor and rate of deformation tensor; principal values, deviators, and other invariants; fundamental laws: conservation of mass, linear momentum, angular momentum, and energy; constitutive equations; non-Newtonian fluids; Visco-Plastic materials. Prerequisites: PC3172 or equivalent.

PH4171 Physics of Explosives (4-0) Summer
The goals of the course are to provide in-depth and advanced understanding of explosives from theoretical and practical standpoints, to formulate the bases for evaluating competitive and alternative explosive systems, and to provide criteria for crisis management. This course covers advanced topics in explosive physics and chemistry: Molecular energetics of the explosive molecule including molecular orbital and valence bonding and resonance stabilization concepts and practical implications of sensitivity and energy potential, oxygen balance and thermodynamic, reaction rate theory, hot-spot theory, shock physics and detonation theory. Special topics in explosive technology and application as applied to metal driving, mine detection and neutralization, chemical and biological dissemination, and computational modeling are offered per student's interests. Prerequisites: PC3172 and PH2652.

PH4209 EO/IR Systems and Countermeasures (3-2) As Required
This unclassified course for students in interdisciplinary curricula treats the military applications of countermeasures to electro-optic systems, including IR and EO seekers and trackers, surveillance and missile and laser warning systems, and laser rangers and designators. Scanning FLIR and IRST systems and array applications will be included. Signature suppression and generic active and passive countermeasure approached will be discussed including decoys and active IRCM. Laboratory work will deal with EO/IR devices and possible countermeasure techniques. Prerequisites: PH3204, MA3139, or equivalent.

PH4253 Sensors, Signals, and Systems (4-2) As Required
This course treats the physical phenomena and practical problems involved in sensor systems for electromagnetic signals in the EO/IR range. Topics included are: optical modulation, nonlinear optics, acousto-optics; atmospheric molecular absorption characteristics and mechanisms of detectors for optical and infrared radiation, noise in detectors, cooling systems; image intensifiers, television and FLIR systems; detecting, tracking and homing systems; signal sources, target signatures and backgrounds; laser target designators, laser radars, the range equation. The laboratory will include experiments related to this material as well as to that of the preceding course, PH3252. Prerequisites: PH2652, PH3292, and PH3352 or equivalent.

PH4254 Thermal Imaging and Surveillance Systems (4-0) As Required

This course is intended as a capstone course on EO/IR systems for the Combat Systems Science and Technology Curriculum, or the Electronic Warfare Systems Technology curriculum. It addresses the system analysis and technology of infrared imaging (FLIR) and search/track systems (IRST), including the derivation of system performance measures such as Minimum Detectable Temperature Difference (MDT), and Minimum Resolvable Temperature Difference (MRTD) in terms of the optics, scanner, detectors, display, and human operator characteristics. Operational Performance Prediction codes and Tactical Decision Aids (TDAs) will be analyzed for current and developmental Forward Looking InfraRed (FLIR) Systems, and comparable codes for IRSTs discussed. Criteria for target detection and transference of contrast will be compared. Integrated Focal Plane Array Technology will be explored for application to second/third generation FLIR and Staring Imager development. Prerequisites: PH4253 or PH4209 or consent of instructor.

PH4271 Lasers, Optoelectronics and Electro-Optics I (4-1) Fall

The first course in a comprehensive two-course sequence covering the physics of lasers, optoelectronic and electro-optical devices. Review of Atomic and molecular energy levels, time-dependent perturbation theory, radiative transitions, transition rates. Einstein A and B coefficients for spontaneous and stimulated radiative transitions, blackbody radiation. Optical attenuation and amplification, rate equations. Basic laser theory, gain saturation, homogeneous and inhomogeneous effects. Optical resonators, laser modes, coherence. Q-switching, mode locking, pulse compression, laser pumping and tuning mechanisms. Gaussian beams. Introduction to multiple-mode and single mode optical fibers. Prerequisites: PH3292, PH3352, PH2652, or equivalent(s).

PH4272 Lasers, Optoelectronics and Electro-Optics II (4-1) Summer

The second course in a two-course sequence covering the physics of lasers, optoelectronic and electro-optical devices. Physics of optoelectronic detection, noise, detector figures-of-merit. Photovoltaic, photoconductive, bolometric and charge-coupled (CCD) detector families. 1-D and 2-D (focal-pave array) detectors. Image intensifiers and night vision systems. Gaussian beams. Physics of optical fibers and their practical applications. Optical properties of anisotropic media and their applications, electro-optical effects and modulators. Introduction to nonlinear optics, optical harmonic generation, parametric amplification and optical heterodyning. Prerequisites: PH3292, PH3352 and PH2652, or equivalent(s).

PH4273 Physics of Advanced Imaging Systems (4-2) Fall

A course in the physical optics of advanced imaging techniques, Introduction to Fourier optics, spatial frequency, sampling, and transfer function concepts, Beam diffraction from the linear systems/Fourier transform perspective, Wavefront coherence and its characterization, Optical transfer functions, modulation transfer functions and diffraction limited resolution of optical and RF systems, Performance characterization of imaging systems, Correlation-based reception in active systems, Computerized tomography and other projection-based imaging methods (including SAR and ISAR). Prerequisites: PH3292 or equivalent; PH4272 is recommended as a concurrent course.

PH4274 Physics of Active Electromagnetic Detection and Engagement (4-1) Summer

A course in the physics of radar and high-power RF/microwave systems. Radiometry and the propagation of electromagnetic energy. Radar equation and its relationship to radiometry. Noise and minimum detection threshold criteria. Range gating, scanning and range ambiguity. Target cross-section and polarization effects. Doppler techniques. Correlation analysis of signals and signal coherence. Synthetic aperture methods. Absorption and scattering of RF/microwave beams by the atmosphere. Modulation and demodulation techniques, pulse compression, chirping and signal recovery. Ultra-wideband and monopulse radars. Tracking and jamming. Propagation of high-power beams and thermal blooming/defocusing in the atmosphere. Introduction to RF/microwave weapons and their effects. Prerequisites: PH2351 and PH3292.

PH4280 Micro Electro Mechanical Systems (MEMS) Design II (2-4) As Required

Same as ME4780 and EC4280. This is the second course in Micro Electro Mechanical Systems (MEMS) Design. This course will expose students to advanced topics on material considerations for MEMS, microfabrication techniques, forces in the micro- and nano-domains, and circuits and systems issues. Case studies of MEMS-based microsensors, microactuators, and microfluidic devices will be discussed. The laboratory work includes computer aided design (CAD) and characterization of existing MEMS devices. The grades will be based on exams, lab projects, and a group design project. Prerequisites: ME/EC/PH3280 or ME3780 or consent of instructor.

PH4353 Topics in Advanced Electricity and Magnetism (4-0) As Required

Topics selected from: Electromagnetic radiation, including radiation from antennas and accelerating particles, and radiation scattering from charged particles. Additional topics may include Cerenkov radiation, free electron lasers, and the relativistic formulation of electrodynamics. Prerequisites: PH3152, PH3352 and PH3991.

PH4354 Advanced Electromagnetic Radiation (4-0) As Required

This course gives an in-depth coverage of scattering of electromagnetic radiation in the microwave to optical region, from randomly distributed scatterers in the atmosphere and the propagation of optical radiation in turbulent randomly fluctuating atmosphere, which has a most significant application in the high energy laser weapon program. Prerequisites: PH3352, PH3991.

PH4371 Classical Electrodynamics (3-0) As Required

Tensors in special relativity. Classical relativistic electromagnetic field theory. Lorentz electron theory. Prerequisites: PH4353 and familiarity with the special theory of relativity and Lagrangian mechanics.

PH4410 Advanced Acoustics Laboratory (1-6) As Required

Advanced laboratory projects in acoustics. Through the performance of experiments drawn from diverse fields of acoustics, the student is introduced to the problems and opportunities of acoustics research. For each experiment, the student is guided through the scientific literature on the subject, the construction of the equipment, the collection and analysis of the data, and the writing of a research report. Prerequisites: PH3451.

PH4453 Scattering and Fluctuation of Sound in the Ocean (4-0) As Required

An advanced treatment of the effects of variations of the ocean and its boundaries on ocean noise and the scattering and fluctuation of sound. Topics include: multiple radiation fields and noise sources in the sea, coherence and incoherence, probability density functions, the Hemholtz integral and general scattering formalism, scattering from objects, correlations and frequency spectra of sound scattered from rough boundaries, fluctuations associated with variability in the medium. Prerequisites: PH3452 or consent of instructor.

PH4454 Sonar Transducer Theory and Design (4-2) Winter

A treatment of the fundamental phenomena basic to the design of sonar transducers, specific examples of their application and design exercises. Topics include piezoelectric, magnetostrictive and hydro mechanical effects. Laboratory includes experiments on measurement techniques, properties of transducer materials, characteristics of typical navy transducers, and a design project. A field trip to visit one or more transducer manufacturers is normally scheduled during the course. Prerequisites: PH3452 (may be taken concurrently).

PH4455 Sound Propagation in the Ocean (4-0) Spring

An advanced treatment of the subject. Topics include: reflection of spherical waves from ocean boundaries; normal mode propagation of sound; inhomogeneous wave equation and the point source in cylindrical coordinates; shallow water channel with fluid and solid bottoms; the deep sound channel and the WKB approximation; range-dependent channels; adiabatic normal modes and the parabolic equation; multi-path propagation; application to matched field processing and source localization. Prerequisites: PH3452 or consent of instructor.

PH4459 Nonlinear Oscillations and Waves (4-0) As Required

This is a self-contained course that emphasizes theory, classroom demonstrations, physical intuition, and applications of nonlinear oscillations and nonlinear waves. Subjects include the following: (i) Nonlinear oscillations: free motion, driven motion (direct, parametric, and maintained drives), quasiperiodicity, and chaos. (ii) Nonlinear dispersive waves (e.g. flexural waves on bars and plates, optical waves in fibers, and surface waves on water): self-interaction, wave-wave scattering, wave turbulence, and solitons. (iii) Nonlinear dispersionless waves, with concentration on acoustics: distortion, shock waves, parametric arrays, radiation pressure, levitation, jetting and streaming, acoustic cavitation, and sonoluminescence. Prerequisites: PH1121 and differential equations.

PH4656 Quantum Mechanics (4-1) Spring/ Fall

Free particles and wave packets, the uncertainty principle, Schrodinger equation, eigenstates and eigen functions, stationary and scattering states, identical particles and the exclusion principle, atomic energy levels, quantum theory of angular momentum, hydrogen atom, coupling of angular momentum with spin, the periodic table, nuclear structure and radioactivity; fission and fusion, time independent perturbation theory, time dependent perturbation theory; selection rules for dipole radiation, magnetic effects (MRI, GMR etc.), quantum computing. Prerequisites: PH2652, PH3152, PH3991.

PH4661 Plasma Physics I (4-0) As Required

Introduction to plasma physics; single particle dynamics (orbit theory), MHD fluid theory, electromagnetic waves, instability, diffusion, and breakdown in gases. Prerequisites: PH3352 or equivalent.

PH4662 Plasma Physics II (3-0) As Required

A continuation of Plasma Physics I. Applications of the hydromagnetic equations to the study of macroscopic motions of plasma; classification of plasma instabilities; kinetic theory, the Boltzmann equation and the macroscopic-momentum transport equation; plasma oscillations and Landau damping; nonlinear effects, shock waves, radiations from plasma, sheath theory. Prerequisites: PH4661 or consent of instructor.

PH4670 Quantum Computing (4-0) Spring

This interdisciplinary survey course explores the evolution and direction of quantum computing technology. Topics include quantum circuits, quantum algorithms (including factoring and search), and quantum key distribution. Jointly listed as CS4670. Prerequisites: familiarity with basic notions of computing, quantum theory, and linear algebra, consistent with the material covered in CS3000, PH2652, MA3042 or PH3991.

PH4760 Solid State Physics (4-0) As Required

Fundamental theory dealing with solids: crystals, binding energy, lattice vibration, dislocations and mechanical properties, free electron theory, band theory, properties of semi-conductors and insulators, magnetism. Prerequisites: PH3655, PH3782.

PH4771 Advanced Statistical Physics (4-0) As Required

Review of thermodynamics. Phase transitions and critical exponents. Ginzburg-Landau theory. Stochastic dynamics and Brownian motion: master equation, Langevin equation, and Fokker-Planck equation. Phase space motion, Liouville theorem. BBGKY hierarchy. Boltzmann equation, H theorem, and entropy. Kinetic theory. Review of equilibrium statistical mechanics and ensemble theory. Information theory. Bose-Einstein condensation, photon gas. Degenerate Fermions: heavily doped semiconductors, degeneracy pressure. Paramagnetism, Curie theory. Ising model of magnetism. Glauber model of time-dependent Ising spins. Widom, Kadanoff scaling theories. Renormalization theory. Onsager relations, linear response theory, fluctuation-dissipation theorem. Prerequisites: PH3782.

PH4857 Terminal Ballistics and Shock Physics (4-0) Summer

This course explores the key physics underlying the lethality of conventional weapons. Particular focus is given to two broad areas: armor penetration and damage from shock and blast waves. Detailed topics covered in the course include: an overview of modern warheads; basic mechanics of materials; high strain-rate deformation of materials under intense loading; terminal ballistics of projectiles, ranging from small-caliber rounds up to shaped charge jets; shock waves in solids and spall phenomena; blast waves from explosive charges and nuclear weapons; and underwater weapons effects. Prerequisites: PC3172, PH3352, PH2151.

PH4858 Electric Ship Weapon Systems (4-1) Fall

This course teaches the physics and engineering concepts underlying two specific weapon systems currently in development for future US Navy electric ships: directed energy free electron/solid state lasers and the electromagnetic railgun. The directed energy topics include current program reviews, laser target damage, laser beam propagation through the atmosphere, thermal blooming, and the physics of free electron and solid state lasers. For the railgun, topics include electromagnetic gun theory and critical design issues including power conditioning, barrel design, barrel life, projectile design, and system cooling. Prerequisites: PH3352.

PH4859 Technical Aspects of Weapon Proliferation, Control and Disposal (3-0) As Required

This course address technical issues of detection of nuclear weapon materials, covert explosions, disposition of weapon grade material and nuclear reactor fuel, control and disposition of chemical and biological weapons, policy issues of arms proliferation and arms control. Prerequisites: Consent of instructor.

PH4860 Nuclear Warfare Analysis (4-0) As Required

This final course in the nuclear weapons effects graduate specialization sequence deals with technical aspects of strategic and tactical nuclear war. Effects which nuclear weapons explosion environments have on various defense platforms and systems are considered, together with methods of hardening to reduce system vulnerability in each of the effected areas: blast and shock, thermal radiation, transient effects on electronics. EMP, biological effects from contamination, atmospheric and ionospheric effects on communication, detection and surveillance systems. Prerequisites: PH4171 Classification: SECRET.

PH4911 Simulation of Physical and Weapon Systems (3-2) Winter

The role of computation physics in modern weapons development and combat simulations is studied. The programming language is C within the UNIX, Apple, or Windows operating systems. Applications emphasize physical principles of weapons development, systems engineering, and the use of graphics. Subject matter includes random number distributions, projectile and fragment dispersion, missile defense, free electron laser simulation, laser beam propagation in a turbulent atmosphere, thermal blooming, diffraction and numerical integration methods. Optional topics include molecular dynamics in solids, liquids, and gases, wave propagation in various media, chaos, and quantum mechanical wave functions. Prerequisites: PO2911.

PH4943 Relativistic Quantum Mechanics (3-0) As Required

The goal of this course is to expose the NPS student to the basic concepts in one of physics' most successful and fundamental formalisms - quantum electrodynamics (QED). The basic topics reviewed are quantum mechanics, electromagnetism, and special relativity. Then, these fundamental theories are extended and combined into QED. Throughout the course the relativistic free electron laser is used as an application of the basic theories encountered. Prerequisites: PH4656, PH2652 (PH4984 recommended).

PH4984 Advanced Quantum Physics (4-0) As Required

Quantum mechanics in the Dirac format. Angular momentum, spin, and spin resonance. Additional topics may include group theoretical applications to selection rules and crystal fields, variational principles, self-consistent fields in the many-electron atom, scattering theory, and polyatomic molecules. Prerequisites: PH3152 and PH4656.

PH4991 Relativity and Cosmology (4-0) As Required

This course is a graduate level introduction to the current thought on the origin of space, time and matter. Topics covered are: The discovery of the cosmic evolution, Description of space in Newtonian and Einsteinian terminology, Kinematics and Dynamics of the Einstein cosmological models, the thermal history of the universe, the very early universe, the problems of a possible quantum origin of the universe and the possible future of the universe. Prerequisites: PH2652, PH3152, PH3360, PH3991.

PH4992/4998 Special Topics in Advanced Physics (Variable Hours 1-0 To 4-0) (V-0) As Required

Study in one of the fields of advanced physics and related applied areas selected to meet special needs or interests of students. The course may be conducted as a seminar or supervised reading. The course carries a letter grade and may be repeated in different topics. Prerequisites: A 3000 level course appropriate to the subject to be studied, and consent of the Department Chairman. It may also be taken on a Pass/Fail basis if the student has requested so at the time of enrollment.

PH5810 Dissertation Research (0-8) As Required

Dissertation research for doctoral studies. Required in the quarter following advancement to candidacy and then continuously each quarter until dissertation is approved by the Academic Council.

Combat Systems Sciences and Engineering - Curriculum 533

Combat Systems Web Page:

http://www.nps.edu/Academics/Schools/GSEAS/Departments/Physics/CSSEC.html

Program Officer

Robert Kerchner, LCDR, USN
Spanagel Hall, Room 211

(831) 656-2950, DSN 756-2950

rwkerchn@nps.edu

Academic Associate

Richard Harkins, MS
Code Ph/Hr, Spanagel Hall, Room 142A

(831) 656-2828, DSN 756-2828
rharkins@nps.edu

Brief Overview

This program is designed to meet the needs of the military services for an officer having a broad-based advanced technical education applicable to combat systems design, development, test and evaluation, acquisition, operation, and support. The student does not necessarily earn a degree in Combat Systems. The majority of students earn a degree in Physics or Applied Physics. Degrees in Engineering Acoustics or Combat Systems Technology are also available on a space available basis. Included in the core of the program are courses on electromagnetic radiation, applied optics, optoelectronics, servo and computer control systems, explosives and warheads, fluid dynamics of weapons, combat simulation, underwater acoustics, semiconductor devices, detection and engagement elements, combat systems integration, and computing resources for advanced combat systems. The officer will also conduct thesis research on a military-relevant technical problem.

Requirements for Entry

A baccalaureate degree with mathematics through differential and integral calculus and a calculus-based basic physics sequence are required for direct input. Courses in the physical sciences and engineering are highly desirable. An APC of 323 is required.

Entry Date

Standard entry dates are January and July. Other entry dates are possible by special arrangement with the program officer. If further information is needed, contact the Academic Associate or Program Officer for this curriculum.

Degree

A student can earn one of the following degrees in the Combat Systems Sciences and Engineering (Curriculum 533): Master of Science in Physics, Applied Physics, Engineering Acoustics or Combat System Technology. Required classes vary by degree.

Subspecialty

The Combat Systems Sciences and Engineering Curriculum has options ranging from a four-quarter program for students ready to commence graduate-level courses, to an eight-quarter course of study for students who require a review of undergraduate coursework. Completion of the full eight-quarter curriculum qualifies an officer as a Combat Systems Sciences and Engineering Sub-specialist with a subspecialty code of 5701-5705P depending on specialization track. U.S. Navy students entering the Combat Systems Curriculum through the one-year Immediate Graduate Education Program receive a sub-specialty code of 5701-5704I. The curriculum sponsor is the Program Executive Officer, Integrated Weapons Systems (PEO-IWS).

Typical Subspecialty Jobs

AEGIS Tech Rep, Morristown, NJ
DOE National Nuclear Security Agency, Washington, DC
Defense Threat Reduction Agency, Los Alamos, NM
Missile Defense Agency, Washington, DC (laser program)
Naval Sea Systems Command, Washington, DC (Battle Force Engineer, Systems Engineering East Coast Battle Group, NATO Sea Sparrow Surface Missile Program)
Naval Surface Warfare Center White Sands, NM (Project Support Officer, Weapons Test Officer)
Naval Surface Warfare Center Dahlgren, VA (Strategic Fire Control)
Naval Surface Warfare Center Port Hueneme, CA (Aegis Ship Qualification Trials, Test and Evaluation Project Officer)
Program Executive Officer Carriers, Washington, DC (Deputy Program Manager Combat Systems)

Supervisor Shipbuilding, Jacksonville, FL (Ship Repair Officer)
Strategic Weapons Facility Atlantic, King's Bay, GA (Weapons Technology)
Strategic Systems Programs, Sunnyvale, CA (Arms Control Coordinator, Fire Control and Guidance Branch Head)
Program Executive Officer Strike, Washington, DC (Tech Director, Combat Systems, Air Dominance, Undersea Domain, Ship Design)
Space and Naval Warfare Systems Command, San Diego, CA (PD-18 Assistant Program Manager for Acoustic Sensor Systems)
United States Naval Academy (Physical Science Instructor)

Typical Course of Study - Applied Physics Option

Quarter 1

PH1994	(4-1)	Math for Scientists and Engineers I
PH1995	(4-1)	Math for Scientists and Engineers II
PH2151	(4-1)	Particle Mechanics
PH2001	(1-0)	Physics Thesis Opportunities

Quarter 2

PH2351	(4-2)	Electromagnetism
PH3996	(3-0)	Special Topics in Physics
PH3991	(4-0)	Theoretical Physics
PH0999	(0-1)	Physics Colloquium

Quarter 3

PH2652	(4-1)	Modern Physics
PH3152	(4-0)	Mechanics of Physical Systems
PH3782	(4-0)	Thermodynamics and Statistical Physics
PH0999	(0-1)	Physics Colloquium

Quarter 4

SE3000	(2-0)	Systems Engineering Colloquium
PH3655	(4-0)	Solid State Physics
PH3360	(4-1)	Electromagnetic Waves
PC3014	(3-4)	Intermediate Applied Physics Laboratory
PH0999	(0-1)	Physics Colloquium

Quarter 5

PC3172	(4-1)	Fluid Dynamics of Weapons Systems
Concentration Course		
PC4015	(4-3)	Advanced Applied Physics Laboratory
PH0999	(0-1)	Physics Colloquium

Quarter 6

PC4022	(4-0)	Combat Systems Capabilities
PC3400	(4-2)	Survey of Underwater Acoustics
PC4860	(4-0)	Advanced Weapon Concepts
Concentration Course		
PH0999	(0-1)	Physics Colloquium

Quarter 7

Concentration Course		
PH4656	(4-0)	Quantum Mechanics

PH0810   (0-8)   Thesis Research
PH0999   (0-1)   Physics Colloquium

Quarter 8
PC3200   (4-1)   Physics of EM Sensors and Devices
PC3800   (4-0)   Survey of the Effects of Weapons
PH0810   (0-8)   Thesis Research
PH0810   (0-8)   Thesis Research
PH4001   (1-0)   Physics Thesis Presentation

Joint Professional Military Education (JPME):

All Unrestricted Line Naval Officers are required to take the following four courses for JPME; these courses are normally added to the matrix in the first 4 quarters:

NW3230 (4-2) Strategy and War

NW3275 (4-0) Joint Maritime Operations Part 1

NW3276 (2-2) Joint Maritime Operations Part 2

NW3285 (4-0) Threat Security Decision Making

Engineering Duty Officers will take only NW3230. Students from other services are not required to take JPME courses.

Concentration Areas:
NOTE: Final approval of an individual student's degree rests with the Chairman of the cognizant department.

MS Applied Physics:

Electromagnetic Sensor Systems (PH3292 is required, then select 3 of the other 5 to fulfill the requirement):
PH3280   (4-1)   Introduction to MEMS
PH3292   (4-2)   Applied Optics
PH4271   (4-1)   Lasers, Optoelectronics, and Electro-Optics I
PH4272   (4-1)   Lasers, Optoelectronics, and Electro-Optics II
PH4273   (4-2)   Physics of Advanced Imaging Systems

Weapons and Effects (Select 4 out of these 5 courses to fulfill the requirement):
PH4055   (4-0)   Free Electron Lasers
PH4171   (4-1)   Physics of Explosives
PH4857   (4-1)   Physics of Directed Energy and Conventional Weapons
PH4858   (4-0)   Weapons Lethality and Survivability
PH4911   (3-2)   Simulation of Physical and Weapon Systems

Acoustics Track (PH3119 is required, then select 4 of the other 5 to fulfill the requirement):
PH3119   (4-2)   Oscillations and Waves
PH3451   (4-2)   Fundamental Acoustics
PH3452   (4-2)   Underwater Acoustics
PH4454   (4-2)   Sonar Transducer Theory and Design
PH4455   (4-0)   Sound Propagation in the Ocean
PH4459   (4-0)   Nonlinear Oscillations and Waves

Total Ship Systems Engineering:
TS3000   (3-2)   Electrical Power Engineering
TS3001   (3-2)   Fundamental Principles of Naval Architecture
TS3002   (3-2)   Principles of Ship Design and Case Studies
TS3003   (3-2)   Naval Combat System Elements
TS4000   (3-2)   Naval Combat System Engineering
TS4001   (3-2)   Integration of Naval Engineering Systems
TS4002   (2-4)   Ship Design Integration
TS4003   (2-4)   Total Ship System Engineering

MS Physics Track (Select all of these to fulfill the requirement):
PH3152   (4-0)   Analytical Mechanics
PH3360   (4-0)   Electromagnetic Waves
PH3782   (4-0)   Thermodynamics and Statistical Physics
PH3991   (4-1)   Theoretical Physics
PH4353   (4-0)   Topics in Advanced Electricity and Magnetism
PH4656   (4-0)   Quantum Mechanics
A two course Physics sequence.

MS Engineering Acoustics Track:
PH3119   (4-2)   Oscillations and Waves
PH3451   (4-2)   Fundamental Acoustics
PH3452   (4-2)   Underwater Acoustics
PH4454   (4-2)   Sonar Transducer Theory and Design
PH4455   (4-0)   Sound Propagation in the Ocean
EO3402   (3-1)   Signals and Noise
EC4450   (4-1)   Sonar Systems Engineering

Typical Course of Study - 4-Quarter Applied Physics Degree

Quarter 1
PH3119   (4-2)   Waves and Oscillations
PC3172   (4-1)   Physics of Weapon Systems: Fluid Dynamics of Weapons, Shock Waves, Explosions
4000 level elective
PH0810   (0-8)   Thesis

Quarter 2
PH3991   (4-0)   Theoretical Physics
PH3451   (4-2)   Fundamental Acoustics
PH3655   (4-0)   Solid State Physics
PH3352   (4-0)   Electromagnetic Waves

Quarter 3
PH3452   (4-2)   Underwater Acoustics
PH4454   (4-2)   Sonar Transducer Theory and Design
PH4656   (4-1)   Quantum Mechanics
PH0810   (0-8)   Thesis

Quarter 4

PH4455   (4-0)   Sound Propagation in the Ocean
4000 level elective
PH0810   (0-8)   Thesis
PH0810   (0-8)   Thesis

Educational Skill Requirements (ESR)
Combat Systems Sciences and Engineering -
Curriculum 533
Subspecialty Code 57xxP

1. MATHEMATICS, SCIENCE, AND ENGINEERING FUNDAMENTALS: A solid foundation in mathematics, physics, and engineering underpinning combat-systems technology to support the theoretical and experimental aspects of the technical courses in the curriculum.

2. ACOUSTIC AND ELECTROMAGNETIC SYSTEMS: A graduate level understanding of acoustic and electromagnetic propagation; physics of solid state, and electro-optic devices; including the principles of radar and sonar systems; and signal analysis, processing, and decision theory.

3. COMMUNICATION SYSTEMS: A graduate level understanding of various communication systems including fiber optics and automatic control systems.

4. WEAPONS SYSTEMS AND APPLIED FLUID MECHANICS: A graduate-level understanding of the fluid dynamics of subsonic and supersonic weapons, warheads and their effects.

5. COMBAT SYSTEMS ANALYSIS, SIMULATION, AND TESTING: Sufficient foundation in Systems Analysis and Simulation to understand the limits of each, and their effect on required combat systems testing.

6. COMBAT SYSTEMS ENGINEERING: An understanding of the principles of design, development, testing and evaluation; and the importance of performance and economic trade-offs in combat systems. The fundamentals, and requirements for Verification, Validation, and Assessment (VV&A) Processes including open architecture designs and their implications on integration of computing resources in advanced combat systems.

7. MATERIALS SCIENCE: A familiarity with the concepts of materials science sufficient for an understanding of the mechanical, electrical, and thermal properties of materials important in present and future combat systems.

8. STRATEGY AND POLICY: Officers develop a graduate-level ability to think strategically, critically analyze past military campaigns, and apply historical lessons for future joint and combined operations, in order to discern the relationship between a nation's policies and goals and the ways military power may be used to achieve them. Fulfilled by completing the first of the Naval War College course series (Strategy and Policy) leading to Service Intermediate level Professional Military Education (PME) and Phase I Joint PME credit.

9. THESIS: The graduate will demonstrate the ability to conduct independent research in combat systems sciences and engineering, and proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing.

10. TECHNICAL SPECIALIZATION: Each officer will also acquire technical competence in one or more of the following concentrations as it pertains to Combat Systems: Electromagnetic Systems, Weapons & Effects, Physics, Underwater Acoustic Systems, or a specific engineering discipline.

The knowledge required for each of the approved Technical Specialization concentrations is as follows:

A. ELECTROMAGNETIC SYSTEMS (5701)
   1. Propagation and scattering of optical, IR, and microwave radiation in the turbulent atmosphere as they influence target detection.
   2. Advanced sensor and detection techniques for military applications.
   3. Advanced concepts of target surveillance, acquisition, and engagement.

B. WEAPONS & EFFECTS (5702)
   1. Molecular energetics and detonation physics.
   2. Impact phenomena. Fragmentation and rod-like projectile penetration.
   3. Warhead design and lethality considerations; target vulnerability and survivability consideration; kill probability.
   4. Principles of directed energy weapons systems and their effects.
   5. Electric ship weapon systems.

C. PHYSICS (5703)
   1. Statistical physics.
   2. Advanced E&M radiation.
   3. Advanced Quantum Mechanics.

D. UNDERWATER ACOUSTIC SYSTEMS (5704)
   1. Wave propagation in the ocean; scattering, fluctuations and boundary interactions as they effect detection, localization, and prosecution of underwater targets; underwater transducer design and array theory.

2. Active and passive acoustic signal processing for detection of submarines, mines, and other underwater weapons; adaptive techniques.
3. Acoustic influences of oceanographic phenomena, which effect target detection including boundary characteristics, ambient noise, sound speed profiles, fronts, and eddies.

E. TOTAL SHIP SYSTEMS ENGINEERING (5705)
1. Power systems.
2. Naval architecture and ship design.
3. Shipboard combat systems.
4. Integration issues.

Space Systems Academic Group

Chair

Rudy Panholzer, Ph.D.
Code SP, Bullard Hall, Room 205

(831) 656-2154, DSN 756-2154, FAX (831) 656-2816
rpanholzer@nps.edu

Brij Agrawal*, Distinguished Professor, Ph.D., Syracuse, 1970.

Kyle Alfriend*, Visiting Professor, Ph.D., Virginia Tech, 1967.

Karen Anderson*, Program Manager, Remote Sensing Center, B.A. University of California Santa Barbara, 1985.

Thomas Betterton, RADM, USN (Ret.), Professor, Chair Naval Space Technology, EAA-Massachusetts Institute of Technology, 1966.

Dan Boger*, Professor, Chairman of IS department, Ph.D., University of California Berkeley, 1979.

Alex Bordetsky*, Associate Professor, Ph.D., Chelyabinsk St Tec University, 1982.

Christopher Brophy*, Associate Professor, Ph.D., University of Alabama(Huntsville), 1997.

Daniel Bursch, CAPT, USN (Ret.), Astronaut, NRO Chair; M.S, Naval Postgraduate School, 1991.

Bill Colson*, Distinguished Professor, Ph.D., Stanford University, 1977 .

Phil Durkee*, Dean of GSEAS, Ph.D., Colorado State University, 1984.

Stephen Frick, CAPT, USN (Ret.), Astronaut, NASA Chair, M.S., Naval Postgraduate School, 1994.

Douglas Fouts*, Professor, Ph.D., University of California Santa Barbara, 1990.

James A. Horning, Research Associate, M.S., Naval Postgraduate School, 1997.

Mathias Kolsch, Associate Professor, Ph.D., University of California Santa Barbara, 2004.

Herschel H. Loomis, Jr.*, Professor, Ph.D., Massachusetts Institute of Technology, 1963.

Scott Matey, LTC, USA, Military Instructor, M.S., Naval Postgraduate School, 2001.

Sherif Michael*, Associate Professor, Ph.D., West Virginia University, 1983.

Clay Moltz, Associate Professor, Ph.D., University of California Berkley, 1989.

James H. Newman, Professor, Astronaut Ph.D., Rice University, 1984.

Richard C. Olsen*, Professor, Ph.D., University of California, San Diego, 1980.

Rudy Panholzer, Professor, Ph.D., Technical University Graz, Austria, 1961, EE., Stanford University, 1957.

Jason Pratt, CDR, USN, Program Officer, M.S., Georgia Institute of Technology, 1995.

Charles M. Racoosin, CDR, USN (Ret.), Naval Space Systems, Lecturer; M.S., Naval Postgraduate School, 1989.

Jennifer Rhatigan, Associate Professor, Ph.D., Case Western Reserve University, 2001.

Mark Rhoades, CDR, USN (Ret.), Senior Lecturer, M.S., Naval Postgraduate School, 1990.

Marcello Romano, Associate Professor, Ph.D., Politecnico di Milano, Italy, 2001.

Alan Ross, Professor of Practice, Ph.D., University of California, Davis, 1978.

Michael Ross*, Professor, Ph.D., Penn State University, 1991.

Dan Sakoda, Research Associate, M.S., Naval Postgraduate School, 1992.

Timothy Sands, Lt. Col., USAF, Assistant Professor, Ph.D., Naval Postgraduate School, 2004.

Alan Scott, CAPT, USN (Ret), Senior Lecturer; Aeronautical and Astronautical Engineer, Naval Postgraduate School, 1994.

David Trask, MASINT Chair Professor, M.B.A., Embry-Riddle University, 1991.

Stephen Tackett, LCDR USNR (Ret.), Lecturer, M.S., Naval Postgraduate School, 1995.

Todd Weatherford*, Associate Professor, Ph.D., North Carolina State University, 1993.

Joseph Welch*, CDR, USN (Ret.), Lecturer, M.S., Nova Southeastern University, 2001, M.S. Naval Postgraduate School, 1987.

(* indicates faculty member has a joint appointment to another department at NPS)

Brief Overview

The Space Systems Academic Group (SSAG) is an interdisciplinary association of faculty and academic chair professors representing eight separate academic disciplines. The SSAG has established four Chair professorships sponsored by the Aerospace Corporation/NRO, NASA, Navy PEO Space Systems, and the MASINT Chair Professor who supports the SSAG in areas of Measurement and Signature Intelligence (MASINT). The Space Systems Academic Group has responsibility for the academic content of the Space Systems Operations and Space Systems Engineering curricula. Instruction is carried out by faculty members attached to the group, as well as the following academic departments: Mechanical and Aerospace Engineering, Electrical and Computer Engineering, Mathematics, Operations Research, Physics, Information Operations, and Systems Management. The Space Systems Academic Group approves thesis topics for students in Space Systems Operations. For Space Systems Engineering, the group chairman approves the final thesis in addition to the academic department granting the degree.

Degree

Space Systems Operations

The Space Systems Operations students are awarded the Master of Science in Space Systems Operations degree. A minimum of 45 quarter-hours of graduate level work is required, of which at least 15 hours must be at the 4000 level. Graduate courses in at least four different academic disciplines must be included and in two disciplines, a course at the 4000 level must be included. There is also a requirement of three courses constituting advanced study in an area of specialization. Each student is required to write a thesis that is space oriented; a maximum of 13 hours earned for the thesis may be included in satisfaction of the 45 quarter-hour requirement. The Chairman of the Space Systems Academic Group must approve all study programs.

Space Systems Engineering

The Space Systems Engineering students earn a master's degree in one of the following academic areas: Astronautical Engineering, Computer Science, Electrical and Computer Engineering, or Physics. Refer to the degree requirements in the associated departments.

Group Facilities

- ARM (Articulated Robotics Manipulator) Laboratory
- Center for Radiation Hardened Electronics
- Cognitive Systems Laboratory
- CubeSat Development Lab
- DARK MIRROR (Spacecraft Engineering & Operations) Laboratory
- FLTSATCOM Satellite Operations Lab
- GNC (Guidance, Navigation and Control) Laboratory - Ross Magnetic Attitude Control Test Lab
- Nanosat Advanced Concepts Laboratory
- NPS-AFRL Optical-relay Spacecraft Lab
- NPS Vision Lab
- Photogrammetric System ID Laboratory
- Rocket Propulsion Lab
- Small Satellite Development and Test Lab
- Spacecraft Attitude Dynamics & Control Laboratory
- Spacecraft Robotics Laboratory
- Sensitive Compartmented Information Facility

Space Systems Course Descriptions

SS Courses

SS0810 Thesis Research (0-8) As Required
Every student conducting thesis research enrolls in this course.

SS3001 Military Applications of National Space Systems (3-2) Winter
Space Systems and technologies of interest to the military. Strategic and tactical imagery and SIGINT requirements. Tasking and use of national space systems and ground support elements. Vulnerability considerations and impact of current R&D programs. Prerequisites: SS3500, PH3052, EO3525 or EO3516. Classification: TOP SECRET clearance with access to SCI.

SS3011 Space Technology and Applications (3-0) As Required
SS3011 is an introduction to space mission analysis with an emphasis on those space missions supporting military operations. Topics include space history, doctrine and organizations, orbital mechanics, communication link analysis, the space environment, spacecraft technology and design, and military, civil and commercial space systems. Prerequisites: None.

SS3035 Microprocessors for Space Applications (3-2) Spring
An introduction to microprocessors at the hardware/software interface. Machine language programming, assembly language programming, I/O systems and interfacing, and operating systems. Prerequisites: EC2820.

SS3041 Space Systems and Operations II (4-2)Spring
SS3041 introduces space systems mission analysis and design. This course addresses the architecture design of complex space systems. Topics include: mission / capabilities / requirements analysis, architecture development and synthesis, and performance, cost and operational effectiveness evaluation. SS3041 is part of an

architecture design sequence culminating in a group architecture design project in SS4051s. Prerequisites: SS3011, SS3500, and PH3052 (concurrently). Classification: SECRET for resident and UNCLAS for DL.

SS3051 Space Systems and Operations II (4-0) As Required

This course covers joint space doctrine, space policy, and applications of selected military space systems. Topics include the space mission areas of space control and space force enhancement to include space-based navigation, environmental monitoring, and space surveillance systems, along with satellite command and control networks. Additional topics include space threats, tactics, ground application tools and the space annex for an operations plan. Prerequisites: SS3500 and SS3011. Classification: TOP SECRET clearance with access to SCI.

SS3400 Orbital Mechanics, Launch and Space Operations (4-2) Winter

This course provides an understanding of Orbital Mechanics and the associated implications to the use of space-based systems in support of military operations. Fundamental concepts such as conic sections, coordinate systems, coordinate transformations and time are covered, then applied to the understanding and application of Newton's laws, Kepler's laws, orbital elements, perturbations, and orbital maneuvering. Prerequisites: None.

SS3500 Orbital Mechanics and Launch Systems (4-2) Winter

Provides a fundamental understanding of Orbital Mechanics through study of conic sections, coordinate systems, coordinate transformations, and time. Calculation of orbital elements of the two-body problem is covered. Other Orbital Mechanics topics include: Newton's laws, Kepler's equation, orbital perturbations, and orbital maneuvering, including rendezvous and proximity operations. Launch systems topics include: the rocket equation, single and multi-stage rockets, launch windows, launch profiles, ascent and payload delivery performance, and mission design. Supporting lab work utilizes the Satellite Tool Kit (STK) as an orbit analysis tool. The use of Excel and / or MATLAB for solving problems is encouraged. Prerequisites: None.

SS3600 Space Systems Modeling and Simulation (2-3) Spring

SS3600 provides students with knowledge of modeling and simulation theory and the ability to apply space systems modeling and simulation tools to real world problems. Concepts covered include the development and applicability of models and simulations, with a focus on specific space applications. Students will apply these concepts through laboratory exercises and a project to simulate an end-to-end space architecture, evaluate system performance, and compare alternative solutions. Prerequisites: SS3500.

SS3613 Military Satellite Communications (3-0)Summer/Fall

SS3613 addresses military satellite communications mission analysis, systems design, and applications. This course covers requirements, tactical employment, system architectures, satellite design and performance, terminal design and performance, associated information systems, link budget calculations, telemetry and control and IO/IW implications. Prerequisites: SS3011, or consent of instructor. U.S. Citizen, Classification: FOUO.

SS3900 Special Topics in Space Systems (Variable Hours 1-0 to 5-0) (V-0) As Required

Directed study either experimental or theoretical in nature. Prerequisites: Consent of Chairman of Space Systems Academic Group and instructor. May be taken on Pass/Fail basis if the student has requested so at the time of enrollment. Prerequisites: None.

SS4000 Space Systems Seminars (0-1) Fall/Winter/Spring/Summer

Seminars consist of lectures to provide perspective on Space Systems And to expose the student to various space activities such as industry, NASA and DoD laboratories and commands. Prerequisites: None.

SS4051 Military Space Systems and Architectures (3-2) Fall

This course covers the system level architectural design of selected Space Systems. Emphasis is on a balanced design of all seven components of space systems: space segment, launch segment, ground segment, mission operations, C3 architecture, subject, and orbit and constellation. Prerequisites: SS3001 , SS3041, SS3500. Classification: TOP SECRET clearance with access to SCI for resident and SECRET for DL.

SS4801 Space Autonomy Laboratory (2-4) As Required

This course provides students a hands-on experience in current and advance space autonomy concepts. Students will be exposed to the command, control and operations of a satellite while understanding the engineering ramifications of various space sensors and actuators and the resulting telmetry. Each lab will involve students designing and implementing a space mission in the reconfigurable space autonomy testbed. Students will gain hands-on experience in understanding the role of autonomy for tactical and strategic needs. Each laboratory experiment exposes a student to the range of capabilities as well as the limits of autonomy. Prerequisite: SS3500.

SS4900 Advanced Study in Space Systems (Variable Hours 1-0 to 5-0) (V-0) As Required

Directed graduate study based on journal literature, experimental projects, or other sources. Prerequisites: Consent of Chairman of Space Systems Academic Group and instructor. May be taken on Pass/Fail basis if the student has requested so at the time of enrollment. Prerequisites: None.

Space Systems Certificate (SSC) - Curriculum 273

Program Officer
Jason W. Pratt, CDR
Code 71, Bullard Hall, Room 203

(831) 656-7517, DSN 756-7517
jwpratt@nps.edu

Academic Associate
Steve Tackett, Lecturer
Code SP/Ta, Root Hall, Room 276

(831) 656-2944, DSN 756-2944
shtacket@nps.edu

Brief Overview

The Space Systems Certificate program is comprised of four courses (SS3011, PH3052, SS3613, and PH2514 or SS3051 classified option). Upon successful completion of the course work, students will be awarded a certificate of accomplishment in keeping with standard practices of the Naval Postgraduate School as well as the 6206L subspecialty code. The Space Systems Certificate program supports Navy and DoD space educational needs and complements existing resident training by providing cross-disciplinary science and technical education. The Space Systems Certificate program is targeted primarily at enhancing the education and preparation for the USN Space Cadre personnel. The Navy's Space Cadre represents a distinct body of expertise horizontally integrated within the Navy active duty, reserves, both officer and enlisted, and civilian employee communities organized to operationalize space.

Two significant events specified the requirement to establish a distance learning program for National Security Space (NSS) personnel in space systems and space applications. First, the DoD-wide space educational requirement was identified by the Undersecretary of the Air Force, as the Executive Agent for Space, as required in the "Commission to Assess United States National Security Space Management and Organization" (2001). Second, the USN Space Cadre Human Capital Strategy was signed by Commander, Naval Network Warfare Command on 25 Jan 2005, stating that completion of NPS Space Systems Certificate satisfied approved entry level space education for Space Cadre personnel.

Based upon these events, the NPS Space Systems Certificate (SSC) was developed, comprised of the following four courses:
· SS3011 Space Technology and Applications
· PH3052 Physics of Space and Airborne Sensor Systems
· SS3613 Military Satellite Communications (MILSATCOM)
· PH2514 Introduction to the Space Environment or SS3051

The original course and academic content for the SSC was vetted and approved by USN space and space training leaders. The Space Systems Certificate is a completely Web-based, asynchronous education program that covers fundamental areas of twenty-first century space enhancement to military operations as validated by NETWARCOM (November 2004). The learning outcomes for the SSC Certificate program directly support the Educational Skill Requirements within the Space Systems Operation (subspecialty code 6206P) degree. Evaluation of the Space Systems Certificate occurs in conjunction with the biannual Space Systems curriculum review.

Requirements for Entry

A baccalaureate degree with above-average grades. Completion of college level Algebra 2 and college level Physics with a grade of 'C' or better is required.

Entry Dates

At the beginning of the following quarters for each academic year (Oct, Apr).

Program Length

Four Quarters

Graduate Certificate Requirements

Requirements for the certificate in Space Systems are met by successful completion of all four courses. Certificate credit is obtained by maintenance of a 3.0 grade point average on a 4.0 scale.

Required Courses: Curriculum 273

SS3011	(3-0)	Space Technology and Applications
SS3613	(3-0)	Military Satellite Communications (MILSATCOM)
PH3052	(4-0)	Physics of Space and Airborne Sensor Systems
PH2514 or	(4-0)	Introduction to the Space Environment (4-0) As Required
SS3501	(4-0)	Space Systems and Operations

Space Systems Operations (DL) - Curriculum 316

Program Officer
Jason Pratt, CDR
Code 71, Bullard Hall, Room 203

(831) 656-7517, DSN 756-7517
jwpratt@nps.edu

Academic Associate
Steve Tackett, Lecturer
Code SP/Ta, Root Hall, Room 276

(831) 656-2944, DSN 756-2944
shtacket@nps.edu

Brief Overview

The Space Systems Operations (Distance Learning) curriculum is designed to provide officers and U.S. government civilians with knowledge of military opportunities and applications in space. Students are provided instruction about the operation, tasking and employment of space surveillance, communications, navigation and atmospheric /oceanographic /environmental sensing systems as well as payload design and integration-specifically for the exploitation of Space and Information products. DoD organizations or sponsors

provide the students, and the Space Systems Academic Group coordinates the instruction, course materials, and experience, which are provided by faculty from various NPS departments. Courses are delivered at the students' local site using a combination of, web-conferencing tools, and web-enhanced on-line courses.

Requirements for Entry

This curriculum is open to officers of the U.S. Armed Forces and selected civilian employees of the U.S. Federal Government. Admission requires a baccalaureate degree with above-average grades, completion of mathematics through integral calculus, plus at least one course in calculus-based physics. An APC of 324 or GPA of 2.6 is required for entry. A security clearance is not required but highly recommended. In the event a student does not have access to SIPR, SS3051 may be substituted with IO3100.

Entry Date

The Space Systems Operations (Distance Learning) curriculum is an eight-quarter course of study with a single entry date in the Fall quarter. If further information is needed, contact the Academic Associate or Program Officer.

Program Length

Eight Quarters

Degree

The course of study yields the Master of Science in Space Systems Operations degree.

Subspecialty

Completion of this curriculum qualifies an officer as a Space Systems Operations Subspecialist with a subspecialty code of 6206G. The curriculum sponsor is OPNAV N2/N6, The subject Matter Expert is Naval Network Warfare Command (NETWARCOM).

Typical Course of Study - Space Systems Operations-Fall Entry

Quarter 1

| SS3011 | (3-0) | Space Technology and Applications |
| PH2514 | (4-0) | Introduction to the Space Environment |

Quarter 2

| SS3500 | (4-2) | Orbital Mechanics and Launch Systems |
| PH3052 | (4-0) | Physics of Space and Airborne Sensor Systems |

Quarter 3

| EO3516 | (4-2) | Intro to Communication System Engineering |
| AE4830 | (3-2) | Spacecraft Systems I |

Quarter 4

| EO4516 | (4-2) | Communication Systems Analysis |

| AE4831 | (3-2) | Spacecraft Systems II |

Quarter 5

| SS3041 | (4-2) | Space Systems & Operations I |
| SS3613 | (3-0) | Military Satellite Communications |

Quarter 6

SS0810	(0-8)	Thesis
SS3051	(4-0)	Space Systems and Operations II
or IO3100	(4-0)	Information Operations

Quarter 7

| SS0810 | (0-8) | Thesis |
| SS4051 | (3-2) | Military Space Systems and Architectures |

Quarter 8

| SS0810 | (0-8) | Thesis |

Educational Skill Requirements (ESR)
Space Systems Operations (DL) - Curriculum 316
Subspecialty Code: 6206G

Graduates of the Space Systems Operations Specialization of the Information Sciences, Systems, and Operations (ISSO) Curriculum shall be able to determine space systems requirements which support the following operational concepts: control of space, global engagement, full force integration, and global partnerships. The graduates shall be able to analyze courses of action for the best employment of available space assets for ongoing and future military operations, and communicate this assessment to shore and afloat staffs and commanders.

Supporting these goals are the following specific requirements:

1. **Orbital Mechanics and Space Environment:**
   a. Graduates will examine the basic physics of orbital motion, and calculate and distinguish the parameters used in the description of orbits and their ground tracks.
   b. Graduates will examine the design of orbits and constellations, and analyze how they are achieved, maintained, and controlled; to include spacecraft maneuver and orbit transfer calculations.
   c. Graduates will examine the fundamentals of spacecraft tracking and command/control from a ground station.
   d. Graduates will analyze the relationship between various orbital characteristics and the satisfaction of mission requirements, including the advantages and disadvantages of various orbits.
   e. Graduates examine the space environment impacts on spacecraft parts, materials, and operations to spacecraft and mission design.

2. **Spacecraft Design:**
   a. Graduates will examine the basic system design of a spacecraft including its various subsystems: propulsion; structure; thermal; attitude determination and control; electrical power; and telemetry, tracking and commanding.
   b. Graduates will assess key interactions between the various subsystems and their effects on system performance.
3. **National Security Systems:**
   a. Graduates will examine the nature of space warfare (theory, history, doctrine, and policy); distinguish between the four JP 3-14 defined Space Mission Areas (Space Control, Space Support, Force Enhancement, Force Application); and interpret how current and planned space capabilities contribute to the satisfaction of these mission areas.
   b. Graduates will examine the roles, responsibilities, and relationships of National and DoD organizations in establishing policies, priorities, and requirements for National Security Space systems; and in the design, acquisition, operation, and exploitation of these systems.
   c. Graduates will examine the role of the Services / Agencies in establishing required space system capabilities, and will translate these capabilities into system performance requirements.
   d. Graduates will examine: current and planned Intelligence, Surveillance, and Reconnaissance (ISR) capabilities; how space systems contribute to these capabilities; the intelligence collection and analysis process; and how war-fighters access information from these sources.
4. **Project Management and System Acquisition:**
   a. Graduates will examine project management and DoD system acquisition methods and procedures to include contract management, financial management and control, and the Planning, Programming, Budgeting and Execution system (PPBE).
   b. Graduates will examine system acquisition organizational responsibilities and relationships (e.g., Congress, DoD, Services, Resource Sponsor, Systems Commands, Operating Forces) as they pertain to the acquisition of systems for DoD, Naval, and civilian agency users.
   c. Graduates will examine the unique nature of space acquisition programs using the Space Systems Acquisition Policy process. Based on this knowledge, they will plan and structure a notional space system acquisition program.

   d. Graduates will examine how proposed space-related capabilities and DOTMLPF requirements are translated from concept to real-world implementation.
   e. Graduates will apply the tools of project management (e.g., scheduling, costing, budgeting, planning, resource negotiation, risk management) to a space project.
   f. Graduates will prepare for and conduct program reviews, from systems requirements through critical design, during spacecraft and architecture design projects.
5. **Communications:**
   a. Graduates will examine the basic principles of communications systems engineering to include both the space and ground segments.
   b. Graduates will examine digital and analog communications architecture design, including such topics as frequency reuse, multiple access, link design, repeater architecture, source encoding, waveforms/modulations, and propagation media.
   c. Graduates will calculate and analyze link budgets to assess communication system suitability to support mission requirements, and to translate mission requirements into communications system design characteristics.
   d. Graduates will differentiate, compare, and contrast the characteristics and capabilities of current and future communications systems in use or planned by Naval operating and Joint forces afloat and ashore.
   e. Graduates will recognize the national and international issues involving use of the frequency spectrum.
   f. Graduates will discuss the nature of the rapid evolution in commercial satellite communications systems, and recognize the impact of such advancements on military operations and systems development.
6. **Remote Sensing:**
   a. Graduates will examine principles of active and passive sensors in current or planned use.
   b. Graduates will examine the effects of the space, atmospheric, and terrestrial environments (including countermeasures) on sensor performance.
   c. Graduates will examine tradeoffs among various sensors and platforms, evaluating how each satisfies mission requirements such as access area, resolution, timeliness, and capacity.

7. **Analysis, Synthesis, and Evaluation:**
   a. Graduates will derive, assess, and articulate capabilities necessary for the use of National Security Space systems in support of military operations.
   b. Graduates will examine various engineering and mathematical definitions of cost functions (revisit time, dwell time, local coverage, etc.)
   c. Graduates will use business case (economic) and performance data to analyze trade-offs between commercial and DoD systems to provide desired operational capabilities.

8. **Architecting Joint Military Space Missions:**
   a. Graduates will examine and relate the principles of architecting a complex, Joint National Security Space mission, and the life cycle process by which a space system is conceived, structured, designed, built, tested, certified and operated in a way that ensures its integrity and performance.
   b. Graduates will develop and assess system requirements; compose alternate architectures to satisfy those requirements; and evaluate and select the most effective alternative.
   c. Graduates will develop system design criteria from stated performance requirements, and conduct trade-offs between payloads and other spacecraft subsystems.
   d. Graduates will examine the design of current and planned space-based mission payloads (e.g., ISR, Communications, PNT, SIGINT).
   e. Graduates will examine the basic principles and operational issues of space access to include launch vehicle performance, launch windows, and their impact on military operations.
   f. Graduates will examine the basic elements of mission operations – spacecraft commanding, payload management, anomaly resolution, orbital maneuver planning – and will apply these concepts during satellite and architecture design projects.
   g. Graduates will understand the role of space in the development of an OPLAN. Graduates will have the ability to assess a concept of operations that includes all four mission areas identified in JP 3-14. Graduates will demonstrate the ability to develop an acceptable command and control structure for space operations and the space annex of an OPLAN.

9. **Advanced Concepts and Technologies in Space Systems:**
   a. Graduates will examine how current and future space systems contribute to National Security and will examine means to employ space-based capabilities to support information dominance.
   b. Graduates will examine potential future military space requirements stemming from desired information superiority capabilities.
   c. Graduates will examine future concepts of operation published by various DoD and international organizations (ESA, ISA, WSO, etc.) based on emerging technologies and appraise their impact on military space.
   d. Graduates will examine the advanced concepts and technologies which could be used in future military space systems.

10. **Conduct and Report Research:**
    a. Graduates will conduct independent or group research on a space systems problem, including resolution of the problem and presentation of the results and analysis in both written and oral form.

ESR Approval Authority
Deputy Chief of Naval Operations for Information Dominance (OPNAV N2/N6) April 2012

Space Systems Operations (International) - Curriculum 364

Program Officer
Jason W. Pratt, CDR
Code 71, Bullard Hall, Room 203

(831) 656-7517, DSN 756-7517
jwpratt@nps.edu

Academic Associate

Steve Tackett, Instructor
Code SP/Ta, Watkins Hall, Room 138A

(831) 656-2944, DSN 756-2944
shtacket@nps.edu

Brief Overview

The Space Systems Operations (International) curriculum is designed to provide international officers with knowledge of military opportunities and applications in space. It is also available to US citizens who may not have a security clearance. Students are provided instruction about the operation, tasking, and employment of space surveillance, communications, navigation, and atmospheric/oceanographic/environmental sensing systems as well as payload design and integration — specifically for the exploitation of Space and Information products. For a complete description, see the Space Systems Operations (366) section of the catalog.

Requirements for Entry

This curriculum is open to International Officers. Admission requires a baccalaureate degree with above-average grades, completion of mathematics through differential equations and integral calculus, plus at least one course in calculus-based physics. An APC of 324 is required for direct entry. Students lacking this background may matriculate through the one-quarter Engineering Science program (Curriculum 460).

Entry Date

The Space Systems Operations curriculum is a six-quarter course of study with a single entry date in the Fall Quarter. A summer academic refresher quarter is available as needed. If further information is needed, contact the Academic Associate or Program Officer.

Program Length

Six Quarters

Degree

Space Systems Operations (International) students are awarded the Master of Science in Space Systems Operations degree as specified previously in the Space Systems Academic Group section of the Catalog.

Typical Course of Study - Space Systems Operations (International)

Quarter 1

IT1500	(4-0)	Informational Program Seminar for International Officers
PH2514	(4-0)	Space Environment
PH3052	(4-0)	Physics of Space and Airborne Sensor Systems
SS3011	(3-0)	Space Technology and Applications
SS4000	(0-1)	Seminar

Quarter 2

EO3516	(4-2)	Intro to Communication Systems Engineering
SS3500	(4-2)	Orbital Mechanics and Launch Systems
AE4830	(3-2)	Spacecraft Systems I
NS4677	(4-0)	Space and International Security
SS4000	(0-1)	Seminar

Quarter 3

EO4516	(4-2)	Communication Systems Analysis
IT1600	(3-0)	Communication Skills for International Officers
AE4831	(3-2)	Spacecraft Systems II
SS3600	(3-2)	Space Systems Modeling and Simulation
SS4000	(0-1)	Seminar

Quarter 4

IS3502	(4-2)	Network Operations I

IT1700	(3-0)	Academic Writing for International Officers
Elective	(3-0)	Elective
SS0810	(0-8)	Thesis Research
SS4000	(0-1)	Seminar

Quarter 5

SE3100	(3-2)	Fundamentals of Systems Engineering
SS0810	(0-8)	Thesis
GB3031	(3-0)	Principles of Acquisition Management
Elective	(3-0)	Elective
SS4000	(0-1)	Seminar

Quarter 6

EC4590	(3-0)	Communications Satellite Systems Engineering
SS0810	(0-8)	Thesis Research
SS0810	(0-8)	Thesis Research
Elective	(3-0)	Elective
SS4000	(0-1)	Seminar

Space Systems Operations - Curriculum 366

Program Officer

Jason W. Pratt, CDR
Code 71, Bullard Hall, Room 203

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Academic Associate

Steve Tackett, Instructor
Code SP/Ta, Watkins Hall, Room 138A

(831) 656-2944, DSN 756-2944
shtacket@nps.edu

Brief Overview

The Space Systems Operations curriculum is designed to provide officers with knowledge of military opportunities and applications in space. Students are provided instruction about the operation, tasking and employment of space surveillance, communications, navigation and atmospheric, oceanographic, and environmental sensing systems as well as payload design and integration—specifically for the exploitation of Space and Information products.

The Space Systems Operations curriculum is one of the Information Superiority (IS) curricula, which encompasses several degree tracks: Computer Sciences, Joint C4I Systems, Information Systems and Technology, Information Warfare, Intelligence Information Management, Modeling, Virtual Environments and Simulation, and Space Systems Operations. The Professional Practice Core of the Information Superiority

(IS) curricula consists of material in Information Sciences and Technology, Command and Control, C4ISR Systems, Acquisition, C4ISR System Evaluation, Information Operations/Warfare, and Enterprise Policy, Strategy and Change. This specialization satisfies the Information Superiority education skill requirements as established by CNO-N6.

Requirements for Entry

This curriculum is open to officers of the U.S. Armed Forces and selected civilian employees of the U.S. Federal Government. Admission requires a baccalaureate degree with above-average grades, completion of mathematics through differential equations and integral calculus, plus at least one course in calculus-based physics. An APC of 324 is required for direct entry. Students lacking this background may matriculate through the one-quarter Engineering Science program (Curriculum 460). A TOP SECRET security clearance is required with SPECIAL INTELLIGENCE (SI) clearance obtainable for all students.

Entry Date

The Space Systems Operations curriculum is an six-quarter course of study with a single entry date in the Fall Quarter. A summer academic refresher quarter is available as needed. If further information is needed, contact the Academic Associate or Program Officer.

Program Length

Six Quarters

Degree

Requirements for the Master of Science in Space Systems Operations degree are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

Subspecialty

Completion of this curriculum qualifies an officer as a Space Systems Operations Subspecialist with a subspecialty code of 6206P. The curriculum sponsor is OPNAV N2/N6. The designated Subject Matter Expert is the Naval Networks Warfare Command (NETWARCOM).

Typical Subspecialty Jobs

Project Officer: OPNAV (N2/N6) TENCAP, Arlington, VA

Project Officer: SPAWAR Space Field Activity (SSFA)/NRO, Chantilly, VA

Space Advisor: NAVNETWARCOM, Norfolk, VA

Detachment OIC: Naval Space Operations Command (NAVSOC), Colorado Springs, CO

Staff Officer, Space and Global Strike: USSTRATCOM, Omaha, NE

Typical Course of Study - Space Systems Operations-Fall Entry

Quarter 1
PH2514	(4-0)	Space Environment
PH3052	(4-0)	Physics of Space and Airborne Sensor Systems
SS3011	(3-0)	Space Technology and Applications
NW3230	(4-2)	Strategy and Policy (All DoN) (JPME)
SS4000	(0-1)	Seminar

Quarter 2
NW3285	(4-0)	National Security Decision Making (JPME)
EO3516	(4-2)	Intro to Communication Systems Engineering
AE4830	(3-2)	Spacecraft Systems I
SS3500	(4-2)	Orbital Mechanics and Launch Systems
SS4000	(0-1)	Seminar

Quarter 3
SS3041	(4-2)	Space Systems &Operations I (SECRET)
EO4516	(4-2)	Communications Systems Analysis
AE4831	(3-2)	Spacecraft Systems II
Elective	(3-0)	Elective
SS4000	(0-1)	Seminar

Quarter 4
SS3051	(4-0)	Space Systems & Operations II (TS/SCI)
SS3001	(3-2)	Military Applications of National Space Systems (TS/SCI)
SS3613	(3-0)	MILSATCOM System & Applications (FOUO)
SS0810	(0-8)	Thesis Research
SS4000	(0-1)	Seminar

Quarter 5
SS4051	(3-2)	Military Space Systems and Architectures (TS/SCI)
SS0810	(0-8)	Thesis Research
Elective	(3-0)	Elective
NW3275	(4-0)	Joint Maritime Operations Part I (JPME)
SS4000	(0-1)	Seminar

Quarter 6
Elective	(3-0)	Elective
SS0810	(0-8)	Thesis Research
SS0810	(0-8)	Thesis Research
NW3276	(2-2)	Joint Maritime Operations Part II
SS4000	(0-1)	Seminar

Educational Skill Requirements (ESR)
Information Sciences, Systems, and Operations -
Curriculum 366
Subspecialty Code: 6206P

Graduates of the Space Systems Operations Specialization of the Information Sciences, Systems, and Operations (ISSO) Curriculum shall be able to determine space systems requirements which support the following operational concepts: control of space, global engagement, full force integration, and global partnerships. The graduates shall be able to analyze courses of action for the best employment of available space assets for ongoing and future military operations, and communicate this assessment to shore and afloat staffs and commanders.

Supporting these goals are the following specific requirements:

1. **Orbital Mechanics, Space Environment, and Remote Sensing:**
   a. Graduates will examine the basic physics of orbital motion, and calculate and distinguish the parameters used in the description of orbits and their ground tracks.
   b. Graduates will examine the design of orbits and constellations, and analyze how they are achieved, maintained, and controlled; to include spacecraft maneuver and orbit transfer calculations.
   c. Graduates will examine the fundamentals of spacecraft tracking and command/control from a ground station.
   d. Graduates will analyze the relationship between various orbital characteristics and the satisfaction of mission requirements, including the advantages and disadvantages of various orbits.
   e. Graduates will apply this understanding of how the space environment impacts spacecraft parts, materials, and operations to spacecraft and mission design.

2. **Spacecraft Design:**
   a. Graduates will examine the basic system design of a spacecraft including its various subsystems: propulsion; structure; thermal; attitude determination and control; electrical power; and telemetry, tracking and commanding.
   b. Graduates will assess key interactions between the various subsystems and their effects on system performance.

3. **National Security Systems:**
   a. Graduates will examine the nature of space warfare (theory, history, doctrine, and policy); distinguish between the four JP 3-14 defined Space Mission Areas (Space Control, Space Support, Force Enhancement, Force Application); and interpret how current and planned space capabilities contribute to the satisfaction of these mission areas.
   b. Graduates will examine the roles, responsibilities, and relationships of National and DoD organizations in establishing policies, priorities, and requirements for National Security Space systems; and in the design, acquisition, operation, and exploitation of these systems.
   c. Graduates will examine the role of the Services / Agencies in establishing required space system capabilities, and will translate these capabilities into system performance requirements.
   d. Graduates will examine: current and planned Intelligence, Surveillance, and Reconnaissance (ISR) capabilities; how space systems contribute to these capabilities; the intelligence collection and analysis process; and how war-fighters access information from these sources.

4. **Project Management and System Acquisition:**
   a. Graduates will examine project management and DoD system acquisition methods and procedures to include contract management, financial management and control, and the Planning, Programming, Budgeting and Execution System (PPBE).
   b. Graduates will examine system acquisition organizational responsibilities and relationships (e.g., Congress, DoD, Services, Resource Sponsor, Systems Commands, Operating Forces) as they pertain to the acquisition of systems for DoD, Naval, and civilian agency users.
   c. Graduates will examine the unique nature of space acquisition programs using the Space Systems Acquisition Policy process. Based on this knowledge, they will plan and structure a notional space system acquisition program.
   d. Graduates will examine how proposed space-related capabilities and DOTMLPF requirements are translated from concept to real-world implementation.
   e. Graduates will apply the tools of project management (e.g., scheduling, costing, budgeting, planning, resource negotiation, risk management) to a space project.
   f. Graduates will prepare for and conduct program reviews, from systems requirements through critical design, during spacecraft and architecture design projects.

5. **Communications:**
   a. Graduates will examine the basic principles of networks and communications systems operations

and engineering to include both the space and ground segments.

b. Graduates will examine digital and analog communications architecture design, including such topics as frequency reuse, multiple access, link design, repeater architecture, source encoding, waveforms/modulations, and propagation media.

c. Graduates will calculate and analyze link budgets to assess communication system suitability to support mission requirements, and to translate mission requirements into communications system design characteristics.

d. Graduates will differentiate, compare, and contrast the characteristics and capabilities of current and future communications systems in use or planned by Naval operating and Joint forces afloat and ashore.

e. Graduates will recognize the national and international issues involving use of the frequency spectrum.

f. Graduates will discuss the nature of the rapid evolution in commercial satellite communications systems, and recognize the impact of such advancements on military operations and systems development.

6. **Remote Sensing**:

a. Graduates will examine principles of active and passive sensors in current or planned use.

b. Graduates will examine the effects of the space, atmospheric, and terrestrial environments (including countermeasures) on sensor performance.

c. Graduates will assess and conduct tradeoffs among various sensors and platforms, evaluating how each satisfies mission requirements such as access area, resolution, timeliness, and capacity.

7. **Analysis, Synthesis, and Evaluation:**

a. Graduates will derive, assess, and articulate capabilities necessary for the use of National Security Space systems in support of military operations.

b. Graduates will examine various engineering and mathematical definitions of cost functions (revisit time, dwell time, local coverage, etc.)

c. Graduates will use business case (economic) and performance data to analyze trade-offs between commercial and DoD systems to provide desired operational capabilities.

8. **Architecting Joint Military Space Missions:**

a. Graduates will examine and relate the principles of architecting a complex, Joint National Security Space mission, and the life cycle process by which

a space system is conceived, structured, designed, built, tested, certified and operated in a way that ensures its integrity and performance.

b. Graduates will develop and assess system requirements; compose alternate architectures to satisfy those requirements; and evaluate and select the most effective alternative.

c. Graduates will develop system design criteria from stated performance requirements, and conduct trade-offs between payloads and other spacecraft subsystems.

d. Graduates will examine the design of current and planned space-based mission payloads (e.g., ISR, Communications, PNT, SIGINT).

e. Graduates will examine the basic principles and operational issues of space access to include launch vehicle performance, launch windows, and their impact on military operations.

f. Graduates will examine the basic elements of mission operations – spacecraft commanding, payload management, anomaly resolution, orbital maneuver planning – and will apply these concepts during satellite and architecture design projects.

g. Graduates will understand the role of space in the development of an OPLAN. Graduates will have the ability to assess a concept of operations that includes all four mission areas identified in JP 3-14. Graduates will demonstrate the ability to develop an acceptable command and control structure for space operations and the space annex of an OPLAN.

9. **Advanced Concepts and Technologies in Space Systems:**

a. Graduates will examine how current and future space systems contribute to National Security and will examine means to employ space-based capabilities to support information dominance.

b. Graduates will examine potential future military space requirements stemming from desired information superiority capabilities.

c. Graduates will examine future concepts of operation published by various DoD and international organizations (ESA, ISA, WSO) based on emerging technologies and appraise their impact on military space.

d. Graduates will examine the advanced concepts and technologies which could be used in future military space systems.

10. **Conduct and Report Research:** Graduates will conduct independent or group research on a space systems problem, including resolution of the problem and presentation of the results and analysis in both written and oral form.

Curriculum Sponsor and ESR Approval Authority
Deputy Chief of Naval Operations for Information
Dominance (OPNAV N2/N6)
April 2012

Space Systems Engineering - Curriculum 591

Program Officer
Jason W. Pratt, CDR
Code 71, Bullard Hall, Room 203

(831) 656-7517, DSN 756-7517
jwpratt@nps.edu

Academic Associate
Alan Scott, Senior Lecturer
Code MAE, Halligan Hall, Room 254

(831) 656-2453, DSN 756-2453
adscott@nps.edu

Brief Overview

The Space Systems Engineering program provides officers,
through graduate education, with a comprehensive
scientific and technical knowledge of national security,
military and naval space systems. This curriculum is
designed to equip officers with the theoretical and practical
skills required to design and integrate national security and
military space payloads with other spacecraft subsystems.
Graduates will be prepared by their education to design,
develop and manage the acquisition of space
communications, navigation, surveillance, electronic
warfare and environmental sensing systems.

Requirements for Entry

A baccalaureate degree, or its equivalent, in engineering or
the physical sciences is preferred. An APC of 323 is
required for direct entry. The Engineering Science
program (Curriculum 460) is available for candidates who
do not meet all admission requirements. The additional
required time to complete the Engineering Science
program will vary upon the candidate's background. For
those wishing to pursue the electrical engineering or
computer science degree option, the candidate will need to
have earned the equivalent of an accredited BSEE or
BSCS. A TOP SECRET security clearance is required
with SPECIAL INTELLIGENCE (SI) clearance
obtainable for all students.

Entry Date

Space Systems Engineering is a nine-quarter course of
study with an entry date in Fall Quarter. Those requiring
the one-quarter Engineering Science curriculum will have
their time of arrival adjusted to accommodate it. If further

information is needed, contact the Academic Associate or
the Program Officer.

Degree

A student can earn one of the following degrees in the
Space Systems Engineering (Curriculum 591): Master of
Science in Electrical Engineering, Astronautical
Engineering, Physics, Computer Science, or Engineering
Science (Astronautical Engineering). In addition to the
master's degree programs offered by the Space Systems
Engineering (Curriculum 591) an Astronautical Engineers
Degree, and Ph.D. in Astronautical Engineering,
Electrical Engineering and Physics are also available.
Required classes vary by degree. The placement of these
required classes in the course of study shown below is
indicated as Degree Specialization Electives.

Subspecialty

Completion of this curriculum qualifies an officer as a
Space Systems Engineering Specialist with a subspecialty
code of 5500P. The curriculum sponsor is NAVSEA and
the designated Subject Matter Expert is the Space and
Naval Warfare Systems Command Space Field Activity
(SSFA).

Typical Subspecialty Jobs

Project Officer/Engineer: SPAWAR, San Diego, CA
Project Officer/Engineer: SPAWAR Space Field
    Activity/NRO, Chantilly, VA
Satellite Communications Engineer: NAVSOC, Point
    Mugu, CA
Space Advisor: Naval Network Warfare Command,
    Norfolk, VA
Project Officer: Space Warfare Center, USSTRATCOM,
    Omaha, NE
Project Officer/Engineer, C4ISR Programs: SPAWAR
    Systems Center, San Diego, CA

Typical Course of Study - (Astronautical Engineering Track)

Quarter 1

MA2121	(4-0)	Differential Equations
AE2820	(3-2)	Introduction to Spacecraft Structures
EC2820	(3-2)	Digital Logic Circuits
NW3230	(4-2)	Strategy and Policy (JPME)
SS4000	(0-1)	Space Systems Seminar

Quarter 2

SS3500	(4-2)	Orbital Mechanics and Launch Systems
PH2514	(4-0)	Introduction to Space Environment
MA3046	(4-1)	Matrix Analysis
EC2300	(3-2)	Control Systems
SS4000	(0-1)	Space Systems Seminar

Quarter 3

AE3815	(3-2)	Spacecraft Rotational Mechanics
EO2525	(4-1)	Analysis of Signals and Communications Systems
PH3052	(4-0)	Remote Sensing
AE3830	(3-2)	Guidance and Controls
AE3811	(2-2)	Space Lab
SS4000	(0-1)	Space Systems Seminar

Quarter 4

AE3851	(3-2)	Spacecraft Propulsion
EO3525	(4-1)	Communications Engineering
PH3360	(4-1)	Electromagnetic Waves Propagation
ME3521	(3-2)	Mechanical Vibrations
SS4000	(0-1)	Space Systems Seminar

Quarter 5

AE3804	(3-0)	Thermal Control of Spacecraft
AE3818	(3-2)	Spacecraft Attitude, Determination and Control
AE4850	(3-2)	Astrodynamic Optimization
AE3820	(3-2)	Advanced Mechanics and Orbital Robotics
SS4000	(0-1)	Space Systems Seminar

Quarter 6

AE3870	(2-4)	Spacecraft Design Tools
SS3051	(4-0)	Space Systems and Operations II (TS/SCI)
SS3001	(3-2)	Military Applications of National Space Systems (TS/SCI)
SS0810	(0-8)	Thesis Research
SS4000	(0-1)	Space Systems Seminar

Quarter 7

AE4870	(4-0)	Spacecraft Design and Integration I
EC3230	(3-1)	Space Power and Radiation Effects
SS3035	(3-2)	Microprocessors for Space Applications
AE4816	(4-0)	Dynamics and Control of Space Structures
SS4000	(0-1)	Space Systems Seminar

Quarter 8

AE4871	(2-4)	Spacecraft Design & Integration II
SS0810	(0-8)	Thesis Research
NW3285	(4-0)	National Security Decision Making (JPME)
NW3275	(4-0)	Joint Maritime Operations, Part I (JPME)
SS4000	(0-1)	Space Systems Seminars

Quarter 9

MN3331	(5-1)	Systems Acquisition and Program Management
SS0810	(0-8)	Thesis Research
SS0810	(0-8)	Thesis Research
NW3276	(4-0)	Joint Maritime Operations, Part II (JPME)

SS4000	(0-1)	Space Systems Seminars

Educational Skill Requirements (ESR)
Space Systems Engineering- Curriculum 591
Subspecialty Code: 5500P

1. **Joint Strategy and Policy:**
   a. Officers develop a graduate-level ability to think strategically, critically analyze past military campaigns, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's policies and goals and the ways military power may be used to achieve them. This is fulfilled by completion of the first of the Naval War College course series leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit.
   b. Officers gain an understanding of current Navy and USMC doctrine (e.g., Sea Power 21, Expeditionary Maneuver Warfare).

2. **Orbital Mechanics, Space Environment and Remote Sensing:**
   a. Graduates will examine the basic physics of orbital motion, and calculate and distinguish the parameters used in the description of orbits and their ground tracks.
   b. Graduates will examine the design of orbits and constellations, and analyze how they are achieved, maintained, and controlled; to include spacecraft maneuver and orbit transfer calculations.
   c. Graduates will examine the fundamentals of spacecraft tracking and command/control from a ground station.
   d. Graduates will examine the various orbital perturbations, including those due to non-spherical earth and due to atmospheric drag, and interpret their effects.
   e. Graduates will analyze the relationship between various orbital characteristics and the satisfaction of mission requirements, including the advantages and disadvantages of various orbits.
   f. Graduates will design and optimize mission orbits through the analysis of common performance measures such as access, coverage, and revisit; and will employ appropriate tools to conduct these analyses.
   g. Graduates will examine the physical behavior of the upper atmosphere, ionosphere and space environment under the influence of both natural and artificial phenomena such as solar activity, geomagnetic and magnetospheric effects, and man-made disturbances.

h.   Graduates will apply this understanding of how the space environment impacts spacecraft parts, materials, and operations to spacecraft and mission design.

3.   **National Security Space Systems:**
   a.   Graduates will examine the nature of space warfare (theory, history, doctrine, and policy); distinguish between the four JP 3-14 defined Space Mission Areas (Space Control, Space Support, Force Enhancement, Force Application); and interpret how current and planned space capabilities contribute to the satisfaction of these mission areas.
   b.   Graduates will examine the roles, responsibilities, and relationships of National and DoD organizations in establishing policies, priorities, and requirements for National Security Space systems; and in the design, acquisition, operation, and exploitation of these systems.
   c.   Graduates will examine the role of the Services / Agencies in establishing required space system capabilities, and will translate these capabilities into system performance requirements.
   d.   Graduates will examine: current and planned Intelligence, Surveillance, and Reconnaissance (ISR) capabilities; how space systems contribute to these capabilities; the intelligence collection and analysis process; and how war-fighters access information from these sources.
   e.   Graduates will develop and assess space tactics and/or CONOPS that integrate with and enhance or support military operations.
   f.   Graduates will identify how proposed space-related capabilities / doctrine are translated from concept to real-world implementation through experimentation.

4.   **Project Management and System Acquisition:**
   a.   Graduates will examine project management and DoD system acquisition methods and procedures to include contract management, financial management and control, and the Planning, Programming and Budgeting System (PPBS).
   b.   Graduates will recognize the role of the Defense Acquisition University and the acquisition courses and qualifications available.
   c.   Graduates will examine system acquisition organizational responsibilities and relationships (e.g., Congress, DoD, Services, Resource Sponsor, Systems Commands, Operating Forces) as they pertain to the acquisition of systems for DoD, Naval, and civilian agency users.

d.   Graduates will examine the unique nature of space acquisition programs and the differences between the DoD 5000 acquisition process and space-specific acquisition processes (e.g., NRO Directive 7). Based on this knowledge, they will plan and structure a notional space system acquisition program.

5.   **Spacecraft Communications and Signal Processing:**
   a.   Graduates will examine the basic principles of communications systems engineering to include both the space and ground segments.
   b.   Graduates will examine digital and analog communications architecture design, including such topics as frequency reuse, multiple access, link design, repeater architecture, source encoding, waveforms/modulations, and propagation media.
   c.   Graduates will calculate and analyze link budgets to assess communication system suitability to support mission requirements, and to translate mission requirements into communications system design characteristics.
   d.   Graduates will differentiate, compare, and contrast the characteristics and capabilities of current and future communications systems in use or planned by Naval operating and Joint forces afloat and ashore.
   e.   Graduates will examine how these space systems are used to meet Joint war-fighters' communications requirements.
   f.   Graduates will differentiate signal processing techniques, both digital and analog, as applied to missions such as spacecraft communications, surveillance, and signals intelligence.
   g.   Graduates will examine spacecraft vulnerabilities in an electronic warfare context.

6.   **Computers: Hardware and Software:**
   a.   Graduates will apply the fundamentals of digital logic and digital system design to the modeling / design of simple digital computer subsystems.
   b.   Graduates will examine the design of current and planned computer hardware and software architectures for space-based applications.
   c.   Graduates will examine the use of computers in complex systems such as guidance, signal processing, communications, and control systems.
   d.   Graduates will examine the fundamentals of electronic component design, fabrication, reliability, and testing (to include radiation hardening), with an emphasis on parts, materials, and processes.
   e.   Graduates will examine modern Information Technology capabilities and their applications for

space systems ground processing, data storage, information sharing, and network design.

7. **Spacecraft Guidance and Control:**
   a. Graduates will examine the field of spacecraft guidance and control, to include topics such as linear control, rotational kinematics, rigid body dynamics, gravity gradient, spin and three-axis stabilization design, active nutation control, sources of and response to disturbance torques, and attitude determination and associated sensors and actuators.
   b. Graduates will apply these techniques to the analysis and design of spacecraft guidance and control systems.

8. **Spacecraft Structures, Materials and Dynamics:**
   a. Graduates will examine the engineering of space structures and perform simplified sizing calculations and analytical modeling of advanced materials.
   b. Graduates will analyze the advanced dynamics and control of these structures.

9. **Propulsion Systems:**
   a. Graduates will examine the operating principles (fluid mechanics, thermodynamics, electricity and magnetism) and propulsion devices used in current and proposed space applications.
   b. Graduates will analyze and choose appropriate propulsion systems for spacecraft applications to include launch, orbit transfers, and spacecraft maneuvering.

10. **Spacecraft Thermal Control:**
    a. Graduates will examine the principles of heat transfer and how surfaces and materials are manipulated in spacecraft thermal control.
    b. Graduates will examine the design, analysis, and applications of current active and passive thermal control devices (including heat pipes, louvers, and materials).
    c. Graduates will examine the sources of heat in space (solar, terrestrial, reflected solar, internal vehicle generation) and their variation as a function of vehicle orbit, and apply this knowledge to thermal subsystem analysis and design.

11. **Spacecraft Power:**
    a. Graduates will examine the principles and operating characteristics of major power generating systems for spacecraft, including the performance of photovoltaic sources in the natural and artificial radiation environment.
    b. Graduates will examine the principles and operating characteristics of energy storage devices in power systems design.

12. **Remote Sensing and Payload Design:**
    a. Graduates will examine principles of active and passive sensors in current or planned use, to include analysis of electromagnetic wave propagation and design of optics, detectors, and antennae.
    b. Graduates will examine the effects of the space, atmospheric, and terrestrial environments (including countermeasures) on sensor performance.
    c. Graduates will assess and conduct tradeoffs among various sensors and platforms, evaluating how each satisfies mission requirements such as access area, resolution, timeliness, and capacity.
    d. Graduates will examine the design of current and planned space-based mission payloads (e.g., ISR, Communications, PNT, SIGINT).
    e. Graduates will analyze mission capabilities and conduct associated trades in order to develop associated payload design requirements.

13. **Spacecraft Design, Integration and Systems Engineering:**
    a. Graduates will develop and assess an overall space system architecture to meet defined mission requirements through the use of systems engineering tools and processes.
    b. Graduates will derive system and subsystem performance criteria from stated mission capabilities and conduct trade-offs between payload and other spacecraft subsystems in addressing these capabilities.
    c. Graduates will examine a broad spectrum of mission assurance concerns such as reliability, risk management, configuration management, qualification and acceptance testing, and parts materials and processes.
    d. Graduates will examine various engineering and mathematical definitions of cost functions (revisit time, dwell time, local coverage, etc.) and apply emerging methods and tools to optimizing these utility measures in support of mission objectives.
    e. Graduates will examine the basic principles and operational issues of space access to include launch vehicle performance, launch windows, and their impact on military operations.
    f. Graduates will examine the capabilities of the various current and planned launch systems, and characterize the issues associated with integrating a spacecraft with a launch vehicle, to include the effects of launch environment.
    g. Graduates will perform a trade-off analysis in the selection of a launch vehicle based on mission requirements, performance and design constraints,

and business issues involved (e.g., pricing, insurance, policy).

h. Graduates will demonstrate proficiency in design, analysis, and modeling / simulation tools such as IDEAS, MATLAB / Simulink, and Satellite Tool Kit (STK).

i. Graduates will examine the processes and methods of systems engineering including requirements analysis, functional analysis and allocation, system design, and verification.

14. **Conduct and Report Independent Research:**

a. Graduates will conduct independent research on a space systems problem, including resolution of the problem and presentation of the results and analysis in both written and oral form.

Curriculum Sponsor and ESR Approval Authority

Commander SPAWAR Space Field Activity
Sept 2009

Department of Systems Engineering

Chairman

Cliff Whitcomb, Ph.D., CSEP
Code SE/Wh, Bullard Hall, Room 201K

(831) 656-3001, DSN 756-3001, FAX (831) 656-3129
cawhitco@nps.edu

Associate Chair for Research

Robert C. Harney, Ph.D.
Code SE/Ha, Bullard Hall, Room 201A

(831) 656-2685, DSN 756-2685
harney@nps.edu

Associate Chair for Instruction

Eugene P. Paulo, Ph.D.
Code SE/Pa, Bullard Hall, Room 201D

(831) 656-3452, DSN 756-3452
eppaulo@nps.edu

Associate Chair for Operations

Matthew J. Boensel
Code SE/Bn, Bullard Hall, Room 217A

(831) 656-3489, DSN 756-3489
mgboense@nps.edu

Associate Chair for Distance Learning Programs and Outreach

Walter E. Owen
Code SE/WO, St Louis

(636) 935-2982
wowen@nps.edu

Rodman Abbott*, Military Associate Dean of Research (2009);, M.S., University of Minnesota, 1984.

Timothy Anderson, Lecturer (2007); M.S., Naval Postgraduate School, 1994.

Peter Ateshian, Visiting Lecturer (2004); M.Eng., University of California Berkeley, 1979.

Paul T. Beery, Research Associate (2009);, M.S., Naval Postgraduate School, 2011.

Barbara Berlitz, Senior Lecturer (2011); J.D., Monterey College of Law, 1985.

Matthew G. Boensel, Senior Lecturer (1999); M.S., Naval Postgraduate School, 1988.

Daniel P. Burns, Professor of Practice (2011);, M.S., Naval Postgraduate School, 1991.

Katherine M. Cain, Research Associate (2002); M.S., University of Massachusetts Amherst, 1989.

Charles N. Calvano, Professor (1991); Engineering Degree, Massachusetts Institute of Technology, 1970.

Ronald R. Carlson, Professor of Practice (2009), M.S., Naval War College, 1987.

Timothy H. Chung, Assistant Professor (2008); Ph.D., California Institute of Technology, 2007.

Michael Day, Research Associate (2012); MS, Naval Postgraduate School, 2012.

Stephanie Enck, Research Assistant (2007); B.S., Appalachian State University, 1999.

William "Yitz" Finch, Research Assistant Professor (2012); Ph.D., University of Michigan, 1997.

Rama Gehris, Professor of Practice (2011); DSc, George Washington University, 2008

Ronald Giachetti, Professor (2011); Ph.D., North Carolina State University, 1996.

Kristin Giammarco, Associate Professor (2009); Ph.D., Naval Postgraduate School, 2012.

John "Mike" Green, Senior Lecturer (2002); M.S., MBA, University of New Haven, 1986 and 1998.

Robert C. Harney, Associate Professor, Associate Chair for Research (1995); Ph.D., University of California at Davis, 1976.

Alejandro Hernandez, Associate Professor (2011); Ph.D., Naval Postgraduate School, 2008.

Jean M. Johnson, Lecturer (2006); M.S., Old Dominion University, 2004.

James L. Kays, Professor (2002); Ph. D., Rensselaer Polytechnic Institute, 1980.

Rabia Khan, Research Assistant (2012); B.S., University of California - Davis, 2007.

Brigitte E. Kwinn, Lecturer (2008); M.S., University of Arizona, 1994.

Gary O. Langford, Senior Lecturer (2005); M.S., California State University Hayward 1971.

Raymond J. Madachy, Associate Professor (2008); University of Southern California, 1994.

Richard C. Millar, Associate Professor (2008); DSc, George Washington University, 2008.

Gregory Miller, Senior Lecturer (2004); M.S., Naval Postgraduate School (1992).

Paul Montgomery, Associate Professor (2008); DSc, George Washington University, 2007.

Donald Muehlbach, Professor of Practice (2009); Ph.D., Capella University, 2008.

Douglas Nelson, Associate Professor (2011); Ph.D., University of New Mexico, 1999.

David H. Olwell, Professor (1998); Ph.D., University of Minnesota, 1996.

Walter Owen, Senior Lecturer (1992); DPA, Golden Gate University, 2002.

Fotis A. Papoulias, Associate Professor and Academic Associate (1988); Ph.D., University of Michigan, 1987.

Gary Parker, Research Associate (2010); M.S., Naval Postgraduate School, 1986.

Eugene P. Paulo, Associate Professor (2000); Ph.D., University of Central Florida, 1998.

Mark R. Rhoades, Senior Lecturer (1999); M.S., Naval Postgraduate School, 1990, 2006.

Paul V. Shebalin, Professor of Practice and Director, Wayne E. Meyer Institute of SE (2003); DSc, George Washington University, 1997.

William A. Solitario, Visiting Professor of Practice (2003); B.S., City College of New York, 1962.

Mark R. Stevens, Senior Lecturer and Academic Associate (2003); M.S., Rensselaer Polytechnic Institute, 1988.

Joseph Sweeney III, Lecture and Program Officer PD21 (2010); MS, Naval Post Graduate School, 1987.

Ravi Vaidyanathan, Assistant Professor (2004); Ph.D., Case Western Reserve University, 2003.

Warren Vaneman, Professor of Practice (2012); Ph.D., Virginia Tech, 2002.

Mary Vizzini, Lecturer (2010); MA, Washington University in St. Louis, 2006.

Clifford Whitcomb, Professor and Chair (2005); Ph.D., CSEP, University of Maryland, 1998.

Corina White, Research Assistant (2012); B.S., Prairie View A&M, 2007.

Oleg Yakimenko, Professor (1989); Ph.D., Russian Academy of Sciences, 1991.

Bonnie W. Young, Lecturer (2011); M.S., John Hopkins, 2002

The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

(* indicates faculty member has a joint appointment to another department at NPS)

Mission

The mission of the Department of Systems Engineering is to provide relevant, tailored, and unique advanced education and research programs in Systems Engineering in order to increase the combat effectiveness of US and Allied armed forces and to enhance the security of the United States.

Brief Overview

The Department of Systems Engineering provides strong academic programs which span the engineering disciplines and the analytical sciences. These disciplines are blended together with a strong emphasis on naval combat systems engineering applications.

The Systems Engineering Department offers six degrees:
1. Master of Science in Systems Engineering (MSSE) – requires an ABET EAC undergraduate engineering degree, or equivalent. The MSSE degree is awarded for either the residential program as the MSSE or the distributed learning (DL) program as the MSSE (Distributed Learning) degree.
2. Master of Science in Engineering Systems (MSES) – does not require an undergraduate engineering degree.
3. Master of Science in Systems Engineering Analysis (MSSEA) – does not require an undergraduate engineering degree.
4. Master of Science in Product Development (MSPD)– does not require an undergraduate engineering degree.

5. Master of Science in Systems Engineering Management (MSSEM)– does not require an undergraduate engineering degree.
6. Doctor of Philosophy (Ph.D.) degree in Systems Engineering.

A specific curriculum must be consistent with the general minimum requirements for the degree as determined by the Academic Council.

Any student study plan leading to award of a degree offered by the SE department must be approved by the Chairman of the Department of Systems Engineering at least two quarters before completion. In general, approved curricula may require more than minimum degree requirements in order to conform to the needs and objectives of the service or agency sponsoring the student.

The six degrees are offered under the Systems Engineering department's five curricula, 308, 311, 580, 581, and 721.

The two MSSE degrees, the MSSE and MSSE (Distributed Learning) are ABET EAC accredited. The other degrees, MSES, MSSEA, MSPD, MSSEM, and Ph.D. are not ABET EAC accredited.

Objectives

The Systems Engineering program supports the NPS mission by producing graduates who have, at an advanced level, knowledge and technical competence in systems engineering and an application domain; and who can use that knowledge and competence to support national security. Specific program educational objectives (i.e., skills and abilities that graduates can bring to their position after having graduated from NPS and having received 3-5 more years of on-the-job training and professional development) are:
·   Technical Leadership: Graduates will apply their engineering knowledge in leadership roles along diverse career paths in government service.
·   Program Management: Graduates will perform research, design, development, procurement, integration, maintenance, and life-cycle management of systems for defense and national security.
·   Operational Utilization: Graduates will apply systems engineering in diverse military settings and understand its capabilities and limitations.

Outcomes

In order to achieve the goals for the **SE** program, the outcomes are to produce graduates who:
·   Demonstrate the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. This includes the ability to apply knowledge of mathematics, science and engineering to identify, formulate, and solve operational, technical, and engineering problems in systems engineering and related disciplines using the techniques, skills, and modern engineering tools necessary for engineering practice, including modeling and simulation. These problems may include issues of research, design, development, procurement, operation, maintenance or disposal of systems and processes for military applications.
·   Demonstrate an ability to design a system, component, or process to meet desired needs incorporating appropriate engineering standards within multiple realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and lifecycle sustainability. Demonstrate proficiency in the application of systems engineering methods and processes, including systems thinking, stakeholder needs analysis, concept of operations, requirements definition and analysis, functional analysis and allocation, human systems integration, design, architecture, lifecycle support, lifecycle cost, systems assessment, trade-off, selection, and test and evaluation.
·   Demonstrate proficiency in core skills of systems analysis, to include an ability to design and conduct experiments, as well as to analyze and interpret data and to perform deterministic and stochastic modeling of systems, optimization, decision analysis, risk analysis, economic modeling, and lifecycle supportability analysis. This includes familiarity with combat simulations and combat modeling.
·   Demonstrate an ability to function on multidisciplinary teams working as a team member or leader in an authentic systems engineering project through both individual and team level contributions. Demonstrate proficiency in interpersonal skills and communications. Demonstrate competence in the planning and management of authentic systems engineering projects.
·   Demonstrate an ability to communicate effectively through written and oral presentation of technical material.
·   Demonstrate an understanding of professional and ethical responsibility.
·   Demonstrate a recognition of, the need for, and an ability to engage in, life-long learning and a knowledge of contemporary issues.

In order to achieve the goals for the **SEM** program, the outcomes are to produce graduates who:
·   Demonstrate proficiency in modern techniques of management, including organizational theory, finance and accounting, marketing, risk management, and operations management.

· Demonstrate proficiency in the application of systems engineering methods and processes, including systems thinking, stakeholder needs analysis, concept of operations, requirements definition and analysis, functional analysis and allocation, human systems integration, design, architecture, lifecycle support, lifecycle cost, systems assessment, trade-off, selection, and test and evaluation.*

· Demonstrate competence in the planning and management of authentic systems engineering projects.*

· Demonstrate an ability to communicate effectively through written and oral presentation of technical material.*

(*Means an outcome is shared with the SE Program.)

SE Degrees

Master of Science in Systems Engineering

*Accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org

A candidate shall have completed work equivalent to the requirements of this department for the ABET EAC Bachelor of Science degree in an engineering discipline. Candidates who have not majored in engineering, or who have experienced significant lapses in continuity with previous academic work, may initially take undergraduate courses in engineering and mathematics to fulfill these requirements in preparation for their graduate program.

The Master of Science in Systems Engineering requires a minimum of 48 quarter-hours of graduate level work.

The candidate must take all courses in an approved study program, which must satisfy the following requirements: there must be a minimum of 36 quarter-hours of credits in 3000 and 4000 level courses, including a minimum of 16 quarter-hours at the 4000 level. The course work must include the four core SE courses.

The candidate must complete a thesis or a 12-hour equivalent team systems engineering project. This degree is offered both in residence and non-residence forms.

Master of Science in Engineering Systems

A candidate shall have earned the Bachelor of Science or Bachelor of Arts degree.

The Master of Science in Engineering Systems requires a minimum of 48 quarter-hours of graduate level work.

The candidate must take all courses in an approved study program, which must satisfy the following requirements: There must be a minimum of 36 quarter-hours of credits in 3000 and 4000 level courses, including a minimum of 16

quarter-hours at the 4000 level. The course work must include the four core SE courses.

The candidate must complete either a 12-hour equivalent team systems engineering project or an individual thesis. This degree is offered both in residence and non-residence.

Doctor of Philosophy

The Department of Systems Engineering offers a Doctor of Philosophy (Ph.D.) degree in Systems Engineering. Students take graduate level course in systems engineering (as needed to pass the oral and written qualifying examinations), advanced graduate courses in systems engineering and an application domain, and perform research that leads to a dissertation involving some aspect of systems engineering. Research topics may be selected from a broad variety of studies of the systems engineering process, applications of systems engineering to solving complex problems, systems level modeling and simulation, and systems suitability assessment. Subject to approval of the student's dissertation committee chairman, dissertation research may be conducted away from NPS at cooperating facilities. Students must satisfy a one-year residency requirement. This may be met by completing an NPS M.S. degree plus periodic extended stays (nominally two weeks per quarter) at an NPS campus spread throughout the duration of the student's program. The M.S. degree may be completed before enrollment in the Ph.D. program.

Applicants should possess an M.S. degree in Systems Engineering. Applicants with only a B.S. degree or an M.S. degree in another discipline will be required to take a number of systems engineering courses (equivalent to the coursework portion of an MSSE degree program) to pass the qualifying examinations. Unless an M.S. thesis and any other ABET EAC accreditation requirements are also satisfied, an M.S. in Systems Engineering degree will not be awarded for this preparatory work. Applicants without an M.S. degree are encouraged to enroll in the M.S. in Systems Engineering program as this will satisfy both residence and preparation requirements.

SEM Degrees

Master of Science in Product Development

A candidate shall have earned the Bachelor of Science or Bachelor of Arts degree.

The Master of Science degree in Product Development requires a minimum of 48 quarter-hours of graduate level work.

The candidate must take all courses in an approved study program, which must satisfy the following requirements: there must be a minimum of 36 quarter-hours of credits in 3000 and 4000 level courses, including a minimum of 16 quarter-hours at the 4000 level. The course work must

include a four-course core in systems engineering methods. Additional courses must be selected from an approved list.

The candidate must complete an approved thesis.

Master of Science in Systems Engineering Management

A candidate shall have earned the Bachelor of Science or Bachelor of Arts degree.

The Master of Science degree in Systems Engineering Management requires a minimum of 48 quarter-hours of graduate level work.

The candidate must take all courses in an approved study program, which must satisfy the following requirements: there must be a minimum of 36 quarter-hours of credits in 3000 and 4000 level courses, including a minimum of 16 quarter-hours at the 4000 level. The course work must include a four-course core in systems engineering methods. Additional courses must be selected from an approved list.

The candidate must complete an approved thesis.

Laboratories and Research

Students in the Systems Engineering Department participate in a variety of research activities ranging from course-based experiments and individual classroom projects to larger team-based design projects and individual thesis research. Systems Engineering Department faculty members conduct a variety of research in four broad areas.

Systems Engineering Methodology involves the investigation or development of tools and techniques for conceptualizing, designing, and developing systems. Study areas include discovery of fundamental principles of systems theory, elucidating the use of these principles through systems engineering tools and techniques, analyzing the conditions of employing the tools and techniques, and determining the efficacy of those tools and techniques. Specific methodology areas include system requirements generation, requirements allocation, system architecture, system dynamics and control, and risk engineering.

Systems Engineering Applications involves the application of systems engineering processes to the solution of specific complex problems. This can include conceptual design of systems, investigation of issues associated with integration of system components into system segments, investigation of issues associated with integration of system segments into systems, and the analysis of case studies of successful and/or unsuccessful systems engineering applied to military acquisition programs. Specific application areas include combat systems integration, ship systems engineering, and enterprise systems engineering.

System Simulation and Modeling involves the development of simulations and models of military systems, evaluation of the efficacy of these simulations and models in providing the information to accomplish systems engineering functions (especially system design requirements and comparison of alternative solutions), and investigation of the characteristics of simulations and models that lead to outputs useful in the systems engineering process.

System Suitability Assessment involves the study of tools, techniques, and disciplines that permit the assessment of the suitability of systems in meeting requirements. Requirements can include performance, availability, operability, and cost. Specific suitability assessment areas include reliability engineering, system survivability, and system cost estimation and control.

The Systems Engineering Department maintains a number of laboratories to its support instructional and research objectives. These laboratories serve to:
- Provide broad, hands-on, practical engineering experiences to systems engineering students enhancing application domain understanding at the component level and subsystem levels and balancing analysis with exploratory development and prototyping.
- Provide an environment (facilities and equipment) that fosters student projects with resulting hardware prototypes and investigations that reach beyond concept definition to later stages of the life cycle.
- Provide an environment that facilitates student and faculty experimental research in applications of systems engineering.

Administratively the research facilities of the Systems Engineering Department are organized into five laboratories. Each of these laboratories contains one or more instructional research spaces.

The **SE Demonstrations Lab** provides space & equipment for developing and housing a wide variety of demonstrations that enhance courses in the systems engineering curricula.

The **SE Computation Lab** provides computational support for large-scale simulation, modeling, and systems engineering projects. It houses Lockheed Martin systems engineering software, a variety of complex simulation & modeling software (such as the Navy Simulation System), and the 75 interconnected computers needed to run that software. The lab also provides a general-purpose computing facility that supports all systems engineering classes, thesis projects, and capstone projects. It may be utilized by distance learning students as well as resident students.

The **SE Projects Lab** provides an environment in which students can work together to pursue team-based systems engineering projects or pursue independent study related to

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courses or thesis research. In addition, facilities, tools, and materials are provided to permit fabrication, assembly, integration, and test of electronic and mechanical equipment in support of projects and theses.

The **SE Foundations Lab** provides direct exposure to the scientific concepts and techniques that underlie modern engineering disciplines. It provides facilities and equipment to perform basic experiments in physics, chemistry, biology, electronics, and materials science. This laboratory also provides basic equipment that facilitates hardware-oriented thesis research programs and student capstone projects. Administered within the SE Foundations Lab are the Physical Systems Lab, the Defense Applications Lab, the Nuclear Detector Lab, the Electro-Optical Sensor Systems Lab, and the Virtual Lab.

The Physical Systems Lab supports experiments that elucidate the fundamental properties, characteristics, and interactions of mechanical, thermodynamic, and electromagnetic systems. The Defense Applications Lab supports experiments involving wet chemistry, microorganisms, and/or biological materials. It provides facilities and equipment for simple chemical synthesis, chemical analysis, electrochemistry, microbial culture, microscopy, DNA analysis, and other biotechnologies. The Nuclear Detector Lab supports experiments involving detection of nuclear radiation. It hosts a variety of low-level radioactive sources, detector systems, signal processing electronics, and shielding against background radiation. The Electro-Optical Sensor Systems Lab supports experiments involving electro-optical sensors (television, image intensifiers, thermal imaging, etc.) that require complete darkness for some measurements. The Virtual Lab supports portable laboratory concepts, especially software-based virtual experiments and software that is not available for network use in the SE Computation Lab. It also supports distance learning activities by providing a foundation for future insertion of laboratory experiences into the DL systems engineering courses.

The **SE Applications Lab** augments lecture courses in the engineering applications tracks (including combat systems, ship systems, and enterprise systems, among others) in the SE curriculum. It provides hands-on experience with important concepts and permits direct observation of critical phenomena associated with combat systems and sensor/weapon networks. It also provides equipment that can be used in student thesis projects and capstone design projects. Experiments cover the gamut from signal propagation to sensor fundamentals to specific sensor technologies to weapons operational concepts to sensor & weapon networks to technologies associated with the integration of sensors, weapons, and control technologies into modern military platforms of all types. Administered within the SE Applications Lab are the Ship Systems/Combat Systems Lab, the Enterprise Systems Lab, and the Laser/Lidar Development Lab.

The Ship Systems/Combat Systems Lab supports experiments in the Ship Systems and Combat Systems track courses. It hosts a variety of active & passive microwave, infrared, acoustic, & magnetic sensor hardware, weapon subsystems & simulators of weapon systems, and devices permitting the investigation of platform characteristics. The Enterprise Systems Lab supports experiments in the Enterprise Systems Engineering track courses. It provides network hardware, communication systems, and electronic measurement and analysis equipment, as well as multiple sensor types to provide input and network-controllable systems to utilize output. The Laser/Lidar Development Lab provides optical tables, breadboard optical hardware, laser measurement equipment, and a variety of laser sources in a laser safety-qualified laboratory.

Systems Engineering Course Descriptions

SE Courses

SE0811 Thesis in Systems Engineering (0-8)
Fall/Winter/Spring/Summer
Thesis course for students pursuing a systems engineering master's degree. Students are awarded grade of "T" upon successful completion of their theses.

SE1001 Mathematics for SE I (4-2) Summer
This course provides a brief survey of selected calculus and post-calculus topics: single variable derivatives and integrals, and vector analysis. The course is intended to give students the requisite mathematics needed in SE2003. Prerequisites: Consent of instructor and enrollment in the SE or SEA curriculum.

SE1002 Mathematics For SE II (3-1) Summer
This course provides an introduction to selected pre- and post-calculus topics. Covered will be complex numbers, matrix algebra and differential equations. Prerequisite: SE1001.

SE2003 Introduction to Mechanical Systems (4-2) Summer
The course provides a basic understanding of the physical properties underlying combat systems. It presents calculus based physics covering a broad range of topics in mechanics, heat, and sound. Relevance to military development is discussed. Practical tools are developed to describe motion, Newton's force laws, friction and drag, energy and momentum, rotation, gravitation and orbits, fluids, oscillations, chaos, waves, gases, and thermodynamics. Co-requisites: SE1001.

SE2015 Fundamentals of Material Systems (4-2) Summer
This is an overview course of modern materials science and engineering as applied to the design of complex systems. It describes the structures of materials and the relationship of structure to material properties. All properties of engineering significance (both mechanical and non-mechanical) will be discussed. The broad variety of materials (including single crystals, alloys, ceramics, glasses, polymers, composites, foams, etc.) available for engineering applications is also discussed. Topics include structure and bonding, mechanical properties of materials, thermal properties of materials, electromagnetic properties of materials, superconductivity, chemical properties of materials (including environmental degradation), characteristics of specific engineering materials (alloys, ceramics, etc.), the selection of

materials for specific applications, and the engineering of new materials to fulfill specific requirements. Students will acquire a working vocabulary and conceptual understanding necessary for advanced study, for communication with materials experts, and for the conceptualization of advanced systems. Prerequisite: SE1002 and SE2101.

SE2016 Battlespace Environments (4-2)

This course covers the fundamentals of terrestrial science (geology, oceanography, meteorology, and near-earth space science) necessary for any systems engineer to understand how systems interact with and are influenced by their environment. Topics covered include the internal structure of the earth, tectonic processes, rocks and minerals, erosion and weathering, the water cycle, the structure and composition of the oceans, acoustic oceanography, oceanic currents, wave processes, structure of the atmosphere, temperature, pressure and winds, atmospheric water, weather systems, storms, weather forecasting, the extreme upper atmosphere, solar wind and magnetic storms, and the radiation belts. Prerequisites: SE1002 and SE2101.

SE2017 Fundamentals of Chemical Systems (4-2)

This course covers the fundamentals of chemistry and chemical processes, necessary for any systems engineer to understand many key technologies affecting systems design. Topics covered include chemical bonding and chemical structure, chemical reactions, chemical equilibrium, reaction kinetics, solutions, and oxidation-reduction reactions. Prerequisites: SE2014 or consent of instructor.

SE2018 Fundamentals of Biological Systems (4-2)

This course covers the fundamentals of biological systems, especially human beings, which are necessary for any systems engineer to understand many key biological, biochemical, biophysical technologies affecting future systems design. Topics covered include basic anatomy and physiology, important biochemicals and biochemical processes, cell structure and cell processes, microbiology, disease and immunity, and bioculture. Prerequisite: SE2017.

SE2101 Introduction to Electromagnetic Systems (4-2) Summer

This course provides a basic understanding of the electromagnetic principles underlying combat systems. Relevance to military development is discussed. Practical tools are developed describing electric and magnetic fields, electromagnetic waves, special relativity, atomic energy levels, atomic binding, Schrodinger equation, energy bands in solids, nuclear particles, and radioactive decay. Prerequisites: SE1001, SE2003, Co-requisite: SE1002.

SE2114 Information Systems and Operations (3-0) As required

The impact of the network era through the proliferation of N-Tier applications has significantly transformed organizational processes and provided new strategic capabilities. These new N-Tier applications have complex and dynamic components that require technical knowledge to develop and manage. This course provides an understanding of these technologies and demonstrates how networked applications may be used as a mechanism to support DoD transformation initiatives targeted at meeting the information needs of today's military. It combines the study of theory, best practices and hands-on laboratory exercises to improve understanding of how to select, develop and manage N-Tier applications. Prerequisites: None.

SE2900 Elementary Studies in Systems Engineering (V-V) As required

Directed study at the undergraduate level based on textbooks, journal literature, experimental projects, or other sources. This course is designed to permit study of a selected topic at an elementary level which is prerequisite to subsequent study or use of that topic at a graduate level, and which is not available for study through regularly scheduled courses. Prerequisites: Consent of program officer, academic associate, and instructor.

SE3000 Systems Engineering Colloquium (1-0) As required

This weekly colloquium has two objectives for students to develop and maintain a knowledge of contemporary issues in systems engineering. The first is to provide a forum for guest speakers from industry, government and academia to discuss the practical application of Systems Engineering, and the second is to provide a forum for the student project teams to present their In Process Reviews (IPR's) and meet with across campus project participants. Prerequisites: None.

SE3001 Special Topics in Strategic Analysis I (3-0) As required

This course develops a realistic understanding of processes and ideas that determine our national security posture and behavior: in short, how we design, develop and acquire our forces, and how we use them to influence international events, hopefully to deter war, and eventually, if necessary, to fight and win. Additionally, this course examines the generation of combat system requirements and the relationships between operational, financial planning, and technical communities in fielding a combat system that fulfills those requirements. Prerequisites: Consent of instructor.

SE3011 Engineering Economics and Cost Estimation (3-0)

An introduction to the cost aspects of systems engineering, exploring cost from a decision-making perspective. Examines how cost is used to select alternatives and how the cost of systems can be measured. Concepts covered include economic analysis, cost behavior, cost allocation, system cost, life cycle costs, cost over time, cost estimating techniques, cost uncertainty, and cost risk. Prerequisites: OS3180 or equivalent, or consent of instructor.

SE3030 Quantitative Methods of Systems Engineering (3-2)

This course discusses advanced mathematical and computational techniques that find common application in systems engineering. It also provides an introduction to MATLAB, a computational tool useful in obtaining quantitative answers to engineering problems. Among the topics addressed in this course are vector analysis, complex analysis, integral transforms, special functions, numerical solution of differential equations, and numerical analysis. Prerequisites: SE1002, SE3100 or consent of instructor.

SE3100 Fundamentals of Systems Engineering (3-2)

Introduction to systems thinking and the processes and methods of systems engineering. The course covers fundamentals of systems engineering and system architecting, requirements analysis, functional analysis and allocation, preliminary system architecture, systems analysis, system design, and the basics of test and evaluation. Various perspectives, from frameworks, processes, and standards, such as the DoD Architecture Framework (DoDAF), DoD Joint Capabilities Integration and Development System (JCIDS), EIA 632, ISO 15288, IEEE 1220, IEEE 1471, and the International Council on Systems Engineering (INCOSE) models, are presented. Students analyze case studies. Students also use spreadsheet software for modeling and analyzing requirements and conceptual design alternatives. The course includes the application

of fundamental systems engineering processes and methods to an integrative project, as well as development of communication skills through oral presentations and written reports. Prerequisite: None.

SE3101 Introduction to Department of Defense Modeling and Simulation (4-0) Fall

This course serves as an important overview course for all students enrolled in the MOVES curricula, in addition to other curricula at NPS. It covers the origin, evolution, breadth and importance of DoD modeling and simulation (M&S), and the utilization of M&S in DoD system acquisition life cycle. The course focuses on the functional areas of DoD M&S, which are: Training, Analysis, Acquisition, Planning, Test, and Evaluation. This course also is offered as MV3101. Prerequisite: None.

SE3112 Combat Systems Engineering I - Introduction to Sensors (3-2) Fall

This is the first course of a survey of military sensor technology. It introduces the student to the nature of physical observables and propagators, the effects of the propagation medium on sensor performance, the relationship between signals and noise, and the characteristics of critical sensor functions (including detection, estimation, imaging, and tracking). It is designed to provide a framework for more detailed analysis of specific sensor systems in the follow-on course SE4112. Prerequisites: SE1002, SE2101 and/or consent of instructor.

SE3113 Combat Systems Engineering II - Introduction to Weapons (3-2) Spring

This is a survey of conventional military weapons technology. It introduces the student to both the effects that conventional weapons (artillery, bombs, and missiles) can produce as well as the technologies needed by weapons systems to create those effects. It is designed to provide familiarization of the student with critical weapons concepts that are necessary for enlightened examination of both technology development and military planning. Prerequisites: SE1002, SE2101 and/or consent of instructor.

SE3121 Introduction to C4ISR (3-0) Summer

The study of command and control (C2) information processing and decision making in the context of adaptive combat organizations and the C4ISR System Infrastructure that support it. Topics include: C2 decision processes [Observe-Orient-Decide-Act Loops, Problem Sensemaking (Identification) - Solution Finding and Implementation Processes], operational architectures, intelligence preparation of the Battlespace (IPB); mission success and organizational fitness. Prerequisites: Consent of instructor.

SE3122 Naval Weapon Systems Technology - I (3-0) As Required

This is the first of two courses that introduce the student to the technologies of combat systems. It starts with a brief survey of military sensor technology. It then introduces the student to effects of the propagation medium on sensor performance, the relationship between signals and noise, and the concepts of signature and signature control. The various sensor technologies involved in military applications of all kinds are presented as well as the essentials of C4ISR and the C4ISR Framework. Prerequisites: Consent of instructor.

SE3123 Naval Weapon Systems Technology - II (3-0) As Required

The second of a two course sequence, this course introduces the student to both the effects that weapons can produce as well as the technologies needed by weapons systems to create those effects, including the control elements. It is designed to provide an early initial familiarization of the student with critical weapons concepts. Analytic techniques are presented that allow the student to evaluate the interrelationships between the combat systems. Prerequisites: SE3122, or consent of instructor.

SE3151 Human Systems Engineering in Design (3-2) As Required

This course provides an introduction to human systems engineering as it relates to military system development and life cycle sustainment. An emphasis is placed on systems engineering concepts and principles as they support effective human systems integration as part of the DOD acquisition process. The course initially focuses on human capabilities and their bearing on effective operator integration into system design. It then delves into each major human system domains of human factors, safety and health, habitability, survivability, manpower, personnel and training, underscoring primarily those factors impacting system design. It also stresses evaluating design alternatives with an objective to optimize performance, reduce risk, address constraints, and consider costs. Prerequisites: SE3100 and OS3180 or equivalent.

SE3166 Principles of Advanced Systems Engineering (3-0) As Required

This course is an Introduction to systems thinking and the processes and methods of systems engineering. The course covers fundamentals of systems engineering and system architecting, requirements analysis, functional analysis and allocation, preliminary system architecture, systems analysis, system design, and the basics of test and evaluation. The course also addresses specific DoD systems engineering processes, as well as the DoD life-cycle acquisition framework. Various perspectives, from frameworks, processes, and standards, such as the DoD Architecture Framework (DODAF), DoD Joint Capabilities Integration and Development System (JCIDS), EIA 632, ISO 15288, IEEE 1220, IEEE 1471, and the International Council on Systems Engineering (INCOSE) models, are presented. Students analyze case studies. Students also use spreadsheet software for modeling and analyzing requirements and conceptual design alternatives. The course includes the application of fundamental systems engineering processes and methods to an integrative project, as well as development of communication skills through oral presentations and written reports. This course provides equivalency for DAU courses SYS 101 and SYS 202. Prerequisite: None.

SE3201 Engineering Systems Conceptualization (2-4) Any Quarter

Engineering of systems in the Enterprise, Societal and Environmental Context presents a view of how system development moves through four metaphases, Conceiving, Designing, Implementing, and Operating. The chosen terms are descriptive of activities that address hardware, software, and human integration, for product and process industries. Conceptualization begins with consideration of stakeholder capability, market, or opportunity need though early stage or conceptual design, and includes systems thinking and project management. This course on system conceptualization is the first in a series of three consecutive project courses that augments the core education for all resident students enrolled in the NPS Department of Systems Engineering's Master of Science in Systems Engineering curriculum. It is intended to provide authentic, hands-on engineering experience

within which to apply learning from the core sequence of systems engineering courses. Specifically, this course provides the opportunity to use the language, terminology, concepts, methods, and tools to develop the competency to be a systems engineer. Prerequisite: SE3100. SI3400 can be taken concurrently.

SE3202 Engineering Systems Design (2-4) Any Quarter

Engineering of systems in the Enterprise, Societal and Environmental Context presents a view of how system development moves through four metaphases, Conceiving, Designing, Implementing, and Operating. The chosen terms are descriptive of activities that address hardware, software, and human integration, for defense-related products and processes. Designing includes the design process, including phases and approaches, utilization of knowledge, designing for "X" (sustainability, reliability, manufacturability, etc.), disciplinary, and multidisciplinary design. This course on system design is the second in a series of three consecutive project courses that augments the core education for all resident students enrolled in the NPS Department of Systems Engineering's Master of Science in Systems Engineering curriculum. It is intended to provide an authentic engineering experience within which to apply learning from the core sequence of systems engineering courses. Specifically, this course provides you the language, terminology, concepts, methods, and tools to develop the competency to be a systems engineer. Prerequisites: SE3100, SE3201, SI3400. Corequisites: SE3302 can be taken concurrently.

SE3203 Engineering Systems Implementation & Operation (2-4) Any Quarter

Engineering of systems in the Enterprise, Societal and Environmental Context presents a view of how system development moves through four metaphases, Conceiving, Designing, Implementing, and Operating. The chosen terms are descriptive of activities that address hardware, software, and human integration, for generally for defense-related products and processes. Implementing includes hardware, software, and human systems considerations, test and evaluation, as well as design and management of the implementation process. Operating covers a wide range of issues from designing and managing operations, sustainability through logistics and supporting product lifecycle considerations and improvements, all the way through end-of-life planning. This course on system implementation and operation is the last in a series of three consecutive project courses that augments the core education for all resident students enrolled in the NPS Department of Systems Engineering's Master of Science in Systems Engineering curriculum. It is intended to provide an authentic engineering experience within which to apply learning from the core sequence of systems engineering courses. Specifically, this course provides you the language, terminology, concepts, methods, and tools to develop the competency to be a systems engineer. Prerequisites: SE3202, SE3302.

SE3250 Capability Engineering (3-2) As Required

This course presents a systems engineering approach to determining military capabilities required to execute a mission set. It introduces simulation as a method for assessing performance of a capabilities portfolio. Topics covered include current DOD and Naval practices for capabilities engineering, design and assessment of capability portfolios, and use of commercial and custom simulations to analyze capability portfolio performance. Prerequisites: OS3180 or equivalent, and SE3100.

SE3302 Systems Suitability (3-2) Spring/Fall

This course presents the techniques of system design and assessment for operational feasibility, including reliability, maintainability, usability (including human factors and human performance), supportability, and producibility. Design methods for open architecture of hardware and software are presented. Software integration and management from a systems perspective is presented. Prerequisites: SE3100.

SE3303 Systems Assessment (3-2) Winter/Summer

Systems under development must be assessed for cost and effectiveness, and both cost and effectiveness must be managed during systems trades. This course presents a systems engineering perspective for framing such trade decisions. Topics include cost estimation, effectiveness estimation through the test and evaluation process and modeling, techniques for engineering trades, and managing the risk involved. The course applies these fundamental systems assessment processes and methods to an integrative system project, building on work done in SE3100. Development of communication. Prerequisites: SE3302.

SE3321 Reliability Management and Data Systems (3-2) As Required

The course focuses on the practical aspects of reliability analysis and management. Reliability aspects and functions are explained and illustrated using examples and calculus-level mathematics. Topics include: basic tools and methods of reliability for developing complex systems including electronic components, mechanical components, and software; data needs for effective reliability analysis and how to design and implement systems to acquire and store that data; and the principles and practices for developing cost-effective dependable (reliability and availability) systems. Case studies are used to illustrate the material. Prerequisites: None.

SE3322 Reliability Centered Maintenance (3-2) As Required

The course covers the fundamentals of reliability centered maintenance and current practices following both military and industry standards. It also presents modifications that have been implemented for different applications and explains their suitability. An important aspect of the course is to examine and quantify the role of maintenance on operations, safety, and its economic benefits. Software tools for implementation are presented. The course includes a class project to develop and implement a pilot application of RCM to an identified site need. Prerequisite: SE3321.

SE3351 Human Factors in Systems Design (3-1) As Required

This course will provide an introduction to the field of Human Factors with an emphasis on military systems. Humans are the most important element of any military system. Consequently, the design of effective systems must take into account human strengths and limitations as well as considerations of human variability. The course surveys human factors, human-centered design, and system effectiveness and safety. Topics include system design in light of human cognition and performance as they are influenced by physiological, anthropometric and environmental considerations. Prerequisite: None.

SE3410 Modeling and Simulation Requirements and Proposals (4-0) As Required

This course teaches students to establish and write valid modeling and simulation requirements using a process that includes modeling

and simulation needs analysis, generation of valid modeling and simulation requirements, functional decomposition and conceptual model development, and issuance of "built to" or "buy to" performance specifications. The student will learn to compare M&S proposals received in response to those requirements against measurable program contributions and cost considerations. Prerequisite: MV/SE3101.

SE3411 System of Systems Program Definition and Concept Development (3-2) Fall

Same as MN3411. Managing the integration of Large System of Systems (SoS) through a Lead Systems Integrator brings together all developers through a single, central point of communication and control to direct work activities, plan for SoS integration, organize for effective scheduling, and build the team's commitment to successful integration and interoperability. SoS integration often poses confounding problems due to the myriad of interactions between systems and the overall meta-system. This course discusses the special problems of managing the integration of system of systems. Topics include the characteristics of the large scale SoS, program management of SoS integration, uses of SoS design and architecture for decision analysis, feasibility analysis and approaches for SoS integration, SoS contract management, and execution for SoS acquisitions. Prerequisite: A strong background in systems engineering or approval by instructor.

SE3412 System of Systems Design and Development (3-2) Winter

Same as MN3412. This course discusses the special problems of managing and engineering system of systems from the LSI perspective. Topics include characteristics of SoS in the LSI management environment, engineering implications of SoS issues, management and engineering methodology of SoS, SoS architecture, analysis of SoS, and tools for engineering and monitoring SoS. Managing the integration of SoS through an LSI requires attention to the meta-systems implications of changes at the systems level. This course discusses the special problems of managing the integration of system of systems from the LSI perspective. Topics from the LSI perspective include the characteristics of the large scale SoS, program management of SoS integration, uses of SoS design and architecture for decision analysis, feasibility analysis and approaches for SoS integration, SoS contract management, and execution for SoS acquisitions. Prerequisite: SE3411.

SE3413 System of Systems Integration, Qualification and Lifecycle (3-2) Spring

Same as MN3413. This course discusses these special problems of managing and engineering system of systems from the LSI perspective. Topics include complexity theory in program management (PM), integrated risk management, SoS program assessment strategy, SoS governance, SoS integration design & considerations, SoS performance analysis, SoS leading indicators and reference model strategy. Prerequisite: SE3411 and SE3412.

SE3420 Modeling and Simulation in Acquisition I (2-0) As Required

This course surveys the Pre-Acquisition modeling and simulation (M&S) activities, and the M&S used in the initial phases of the Acquisition Life Cycle, using the progression of different modeling and simulation applications in use in each phase as a benchmark. Upon completion, students are able to identify a particular M&S tool and apply it appropriately to the correct point in the lifecycle and to relate specific tools to the decision points that separate the acquisition phases. Prerequisite: MV/SE3313.

SE3430 Modeling and Simulation Strategy and Support Plans (4-0) As Required

This course introduces acquisition workforce professionals to the modeling and simulation (M&S) planning and the generation of support plan documents. This course presents the principles behind the development of the integrated Simulation Support Plan (SSP),surveys the System Engineering Plan (SEP) and Test and Evaluation Master Plan (TEMP),and develops the relationships between them. Prerequisite: MV/SE3101.

SE3501 Distributed Systems Engineering (3-2) As Required

This course is designed as part of the Network-Centric Systems Engineering track of the Master of Science in Systems Engineering (MSSE) program. The course provides the student with an understanding of the principles, concepts, and technology that allow a network-centric enterprise to function. Subject matter includes system communications, computer-based processes, naming conventions, process synchronization, consistency, replication, state-of-the-art middleware, and distributed information systems. Prerequisites: CS2011, SE3130, and CS2020.

SE3503 System Performance Evaluation (3-2) As Required

This course provides the student with the principles, concepts and techniques needed to analyze and plan the capacity of computer systems. The course relies on the use of analytic queuing network models of computer systems. Queuing network modeling is applied to evaluating the performance of centralized, distributed, parallel, client/server, and Web-based systems performance. The course also covers performance measurement tools for various computer operating systems and for large-scale, network-centric systems. Prerequisites: CS2011, CS2900 and SE3501, or consent of instructor.

SE3810 Systems Engineering Seminar (0-2) Fall/Winter/Spring/Summer

This weekly seminar on topics in Systems Engineering is intended to broaden and extend knowledge horizons beyond material covered in regular classes, to provide opportunities for critical discussion of systems engineering topics, to relate course work to the real world and emphasize the implications of engineering choices on a society as a whole, and to promote good lifelong learning habits. The course will provide operational, historical, cultural, and economic contexts for the material studied in the SE curriculum. It will also promote the recognition of, critical analysis of, and planning for development and exploitation of future military capabilities. Students will be required to read, analyze, and discuss in class at least four books per quarter selected by the faculty to address an overall theme that will vary from quarter to quarter. Graded on a Pass/Fail basis only. Prerequisites: None.

SE3900 Topics in Systems Engineering and Analysis (3-0) As Required

This course presents topics in systems engineering and analysis that are relevant to the across-campus project or that meet special interests of the students. Prerequisite: Consent of instructor.

SE3910 System Evolution and Technology Assessment (4-0) As Required

This course discusses technological change, its impact on systems, and ways to predict the impact of future technology developments on system development. General topics include understanding the rate of technological change, how innovations are developed and adopted, methodologies for assessing technology growth and evolution (forecasting), limits on technological growth, and

examples of technology assessment. This course uses a seminar approach with out-of-classroom reading and in-class discussions of the reading replacing traditional lectures. Prerequisites: SE3100, SI3400, SE3302, and SE3303 or consent of instructor.

SE4003 Systems Software Engineering (3-2) As Required
This course is designed to teach students the basic concepts of software engineering and methods for requirements definition, design and testing of software. Specific topics include introduction to the software life cycle, basic concepts and principles of software engineering, object-oriented methods for requirements analysis, software design and development. Special emphasis is placed on the integration of software with other components of a larger system. Prerequisites: SE3100.

SE4007 Introduction to Systems Engineering (3-1) Spring/Summer/Fall/Winter
This course provides an overview of the art and science of systems engineering and an introduction to the systems approach and methodological framework for designing, implementing, managing, and reengineering large-scale systems and processes. Topics covered include the systems approach, understanding and defining customer (stakeholder) problems, eliciting and defining stakeholder requirements, defining stakeholder-driven value systems, developing alternative system concepts, and functional modeling and analysis of alternatives. Students will carry out projects and assignments both individually and as teams. Prerequisites: SI3400 or equivalent.

SE4008 Systems Engineering and Integration (2-1) As Required
Customer requirements modeling and subsequent system functional and architecture modeling, form the basis for engineering and integrating complex technical systems and processes. This course provides the student with the language, terminology, and concepts of system architecting and an introduction to various types of architectures and their interrelationships. Topics covered include organizational systems, architecture modeling (e.g., the Hatley/Hruschka/Pribhai Method, the Rummler-Brache Method), types and relationships of architectures and architectural frameworks (including the C4ISR Framework and the Zachman Framework), human and cultural aspects of architecting, process engineering, information engineering and architectures, and knowledge formation and distribution. Students will carry out projects and assignments both individually and as teams. Prerequisites: SE4007.

SE4009 Systems Architecture for Systems Engineering (2-1) As Required
This course provides the student with an understanding of the context and framework for carrying out a systems engineering project and the system-level responsibilities of a systems engineer. Topics covered include systems architecture, systems design and development, system test and evaluation, system reliability, system maintainability, human factors and system design, system producibility and supportability, balancing live cycle cost, schedule, suitability, and performance, and systems engineering project management and control. Types of systems considered will range from small-scale to large-scale and from primarily technical to primarily social-political. Students will work in teams to complete a system engineering project to analyze, design and architect a working prototype system. Prerequisites: SE4008, or equivalent.

SE4011 Systems Engineering for Acquisition Managers (3-2) As Required
Systems engineers flow requirements down to detailed elements, integrate elements, and verify system performance. This course concentrates on the structural and technical elements of system engineering necessary in the product development domain. Multidisciplinary activities leading to requirements analysis, design trades, and integrated product-process development are complemented by current best manufacturing practices and design for cost principles. Structured methods, decision analysis, and quality engineering foundations are emphasized. Case studies from a variety of industrial contexts are presented and discussed. This course is team taught by experts from several disciplines. Prerequisites: None.

SE4012 Management of Advanced Systems Engineering (4-0) As Required
This course provides the student with an understanding of architecting, Object Oriented Systems Engineering, the Unified Modeling Language, and the control of complex projects with many Systems Engineers through the use of metrics. Specific emphasis is placed on exploring the relationship between science, art, deductive processes, inductive processes, systems engineering, and acquisition management. In order to solve today's complex problems, the student will become familiar with heuristic tools. This course is equivalent to DAU SYS 301. Prerequisites: None.

SE4112 Combat Systems Engineering III (3-2) Summer
This course applies systems engineering principles to the design of combat systems with emphasis on detection, tracking, and identification systems. Sensor technologies covered include radars, ESM, active and passive sonar, infrared, electro-optical, and magnetic/electric/gravity field sensors. The emphasis is on what the elements contribute to a combat system, their basic principles of operation, their performance limitations, trade-offs, and their interfaces with the rest of the combat system. This course builds on the material offered in SE3112 (Intro to Sensors). Prerequisites: SE3112.

SE4113 Combat Systems Engineering IV (3-2) As Required
This course extends the coverage of SE3113 (Conventional Weapons) to include unconventional weapons. Topics include information warfare and weapons (including electronic warfare), directed energy weapons, weapons of mass destruction (nuclear, chemical, biological, and radiological), and nonlethal weapons. It introduces the student to both the effects that unconventional weapons can produce as well as the technologies needed by weapons systems to create those effects. It is designed to provide familiarization of the student with critical weapons concepts that are necessary for enlightened examination of both technology development and military planning. Prerequisite: SE4112.

SE4115 Combat Systems Integration (3-2) As Required
This course presents systems engineering techniques for integrating combat systems into a common system, including technology development, system development and integration, network integration, and system of systems integration. Lectures and projects exploring engineering design tools and analysis methods to meet specified systems requirements are used. Topics include engineering analysis of interfaces for power, data, mechanical, and other attributes; engineering change management; advanced collaboration environments; technology readiness levels; and integration risk mitigation. Prerequisites: SE3113, SE4112 or consent of instructor.

SE4150 Systems Architecture and Design (3-2) As Required
The use of models, from stakeholder needs to requirements, to system functional and physical architecture, through performance specification, for the basis for architecting and designing complex technical systems. This course provides the student with the language, terminology, concepts, methods, and tools of system architecting and design, including exploring the relationship between science, art, and deductive and inductive processes. Topics covered include architecture modeling (e.g. Hatley/Hruschka/Pirbhai and Rummler-Brache Methods), architectural frameworks (including Zachman and DoDAF), object oriented modeling approaches using Unified Modeling Language (UML) and Systems Modeling Language (SysML), human and cultural aspects of architecting and design, requirements generation and definition, and knowledge formation and distribution. Students carry out projects and assignments both individually and as teams. Prerequisites: SE3100 and SE3250.

SE4151 Systems Integration and Development (3-2) As Required
This course provides the student with an understanding of the context and framework for planning and carrying out integration and development, including emergent behavior, manufacturing, and production of complex systems. Topics covered include systems and SoS integration and production with consideration of multiple suitability aspects, including availability, reliability, maintainability, embedded software, human factors, producibility, interoperability, supportability, emergent behavior, life cycle cost, schedule, and performance. Types of systems considered are large-scale spanning applications from purely technical to socio-technical. Students work in teams to complete a systems engineering project to analyze, integrate, and produce a working prototype system. Prerequisite: SE4150.

SE4321 Reliability Growth and Accelerated Testing (4-1) As Required
This course covers mathematical and statistical models used in advanced reliability engineering and the art of their application. Reliability growth models include the AMSSA- Crow, Duane, and Lloyd-Lipow models. Accelerated testing models include the Arrhenius, Eyring, and Inverse-power Law. Statistical and practical issues in model selection and parameter estimation are discussed. Particular emphasis is placed on design of test plans. Prerequisite: OA4302.

SE4350 Logistics Engineering (4-0) As Required
Also offered as MN4310. Prerequisites: OS3180 or equivalent, SE3100 and SI3400.

SE4353 Risk Analysis and Management for Engineering Systems (3-2) Spring/Fall
This course covers three areas in the risk field - Qualitative Risk Analysis, Quantitative Risk Analysis, and Decision Risk Analysis. Qualitative Risk Analysis presents techniques for risk identification/evaluation, risk handling, risk monitoring and risk management. Quantitative Risk Analysis includes Probabilistic Risk Assessment (RPRA) of system performance and project cost/schedule. Decision Risk Analysis gives the students an understanding of how to apply risk and cost benefit techniques in decision making when one must deal with significant risk or uncertainty. The course will present a framework for balancing risks and benefits to applicable situations. Typically these involve human safety, potential environmental effects, and large financial and technological uncertainties. Concepts are applied toward representative problems resulting in risk and decision models that

provide insight and understanding, and consequently lead to more successful projects/programs with better system performance within cost and schedule. This is the same course as ME4753. Prerequisites: OS3180/OS3104, or equivalent graduate level course in probability, or consent of the instructor.

SE4354 Systems Test and Evaluation (4-0) As Required
This course is designed to cover principles of test and evaluation (T&E) and the roles, purposes, functions, and techniques of T&E within the systems engineering process. The course will cover all aspects of T&E throughout the life cycle of a system to include test planning, test resources, development of test requirements, selection of critical test parameters, development of measures of effectiveness and performance, test conduct, analysis of test results, and determination of corrective action in the event of discrepancies. The course will emphasize the application of T&E through all phases of system development to include modeling and simulation (M&S) activities for enhancing the T&E process, developmental test and evaluation (DT&E), live fire test and evaluation (LFT&E), and operational test and evaluation (OT&E). Principles of experiment design and statistical analysis of test results will be reviewed. The course content will be consistent with Congressional and DoD requirements and guidelines and will include case studies and lessons learned from actual defense system tests. This course also offered as OA4603. Prerequisites: OS3180 or equivalent and SE3100.

SE4414 LSI - Leadership in System Integration (4-0) Summer
Same as MN4414. Most major DoD acquisition activities are not the development of new systems but the improvement and integration of existing legacy systems. Furthermore, this acquisition activity is made exceptionally complex because the systems need to be integrated with a "Systems-of-Systems" (SoS) approach. SoS acquisition, development, and integration require skills in system integration that exceed those required with standalone system acquisition. These skills are embodied in the role of the "Lead System Integrator" (LSI), previously a contractor, but increasingly a DoD employee. In this course we examine the roles of the LSI, where DoD acquisition skills may need to be strengthened to perform as the LSI, and discuss methods and tools to do so. This course is a capstone to SE3411, SE3412, and SE3413.

SE4420 Modeling and Simulation in Acquisition II (2-0)
This course surveys the M&S used in the final phases of the Acquisition Life Cycle, using the progression of different modeling and simulation applications in use in each phase as a benchmark. Upon completion, students will be able to identify a particular tool and apply it appropriately to the correct point in the lifecycle and relate specific tools to the decision points that separate the acquisition phases. They will be able to identify sustainment and training support M&S for a representative system. Prerequisite: SE3420.

SE4501 Network-Centric Enterprise Design and Engineering (3-2) Spring
This course provides the concepts, principles, and approaches necessary to understand the enterprise (warfighting force or business organization—private or public) as a functioning system or system of systems. It also introduces a method for enterprise modeling and design and discusses the functions of enterprise engineering. As a result, the student will be given the tools to

understand large-scale system (i.e., enterprise) engineering and its relationship with network-centric technologies and components. Prerequisites: CS2011, CS2020 and SE3501, or consent of instructor.

SE4503 Technology Planning and Replacement (3-2) Spring

Often, enterprise managers make information resource management decisions based only on costs of acquiring, maintaining, and replacing information technology—the proverbial IT tail wags the business dog. While cost is certainly important, planning and replacement of the IT infrastructure should be driven by a solid business case based on total enterprise needs. This course examines the business-driven approach to information resource management in a network-centric enterprise. Prerequisites: SE3130 or consent of instructor.

SE4900 Advanced Studies in Systems Engineering (3-0) Quarterly

Directed study at an advanced graduate level based on textbooks, journal literature, experimental projects, or other sources. This course is designed to permit study of a selected topic at an advanced level, and which is not available for study through regularly scheduled courses. Prerequisites: Consent of program officer, academic associate, and instructor.

SE4930 Model-Based Systems Engineering (3-2) Quarterly

Practical systems engineering relies heavily on models during conceptualization, system definition, system design, system integration, as well as system assessment. This course addresses the use of models in all phases of the systems engineering process. Details of widely-used processes for modeling are described and these tools are used in laboratory exercises and projects. This course uses a seminar approach with out-of-classroom reading and in-class discussions of the reading replacing traditional lectures. Prerequisites: SE3100, SI3400, SE3302, and SE3303.

SE4950 System of Systems Engineering (4-0) Quarterly

Systems of systems (SoS) arise when a number of independently developed systems are integrated to perform tasks of which the independent systems are incapable. This course discusses the special problems of engineering systems of systems. Topics include characteristics of SoS, engineering management of SoS, engineering methodology of SoS, SoS architecture, analysis of SoS, and tools for engineering SoS. This course uses a seminar approach with out-of-classroom reading and in-class discussions of the reading replacing traditional lectures. Case studies are used extensively. Prerequisites: SE4150 and SE4151.

SE5810 Dissertation Research (0-8) Quarterly

Dissertation research for doctoral students. Required in the quarter following advancement to candidacy and then continuously each quarter until dissertation is approved by the Academic Council. Prerequisite: Advancement to Candidacy.

SE5900 Doctoral Research Initiation (0-8) Quarterly

This course provides program continuity and assistance to doctoral students in finding a dissertation topic and supervisor and subsequently initiating a dissertation research program. Required in the quarter following completion of doctoral-level course work and then continuously each quarter until advancement to candidacy.

SI Courses

SI0810 Integrating Project (0-8) Spring/Summer/Fall/Winter

This course serves as a final synthesis of the entire systems engineering curriculum. The course requires completion of an integrating project where student teams provide solutions using systems engineering methods and project management techniques. Prerequisite: Consent of instructor.

SI3400 Fundamentals of Engineering Project Management (3-2)

This course examines modern techniques of engineering project management from a systems perspective, including project planning, organization, and control. Specific topics include discussion of the systems engineering management process, risk management, scheduling methodologies, the DoD acquisition environment, management of design activities, PERT, CPM, and project control mechanisms. Case studies are used to examine application of principles. Large-scale system management, mitigation of technical risk, integrated product and process development, quality management, contracting, and the international environment are discussed. Large scale systems management problems are examined using commercial software suites. Covers application of fundamental systems project management processes and methods to an integrative system project. Development of communication skills is accomplished through oral presentations and written reports. Prerequisite/co-requisite: SE3100.

SI4021 Systems Engineering for Product Development (4-0) Summer/Winter

Systems engineers flow requirements down to detailed elements, integrate elements, and verify system performance. This course concentrates on the structural and technical elements of system engineering necessary in the product development domain. Multidisciplinary activities leading to requirements analysis, design trades, and integrated product-process development are complemented by current best manufacturing practices and design for cost principles. Structured methods, decision analysis, and quality engineering foundations are emphasized. Case studies from a variety of industrial contexts are presented and discussed. This course is team taught by experts from several disciplines. Prerequisites: None.

SI4022 Systems Architecture for Product Development (4-0) Summer/Winter

Systems architects respond to user needs, define and allocate functionality, decompose the system, and define interfaces. This course presents a synthetic view of system architecture: the allocation of functionality and its projection on organizational functionality; the analysis of complexity and methods of decomposition and re-integration; consideration of downstream processes including manufacturing and operations. Physical systems and software systems are discussed. Heuristic and formal methods will be presented. Students are given research assignments that provide opportunities to further learn how systems architecture principles are applied in a variety of application areas. This course provides an integrative forum for PD21 students to stimulate holistic, global, and innovative thinking, and to enable critical evaluation of current modes of architecture. Prerequisites: None.

SI4900 Advanced Studies in Systems Engineering and Integration (3-0) As Required

This course presents advanced topics in Systems Engineering relevant to in depth, focused graduate research and thesis work.

Course may be repeated for credit. Prerequisite: Consent of instructor.

Modeling and Simulation Management Certificate - Curriculum 265

Program Point of Contact

Dr. Gene Paulo

Systems Engineering Department
Bullard Hall, Room 201F

(831) 656-3452

eppaulo@nps.edu

Brief Overview

The Modeling and Simulation Management Certificate consists of 4 courses designed to enable DoD workforce members to efficiently apply Modeling and Simulation (M&S) tools to support acquisition activities throughout a program lifecycle. M&S acquisition requires substantial up front planning and unique considerations for their effective use. Upon completion of this certificate program, students will be awarded a certificate of completion from the Naval Postgraduate School. The Modeling and Simulation Management Certificate program is targeted primarily at personnel in the DoD Acquisition Workforce but has great benefit for all students who seek further knowledge regarding the purposeful, effective application of M&S systems to support the acquisition lifecycle.

Requirements for Entry

The student must have a baccalaureate degree with above-average grades. DAU ACQ101 and ACQ102 or MN3331 or other equivalents are assumed prerequisites.

Entry Date

Fall and Spring quarters

Program Length

12 months

Required Courses

MV/SE3101	Introduction to M&S in DoD
SE3420	Modeling and Simulation in Acquisition I
SE4420	Modeling and Simulation in Acquisition II
MV4460	Management of Modeling and Simulation

Systems Engineering Certificate - Curriculum 282

Program Officer

Joe Keller, CDR, USN

Code 74, ME Building, Room 107

(831) 656-2033, DSN 756-2033
jjkeller@nps.edu

Academic Associate

Gene Paulo, Associate Professor
Code D/SE, Bullard Hall, Room 201F
(831) 656-3452, DSN 756-3452
eppaulo@nps.edu

The Department of Systems Engineering offers a four-course academic certificate in Systems Engineering. The four courses are offered online, beginning Spring and Fall quarters.

Requirements for Entry

For entry, the officer must have at least a C+ undergraduate grade point average, with at least one calculus course with a C or better and at least one calculus-based physics course with a C or better (APC 334). If an officer is an outstanding performer but lacks the necessary academic preparation, the Naval Postgraduate School offers refresher and transition courses before the program start.

Typical Course of Study

Quarter 1
SE3100	(3-2)	Fundamentals of Systems Engineering

Quarter 2
SE3302	(3-2)	Systems Suitability

Quarter 3
SE3303	(3-2)	Systems Assessment

Quarter 4
SI3400	(3-2)	Fundamentals of Engineering Project Management

Systems Engineering Analysis Program - Curriculum 308

This curriculum is described under the Systems Engineering Analysis Curriculum and Program section of this Catalog. The Department of Systems Engineering supports this curriculum with courses, faculty and project advisors. Selected students in the 308 curriculum may earn the MS SE degree, awarded by the Department, if they meet all of the MSSE degree requirements.

Systems Engineering Analysis - Mixed Mode - Curriculum 309

Systems Engineering (DL) - Curriculum 311

Program Officer

Joe Sweeney, Lecturer
Bullard Hall, Room 217

(831) 656-2476
jsweene@nps.edu

Academic Associate

Gene Paulo, Associate Professor

Code D/SE, Bullard Hall, Room 201F

(831) 656-3452, DSN 756-3452

eppaulo@nps.edu

Brief Overview

The Master of Science in Systems Engineering DL degree program is designed for Navy System Commands and DoD organizations involved in a wide range of systems engineering and integration challenges. These commands can partner with NPS to educate and train engineers with tools and technologies relevant to their work, resulting in employees with greater knowledge and expertise to enable them to better meet the needs of their customers.

DoD organizations or sponsors provide the students, and the Department of Systems Engineering provides the instruction, course materials, and hands-on experience. Courses are delivered at the students' local sites using a combination of on-site instruction, video teleconferencing, and Web-enhanced online courses. The program can begin any academic quarter, in accordance with the sponsor's needs.

Students normally take two courses per quarter over a two-year period. There are nine core courses and a three course capstone project sequence in the 16-course program. The remaining four courses can be tailored to meet the sponsor's need. Students must participate in a capstone design project in lieu of writing a thesis.

Students receive an NPS degree, may receive NPS Systems Engineering certificates of accomplishment, and earn DAU equivalency certificates for all SPRDE Level III training requirements.

The program manager will help establish partnership arrangements with other organizations if desired. Additional information on the program can be found at http://www.nps.edu/Academics/GSEAS/se/

Requirements for Entry

An entering student must possess a Bachelor of Science degree in an engineering or related discipline with at least a 2.2 undergraduate grade-point average. Students must have completed ACQ101 and ACQ102 if they wish to receive SPRDE credit.

Entry Dates

This is an eight-quarter curriculum that may start any quarter chosen by the sponsor.

Degree

Master of Science in Systems Engineering

To be considered for this degree, a student must meet the degree requirements (including an ABET EAC accredited engineering BS degree or documented equivalent) and complete all the requirements of curriculum 311.

Master of Science in Engineering Systems

Students who enter without an ABET EAC accredited engineering BS degree and cannot establish equivalency but have had calculus, and who complete all the requirements of curriculum 311, will earn a Master of Science in Engineering Systems degree.

Typical Course of Study

The typical course of study for curriculum 311 involves a nine course core systems engineering sequence, a three-course project, and an agreed-upon emphasis or domain track of four courses. This track is selected by the sponsor, program manager, and academic associate.

Quarter 1

SE3100	(3-2)	Fundamentals of SE
SE3011	(3-2)	Eng Econ and Cost Est

Quarter 2

SE3302	(3-2)	Systems Suitability
SE3250	(3-2)	Capability Engineering

Quarter 3

SE3303	(3-2)	System Assessment
SE4150	(3-2)	Systems Architecture and Design

Quarter 4

SI3400	(3-2)	Fundamentals of Engineering Project Management
SE4003	(3-2)	Systems Software Engineering

Quarter 5

SE4151	(3-2)	System Integration and Development
Elective	(3-0)	Domain/Track Elective

Quarter 6

SE3201	(2-4)	Engineering Systems Conceptualization

Elective	(3-2)	Domain/Track Elective

Quarter 7

SE3202	(2-4)	Engineering Systems Design
Elective	(3-2)	Domain/Track Elective

Quarter 8

SE3203	(2-4)	Systems Implementation & Operation
Elective	(3-2)	Domain/Track Elective

Systems Engineering - Curriculum 580

Program Officer

Joe Keller, CDR, USN
Code 74, Watkins Hall, Room 107A

(831) 656-2033, DSN 756-2033
jjkeller@nps.edu

Academic Associate

Mark Stevens

Bullard Hall, Room 201I

(831) 656-7545, DSN 756-7545
mstevens@nps.edu

Brief Overview

Systems Engineering at NPS provides a broad education in systems engineering methods and tools, and depth in a particular domain of application. Several domain tracks are offered, including combat systems engineering, ship systems engineering, and network-centric systems engineering. Other tracks are added, based on sponsor and student demand. The tracks consist of seven or more courses to gain depth in the domain area. These tracks complement the standard set of systems engineering courses. The curriculum is interdisciplinary and draws on courses from across campus.

Students come from the uniformed services, civilian members of government, and from foreign military services. Navy Engineering Duty Officers constitute a substantial portion of the students.

Requirements for Entry

Students must have an academic profile code of 323, which implies a 2.2 or better undergraduate GPA, a calculus sequence with a C+ or better grade, and a calculus-based physics sequence with a C+ or better grade.

Entry Dates

Students may enter this curriculum twice a year, in September or March. Students requiring a refresher quarter to meet entrance requirements will begin in July or January. For further information, contact the Program Officer or Academic Associate for this curriculum.

Degrees

Master of Science in Systems Engineering

To be considered for this degree, a student must meet the degree requirements (including an ABET EAC accredited engineering BS degree or documented equivalent) and complete all the requirements of curriculum 580.

Master of Science in Engineering Systems

Students who enter without an ABET EAC accredited engineering BS degree and cannot establish equivalency, and who complete all the requirements of curriculum 580, will earn a Master of Science in Engineering Systems degree.

Subspecialty

Completion of this curriculum qualifies a naval officer as a systems engineering sub-specialist, subspecialty code 5800. The curriculum sponsor is the Commander, Naval Sea Systems Command.

Typical Course of Study

Students have a wide set of options for their specialization tracks. Below is a typical course matrix for the ship systems track.

Refresher Quarter

Quarter 1

OS3180	(4-1)	Probability and Statistics for Systems Engineering
SE3100	(3-2)	Fundamentals of Systems Engineering
AE2440	(3-2)	Introduction Digital Computing
TS3000	(3-2)	Electrical Power Engineering
SE3810	(0-2)	Systems Engineering Seminar

Quarter 2

SI3400	(3-2)	Fundamentals of Eng. Project Management
TS3003	(3-2)	Naval Combat System Elements
SE3250	(3-2)	Capability Engineering
TS3001	(3-2)	Naval Architecture
SE3810	(0-2)	Systems Engineering Seminar

Quarter 3

TS4000	(3-2)	Naval Combat System Engineering
SE3302	(3-2)	System Suitability
TS4001	(3-2)	Integration of Naval Engineering Systems
SE4150	(3-2)	Systems Architecting and Design
SE3810	(0-2)	Systems Engineering Seminar

Quarter 4

OS4680	(4-0)	Naval Systems Analysis
SE4151	(3-2)	Systems Integration and Development

TS4002	(2-4)	Ship Design Integration
SE3201	(2-4)	Engineering Systems Conceptualization
SE3810	(0-2)	Systems Engineering Seminar

Quarter 5

OA3401	(3-1)	Human Factors in System Design
TS4003	(2-4)	Total Ship Systems Engineering
SE3202	(2-4)	Engineering Systems Design
SE0811	(0-8)	Thesis
SE3810	(0-2)	Systems Engineering Seminar

Quarter 6

SE3011	(3-2)	Engineering Cost Estimation
Track Elective		
Advanced SE Elective		
SE0811	(0-8)	Systems Engineering Thesis
SE3810	(0-2)	Systems Engineering Seminar

Quarter 7

Advanced SE Elective		
SE0811	(0-8)	Systems Engineering Thesis
SE0811	(0-8)	Systems Engineering Thesis
NW3230	(4-2)	Strategy and Policy

Educational Skill Requirements
Systems Engineering Curriculum 580
Subspecialty Code 5800P

Officers entering the Systems Engineering curriculum will be offered the necessary preparatory-level courses to satisfy the equivalent of a baccalaureate degree in engineering. They shall meet, as a minimum, the requirements set forth by the Engineering Accreditation Commission of ABET. At the graduate level, the officer will acquire the competence to effectively contribute as a systems engineer to naval systems research, design, development, maintenance and acquisition. The officer will gain the ability to effectively integrate future technological, engineering, and acquisition approaches with existing practice through a combination of core systems engineering courses, specialization studies, and project/thesis research. An officer will meet the below-listed ESRs through the completion of a program of study determined by the officer, the Program Officer, and the Academic Associate. Individual programs, and how they support the officer's attainment of the ESRs, will be specifically designed to meet the needs of the Navy and the officer's interests.

1. **Undergraduate Mathematics and Basic Sciences:** Understand and apply engineering-baccalaureate-equivalent mathematics and basic sciences. For mathematics, this includes single- and multi-variable differential and integral calculus, ordinary differential equations, probability, and statistics. Basic sciences include physics, chemistry, and terrestrial sciences. This can be met by the appropriate undergraduate work.

2. **Capability Engineering:** Model and analyze military operations in the context of achieving needed capability. Apply model-based systems engineering approaches, based on UML or SysML, and modeling and simulation techniques, and be able to assess legacy systems, emerging technological concepts, and as-yet-to-be-developed concepts into the joint warfighting environment considering technology readiness levels, effectiveness, cost, and risk. Understand the process of warfighting gaps to synthesis of as-yet-realized system concepts to meet emerging capability needs. Understand and apply modeling and simulation to include deterministic and stochastic modeling of systems, economic models, cost models, and life-cycle suitability analyses. This includes the ability to develop original discrete-event and continuous run-time simulations, as well some familiarity with large-scale government and commercial warfighting simulations.

3. **System Architecting:** Perform system architecting, applying and integrating methods for both software and hardware aspects. Construct feasible system functional and physical architectures that represent a balanced approach to meeting stakeholder needs and expectations, stated, implied, and derived system requirements, and suitability objectives such as being open, modular, extensible, maintainable, and reusable. Understand system architecture frameworks and their role in architecture development. Use model-based systems engineering techniques, based on UML or SySML to create, define, and develop system architectures. Develop, analyze, and compare alternative architectures against appropriate, system-level evaluation criteria and select the best based on quantitative and qualitative analysis, as appropriate.

4. **System Design:** Understand and apply the system design process in a holistic context, applying and integrating methods for both software and hardware aspects including identifying capability need, defining requirements, conducting functional analysis and allocation to hardware, software, and human elements, creating a system functional design, designing a system, deriving and defining requirement specifications, allocating requirement specifications to sub-systems (for hardware, software, and human elements), design for suitability, including reliability, availability, maintainability, operability, and logistical supportability, perform system assessment by conducting trade-off studies, evaluating system design alternatives against system capability need expressed as military effectiveness, estimating and analyzing the system cost and risk, including risk mitigation strategies, integrating human elements into the system

design, and analyzing and planning for system testing and evaluation.

5. **Engineering Design Analysis:** Understand and apply core qualitative and quantitative methods of engineering design analysis, to include problem formulation, alternatives development, alternatives modeling and evaluation, alternatives comparison, optimization, decision analysis, failure analysis, risk analysis, and futures analysis. Mathematical techniques may include multiple criteria optimization, design of experiments, response surface methods, set-based design, real options, systems dynamics, and probabilistic analyses.

6. **System Integration and Development:** Apply the core skills of system integration and development to include integrating relevant technological disciplines that bear on the system effectiveness and cost, including weapons, sensor and information systems, while being responsive to realistic military capability need and warfighting effectiveness, requirements, functions, specifications, cost, and risk. Integrate systems and analyze aspects during the entire life-cycle. Understand system realization methods and processes, including prototyping and production. Apply production quality methods for continuous process improvement, such as statistical process control, lean, and six sigma.

7. **System Test & Evaluation:** Apply the core skills of system test and evaluation to include system effectiveness while being responsive to realistic military capability need and warfighting effectiveness, requirements, functions, and specifications. Evaluate systems and analyze test and evaluation aspects during the entire life-cycle using inferential statistics methods, including design of experiments (DOE) and analysis of variance (ANOVA). Apply fundamental verification and validation principles to systems development methods.

8. **Human Systems Integration:** Address human factors during requirements definition, as well as workload, safety, training, operability and ergonomics during design. Conduct functional analysis and allocation to human elements, performing cost-risk-effectiveness trade-offs among hardware, software, and human elements. Evaluate proposed designs for man-machine integration, human performance testing, and usability during development test and evaluation. Understand basic human biology as applied to human systems.

9. **Project Management:** Work as a team member or leader on a military systems engineering project. Demonstrate an understanding of project management principles. Demonstrate competence in the planning and management of complex projects. Understand the principles of and apply current industry approaches and technology to manage systems design, integration, test, and evaluation for large engineering projects.

10. **Specialization:** Demonstrate in-depth understanding of the principles, technologies, and systems used in at least one major specialty area. These areas can be specific warfare areas, such as combat systems, total ship systems, EW, IW, avionics, undersea warfare, or net-centric systems,, a single traditional engineering specialty, such as mechanical, electrical, software, aerospace engineering, or naval architecture, or specialized disciplines such as human factors, availability, or safety. Demonstrate in-depth understanding of the scientific and engineering principles of the respective specialty, such as sensors, weapons, C4I systems, information systems, ship structures, hydrodynamics, power systems, and reliability. Demonstrate broad understanding of systems context of the specialization. Apply that understanding to the design of system components, sub-systems, and interfaces in the holistic context of the engineering of systems.

11. **Joint and Maritime Strategic Planning:** American and world military history and joint and maritime planning including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. maritime component of national military strategy; the organizational structure of the U.S. defense establishment; the role of the commanders of unified and specified commands in strategic planning, the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

12. **Thesis:** Conduct independent analysis and research in the area of Systems Engineering, and show proficiency in presenting the results in writing and orally by means of a thesis and command-oriented briefing appropriate to this curriculum.

Systems Engineering PhD - Curriculum 581

Program Officer

Paul Montgomery, LCDR, USN

(831) 656-5448, DSN 756-5448
prmontgo@nps.edu

Academic Associate

Gene Paulo, Associate Professor
Code D/SE, Bullard Hall, Room 201F

(831) 656-3452, DSN 756-3452

eppaulo@nps.edu

Brief Overview

The Department of Systems Engineering offers a Doctor of Philosophy (Ph.D.) degree in Systems Engineering. Students take graduate level courses in systems engineering (as needed to pass the oral and written qualifying examinations), advanced graduate courses in systems engineering and an application domain, and perform research that leads to a dissertation involving some aspect of systems engineering. Research topics may be selected from a broad variety of studies of the systems engineering process, applications of systems engineering to solving complex problems, systems level modeling and simulation, and systems suitability assessment. Subject to approval of the student's dissertation committee chairman, dissertation research may be conducted away from NPS at cooperating facilities. Students must satisfy a one-year residency requirement. This may be met by completing periodic extended stays (nominally two weeks per quarter) at an NPS campus spread throughout the duration of the student's program.

Ideally, applicants should possess an M.S. degree in Systems Engineering. Applicants with only a B. S. degree or an M.S. degree in another discipline will be required to take a number of systems engineering courses (equivalent to the coursework portion of an MSSE degree program) to pass the qualifying examinations. Unless an M.S. thesis and any other ABET EAC accreditation requirements are also satisfied, an M.S. in Systems Engineering degree will not be awarded for this preparatory work.

Systems Engineering Management (MSSEM) /Product Development (DL) - Curriculum 721

Program Officer:
Joe Sweeney, Lecturer
Bullard Hall, Room 217

(831) 656-2476
jsweene@nps.edu

Academic Associate:
Ron Carlson
Patuxent River, MD

(301) 757-9743
rrcarlso@nps.edu

Brief Overview

The Naval Postgraduate School (NPS), as a partner in the Massachusetts Institute of Technology's (MIT) "Educational Consortium for Product Development Leadership in the 21st Century" (PD21), is delivering a joint executive systems engineering management degree using distance learning methods to military officers, senior enlisted, federal civilians, and a limited number of defense contractor civilians. The program's joint focus is on joint services, joint engineering-management and joint government-industry. The executive SEM-PD21 degree program is modeled after the graduate program developed jointly by MIT's School of Engineering and Sloan School of Management. The executive SEM-PD21 degree program is designed to produce a cadre of change agents skilled in engineering and management to bring about dramatic improvements in the way American corporations and the defense industry develop and build new systems and products.

Participants in this unique program are exposed to state-of-the-art concepts and tools, as well as world-class companies, leaders, and cross-industry best practices. Students acquire the basic skills and strategic perspective necessary to become future leaders and senior managers responsible for driving product development and business growth through innovation and to become effective change agents at their organizations. They develop a mindset receptive to change and continuous improvement, an understanding of the enablers to business success, and an enhanced ability to recognize barriers to success early in the product development cycle when corrective actions are least costly.

The SEM-PD21 curriculum is an eight-quarter distance learning curriculum with entry in the Fall quarter, which begins in late September with an on-site two-week kickoff at NPS in Monterey, CA. After the kickoff, classes are taken at students' locations by web teleconferencing or online web-based courses. Students are expected to participate in two or three industry trips during the two-year course of study and a graduation ceremony in Monterey at the completion of the program. There will also be occasional Systems Engineering and Product Development seminars for all SEM-PD21 students within their existing course of study.

SEM-PD21 website:
www.nps.edu/DL

Requirements for Entry
For admission into the PD-21 program, the student must hold an undergraduate degree in engineering, a related scientific or technical field, with high academic achievement. The student must be sponsored by an organization committed to supporting the student's full participation and have at least five years of experience directly related to product development (three years if student holds a master's degree). The application requirements can be found at the joint executive SEM-PD21 website at: www.nps.edu/DL.

Program Starting Date
September (Fall quarter)

Program Length

Eight distance learning quarters (two years).

Degree

The student may choose one of the following three degrees. Graduates also earn a MIT certificate signed by Dean of the MIT Sloan School of Management and Dean of the MIT School of Engineering.

Master of Science in Systems Engineering Management

To be considered for this degree, a student must enter the curriculum with a BS or BA degree, complete all the requirements of curriculum 721, complete a minimum of 48 credit hours of graduate-level courses, at least 12 of which are at the 4000 level, complete an acceptable thesis.

Master of Science in Product Development

To be considered for this degree, a student must enter the curriculum with a BS or BA degree, complete a minimum of 48 credit hours of graduate-level courses, at least 12 of which are at the 4000 level, complete an acceptable thesis.

Master of Science in Systems Engineering

To be considered for this degree, a student must enter the curriculum with an ABET EAC engineering BS degree, or establish equivalency with an ABET EAC degree, and satisfy all the requirements of curriculum 721, including the Advanced Systems Engineering Elective Track.

Master of Science in Engineering Systems

Students who enter without an ABET EAC accredited engineering BS degree and cannot establish equivalency but have had calculus, and who complete all the requirements of curriculum 721 including the Advanced Systems Engineering Track, will earn a Master of Science in Engineering Systems degree.

Curriculum Sponsors

Any federal organization or defense contractor can sponsor students into the SEM-PD21 program. In addition to earning a master's degree, the curriculum satisfies the mandatory Defense Acquisition University (DAU) Systems Planning, Research, Development, and Engineering (SPRDE) course requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) through Level III. Students who select the Systems Acquisition elective track also earn mandatory DAU course requirements for Program Management through Level III. The other elective tracks offer additional NPS certificates in Space Systems, Information Systems, Software Engineering, and Advanced Systems Engineering. Students who complete the program also earn a MIT certificate of recognition.

Typical Course of Study

Quarter 1

SE3810/	(3-2)	Systems Engineering Sem./ Product
MN3108		Design and Dev.
MN3117	(4-0)	Organizational Processes
SE3810	(0-2)	Systems Engineering Sem.

Quarter 2

MN3145	(4-0)	Marketing Management
SI4021	(4-0)	Systems Engineering For Product
		Development
SE3810	(0-2)	Systems Engineering Sem.

Quarter 3

ME4702/OS4	(3-2)	Engineering Systems Risk Benefit
010		Analysis
SI4022	(4-0)	Systems Architecture
SE3810	(0-2)	Systems Engineering Sem.

Quarter 4

MN3392	(4-0)	Systems and Project Management
MN3156	(4-0)	Finance and Managerial Accounting
	(0-2)	Systems Engineering Sem.
SE3810		

Quarter 5

OS3211	(4-0)	Systems Optimization
Mgmt/Eng	(4-0)	Elective
SE3810	(0-2)	Systems Engineering Sem.

Quarter 6

MN4379	(4-0)	Operations Management
Mgmt/Eng	(4-0)	Elective
SE3810	(0-2)	Systems Engineering Sem.

Quarter 7

SE0811	(0-8)	Thesis Research
Mgmt/Eng	(4-0)	Elective
SE3810	(0-2)	Systems Engineering Sem.

Quarter 8

SE0811	(0-8)	Thesis Research
Mgmt/Eng	(4-0)	Elective
SE3810	(0-2)	Systems Engineering Seminar

* First quarter SE3810 Includes a Probabilities refresher course (Note: Seminar used throughout program but credits given final quarter)

Elective Tracks:

Sponsors and students have great flexibility in designing their elective structure. Currently, there are five specified elective tracks that, when taken with SEM-PD21 core courses, earn participating students additional certifications in Systems Acquisition (DAWIA PMT352), Space Systems, Information Systems, Software Engineering and Advanced Systems Engineering. Other elective tracks can be designed by contacting the Academic Associate.

The advanced SE track consists of SE3302, SE 3303, SE 3250, and SE 4003.

Undersea Warfare Academic Group

Chair

Dr. Clyde Scandrett
Code MA, Spanagel Hall, Room 242A

(831) 656-2027, DSN 756-2027
clscandr@nps.edu

Chair Professor of Undersea Warfare and Director of Undersea Warfare Research Center

Winford G. Ellis, RADM, USN (Ret.),
(831) 656-2488 /DSN 756-2488

Fax: (831) 656-2336
wgellis@nps.edu

Chair Professor of Mine and Expeditionary Warfare
Rick Williams, RADM USN (Ret.)
(831) 656-7702 /DSN 756-7702

Fax: (831) 656-3679
rdwillia@nps.edu

Steven Richard Baker, Associate Professor (1985); Ph.D., University of California at Los Angeles, 1985.

Mary Batteen, Professor (1985); Ph.D., Oregon State University, 1984.

Ronald E. Brown, Research Professor (2002); Ph.D., University of Southern California, 1972.

Donald P. Brutzman, Associate Professor (1995); Ph.D., Naval Postgraduate School, Monterey, 1994.

Ching-Sang Chiu, Professor (1988); Sc.D, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, 1985.

Peter C. Chu, Distinguished Professor and Chair of Oceanography (1986); Ph.D., University of Chicago, 1985.

Timothy Chung, Assistant Professor (2008); Ph.D., California Institute of Technology, 2007.

Curt Collins, Emeritus Professor (1987); Ph.D., Oregon State University, 1967.

John A. Colosi, Professor (2005); Ph.D., University of California, Santa Cruz (UCSC) 1993.

Roberto Cristi, Professor (1985); Ph.D., University of Massachusetts, 1983.

Bruce C. Denardo, Associate Professor (1998); Ph.D., University of California at Los Angeles, 1990.

James Norfleet Eagle, II, Professor (1983); Ph.D., Stanford University, 1975.

Winford G. Ellis, RADM USN (ret), Chair Professor of Undersea Warfare and Director of Undersea Warfare Research Center (2009); MS, M.I.T., 1974; MS, Sloan School of Management, Massachusetts Institute of Technology, 1974.

Monique P. Fargues, Professor (1989); Ph.D. Electrical Engineering, Virginia Tech, 1988.

Garth V. Hobson, Professor (1990); Ph.D., Pennsylvania State University, 1990.

Douglas P. Horner, Research Associate Professor (2005); M.S., Naval Postgraduate School, 1999.

John Joseph, CDR, USN (Ret.), Research Associate (2006); M.S., Radford University, 1979, M.S., Naval Postgraduate School, 1991.

Isaac I. Kaminer, Professor (1992); Ph.D., University of Michigan, 1992.

Wei Kang, Professor (1994); Ph.D., University of California, Davis, 1991.

Daphne Kapolka, Senior Lecturer, Academic Associate for Undersea Warfare (USW) Curriculum (2003) Chair, Engineering Acoustics Academic Committee; Ph.D., Naval Postgraduate School, 1997.

Andres Larraza, Chair and Associate Professor of Physics, (1994); Ph.D., University of California at Los Angeles, 1987.

James MacMahan, Assistant Professor (2007), Ph.D., University of Florida, 2003.

Knox T. Millsaps, Professor and Chair of Mechanical and Aerospace Engineering (1992); Ph.D., Massachusetts Institute of Technology, 1991.

Jeffrey D. Paduan, Dean of Research and Professor (1991); Ph.D., Oregon State University, Corvallis, 1987.

Steven E. Pilnick, Senior Lecturer (1999); Ph.D., Naval Postgraduate School, 1989.

Joseph Rice, Research Professor (2000); MS, University of California at San Diego, 1990.

I. Michael Ross, Professor (1990); Ph.D., Pennsylvania State University, 1990.

Clyde Scandrett, Professor (1987); Ph.D., Northwestern University, 1985.

David A. Schrady, Distinguished Professor Emeritus (1965); Ph.D., Case Institute of Technology, 1965.

Kevin B. Smith, Professor (1995); Ph.D., University of Miami, 1991.

William Sommer, CDR, USN (2012); MS, Naval Postgraduate School, 2000

Rebecca Stone, CAPT, USN (2004); Ph.D., Naval Postgraduate School, 1999.

Weilian Su, Associate Professor (2004); Ph.D., Georgia Institute of Technology, 2004.

Mike Traweek, Visiting Professor (2010) Program Officer at ONR in Ocean Battlespace Sensing Department, PhD, Pennsylvania State University, 2003 .

Alan Washburn, Emeritus Professor (1970); Ph.D., Carnegie Institute of Technology, 1965.

Richard D. Williams III, RADM, USN (Ret.), Chair Professor of Mine and Expeditionary Warfare, Assistant Director of Undersea Warfare Research Center (2005); MS Physics, Naval Postgraduate School, 1972.

Oleg A. Yakimenko, Professor (1989); Ph.D., Russian Academy of Sciences, 1991.

Xiaoping Yun, Professor (1994); Sc.D., Washington University, 1987.

Lawrence J. Ziomek, Professor (1982); Ph.D., Pennsylvania State University, 1981.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

Brief Overview

The Undersea Warfare Academic Group (USWAG) is an interdisciplinary association of faculty and academic professorships providing oversight for multiple Undersea Warfare (USW) degree programs. The USWAG has administrative responsibility for the academic content of the USW Curriculum. Teaching in this interdisciplinary program is carried out by faculty members attached to the following academic departments: Electrical and Computer Engineering, Mathematics, Oceanography, Operations Research, Mechanical Engineering and Physics. Affiliated with the USWAG is the Undersea Warfare Research Center (USWRC) and the Center for Autonomous Underwater Vehicle (AUV) Research. The Chair, USWAG approves thesis topics for students in the Undersea Warfare curricula.

Degrees

Students seeking the Master of Science in Applied Science degree under the cognizance of the Chair, Undersea Warfare Academic Group must successfully complete at least 20 hours of graduate level coursework to satisfy a major from either the Electrical and Computer Engineering Department (Signal Processing), Oceanography Department (Physical Oceanography), Physics Department (Acoustics) or the Operations Research Department (Operations Research). The program must contain at least 12 hours at the graduate level in a sequence of courses that represents specialization in some area other than that of the major. In addition, the program must include at least 12 hours at the 4000 level. All programs leading to the Master of Science in Applied Science must be approved by the Chair, Undersea Warfare Academic Group. This degree also requires completion of a thesis acceptable to the Chair.

Undersea Warfare Course Descriptions

UW Courses

UW0001 Seminar (0-1) Spring/Summer/Fall/Winter
Special lectures and discussion of matters related to the USW Program, Prerequisite: Enrollment in the USW Curriculum (for U.S. citizens). Classification: SECRET.

UW0810 Thesis Research/Group Project (0-8) As Required
Students in the USW curriculum will enroll in this course while doing either an individual thesis or an equivalent group project involving several students and faculty.

UW2001 History of USW Part I , Mine Warfare (2-0) Summer
A study of mine warfare during the 20th century. Starting with the development of mines at the end of the 19th century, the progression of the warfare area is tracked through the end of the 20th century. The lessons of this history continue to have implications for the future of naval warfare. Numerous lessons reappear from the Russo -Japanese War of 1905 on through World War I, World War II, the Korean conflict, the Vietnam War, the Cold War, Desert Shield/Desert Storm, and Operation Iraqi Freedom. Technical Innovations with significant impact on this historical period are covered as part of this course.

UW2002 Undersea Warfare - Yesterday, Today, Tomorrow (2-0) Summer
A study of Submarine Warfare, Anti-Submarine Warfare, and the new concept of Sub-Sea Warfare using a thematic approach. Each of these Undersea Warfare areas will be taught using applicable themes such as sensor and weapon capabilities, command and control, organization, training, and strategy. A basic Undersea Warfare framework will provide historical perspective in each of the three Undersea Warfare areas, emphasizing the status yesterday, what it is today and why, and where we need to be tomorrow. The new area of Sub-Sea Warfare, which encompasses unmanned vehicles, sea-bed infrastructure, distributed networks, and irregular warfare, will also be introduced and discussed. Upon course conclusion, students will have an appreciation of the current status of Undersea Warfare in the Navy today, where the problems and challenges exist, and how the knowledge gained from their Undersea Warfare curriculum will help the Navy develop solutions to these problems and challenges. . Prerequisite: UW2001.

UW3303 Modeling and Simulation for Undersea Warfare (4-1) Spring

Design, implementation and analysis using digital simulation models, with emphasis on physics-based modeling of military systems. Simulation is a discipline that cut across all technical fields complementing both theory and experiment as a component of the scientific method. Course topics include a broad view of analytic simulation, properly designing and structuring simulation problems, extending student programming skills to include the MATLAB language, use of on-line tutorials, and the use of public-domain X3D model archives. This course provides tools, techniques and repeatable methodology that can be used to support thesis work and projects in other classes. Examples and class projects are typically oriented to problems of military or scientific interests.

UW4999 Special Studies in Undersea Warfare (V-0) As required

Variable hours 1-0 to 4-0.) A course designed to meet the needs of students for special work in advanced topics related to USW.

Anti-Submarine Warfare Certificate - Curriculum 274

Academic Associate & Technical Point of Contact

Daphne Kapolka, Ph.D.
Code PH/KD, Spanagel Hall, Room 200A

(831) 656-1825, DSN 756-1825
Fax: (831) 656-2834
dkapolka@nps.edu

Brief Overview

The ASW Certificate consists of a sequence of four highly technical courses designed to provide our civilian and active-duty workforce with a learning experience which extends their general undergraduate education to include the essential concepts, equations, and skill sets needed to understand, design, and use ASW systems. The web-based courses are paced week-to-week by the instructors, but students have the flexibility to do coursework at times of their choosing during each week.

The total number of NPS credits obtained for the certificate is 11 graduate and three undergraduate.

Requirements for Entry

A Bachelor's degree from an accredited institution including a course in single-variable calculus, a course in calculus-based physics and calculus-based probability.

Entry Date

At the beginning of spring quarter in the academic year.

Program Length

Four quarters with a one quarter break in the fall to provide time to review calculus and/or probability if desired.

Graduate Certificate Requirements

The academic certificate program must be completed within three years of admission to the program. A student must maintain a 3.0 GQPR in the certificate courses to be awarded a certificate.

Required Courses

PH3401	Introduction to Sonar Equations
OC2930	Oceanography for Undersea Warfare
EO3404	Applied Signal Processing
OS3680	Naval Tactical Analysis

Undersea Warfare - Curriculum 525 (US Students), 526 (International Students)

Program Officer

William (Bill) Sommer, CDR, USN
Code 75, Spanagel Hall, Room 304

(831) 656-2045, DSN 756-2045
wlsommer@nps.edu

Academic Associate

Daphne Kapolka, Ph.D.
Code PH/Kd, Spanagel Hall, Room 200A

(831) 656-1825, DSN 756-1825
dkapolka@nps.edu

Brief Overview

The Undersea Warfare Curriculum is jointly sponsored by N97 and N95 to educate officers in the engineering fundamentals, physical principles and analytical concepts that govern operational employment of undersea warfare (USW) sensors and weapons. The USW program is interdisciplinary and integrates many subjects: mathematics, physics, oceanography, electrical and mechanical engineering, and operations analysis.

The 525 curriculum is designed to allow the student to meet all of the requirements for Navy PME (as established by the Chief of Naval Operations) and for Joint Professional Military Education for Intermediate Level Professional Military Education (JPME Phase I) as established by the Chairman, Joint Chiefs of Staff.

The 526 curriculum, modeled after the 525 curriculum, is available for international students. The international version replaces U.S. PME courses with courses specifically developed for international students.

Requirements for Entry

A baccalaureate degree, or equivalent, from a program with a calculus sequence and a calculus-based physics sequence that results in an APC of 323 is required for direct input.

Courses in the physical sciences and engineering are desirable. Officers not meeting the academic requirements for direct input enter the program via one or two quarters of refresher math and/or physics as needed.

Entry Date

The Undersea Warfare curriculum is an eight-quarter course of study with entry dates in March and September. If further information is needed, contact the Academic Associate or Program Officer. A four-quarter course of study has been designed for students that are accepted in the Immediate Graduate Education Program (IGEP). IGEP students begin their program in July.

Degrees

Students in the Undersea Warfare Curriculum can choose from a variety of technical degrees including:

Master of Science in Engineering Acoustics
(with emphasis on underwater acoustics, hardware design, and signal processing)

Master of Science in Physical Oceanography
(with emphasis on the prediction of the littoral battlespace environment, ocean acoustics and environmental effects on sonar performance)

Master of Science in Electrical Engineering
(with emphasis on communications or signal processing)

Master of Science in Mechanical Engineering
(with emphasis on autonomous systems)

Master of Science in Engineering Science
(with emphasis on autonomous systems)

Master of Science in Applied Mathematics
(with emphasis on autonomous systems or secure communications)

Students who have limited time for degree completion or whose technical backgrounds are weak may choose to pursue a Master of Science degree in Applied Science (Signal Processing), (Physical Oceanography), (Acoustics), or (Operations Research).

Anti-Submarine Warfare Certificate Program (274)

The Anti-Submarine Warfare Certificate program comprises four courses (PH3401, OC2930, EO3404, and OS3680). Upon successful completion of the coursework, students will be awarded a certificate of accomplishment in keeping with standard practices of the Naval Postgraduate School.

The Anti-Submarine Warfare Certificate program supports Navy ASW needs and complements existing ASW training by providing cross-disciplinary science and engineering education at the graduate level for the four primary technical disciplines involved:

> Engineering Acoustics (Introduction to Sonar Equations)
>
> Physical Oceanography (Oceanography for USW)
>
> Electrical Engineering (Applied Signal Processing)
>
> Operations Research (Naval Tactical Analysis)

Since completion of the distance-learning ASW Certificate introduces students to each of the four disciplines in USW, it is an excellent way for students to decide on their area of interest. Arriving at NPS for a master's degree with an already-completed ASW certificate can either reduce on-board tour duration or increase thesis research time at NPS.

Subspecialty

Completion of this curriculum qualifies an officer as an Undersea Warfare Subspecialist with a subspecialty code of 6301P. The curriculum sponsors are N97 (Submarine Warfare) and N95 (Expeditionary Warfare).

Typical Subspecialty Jobs

Naval Undersea Warfare Center COMINEWARCOM
    Naval Air Warfare Center
Submarine Development Squadron Twelve
Program Executive Offices
Patrol Wing Staffs
Carrier Group Staffs
Naval Air Systems Command
Naval Surface Warfare Development Group
OPNAV
Destroyer Squadron Staffs
Fleet Mine Warfare Training Center
Operational Test and Evaluation Force

Typical Course of Study - Spring Entry

Notes: Courses indicated by * are Joint Professional Military Education courses and are applicable to U.S. Navy students only. UW0001 (0-1) Seminars on Undersea Warfare related topics are offered approximately bi-weekly throughout the program. USW students are expected to attend UW0001 seminars as offered.

Quarter 1

MA1115 (6wks)	(4-0)	Multi-variable Calculus
MA1116 (6wks)	(4-0)	Vector Calculus
PH3401	(3-0)	Introduction to Sonar Equations
OC3230	(3-1)	Descriptive Physical Oceanography

Quarter 2

MA2121	(4-0)	Ordinary Differential Equations
OC2020	(2-2)	Computer Computations
NW3230*	(4-2)	Strategy & War

NW3285*	(4-0)	National Security Decision Making

Quarter 3

OC3260	(4-1)	Fundamentals of Ocean Acoustics
PH3002	(4-0)	Non-Acoustic Sensors
NW3275*	(4-0)	Joint Maritime Ops I
MA3132	(4-0)	Partial Differential Equations

Quarter 4

OS2103	(4-1)	Applied Probability for Systems Technology
NW3276*	(4-0)	Joint Maritime Ops II
OC4270	(3-4)	Tactical Oceanography
UW9999	(4-0)	Specialization Elective

Quarter 5

ME3720	(3-2)	Intro to Unmanned Systems
OA3602	(4-1)	Search Theory and Detection
UW9999	(4-0)	Specialization Elective
UW9999	(4-0)	Specialization Elective

Quarter 6

UW2001	(2-0)	History of USW: Mine Warfare
UW2002	(2-0)	USW, Yesterday, Today, Tomorrow
OA3604	(4-0)	Statistics and Data Analysis
EO2402	(4-1)	Intro to Linear Systems
UW9999	(4-0)	Specialization Elective

Quarter 7

UW9999	(4-0)	Specialization Elective
OA4607	(4-0)	Tactical Decision Making
EO3402	(3-1)	Signals and Noise
UW0810	(0-8)	Thesis Research Group/Project
UW0810	(0-8)	Thesis Research Group/Project

Quarter 8

UW9999	(4-0)	Specialization Elective
EC4450	(4-1)	Sonar Systems Engineering
UW9999	(4-0)	Specialization Elective
UW0810	(0-8)	Thesis Research
UW0810	(0-8)	Thesis Research

Typical Course of Study - Fall Entry

Notes: Courses indicated by * are Joint Professional Military Education courses and are applicable to U.S. Navy students only. UW0001 (0-1) Seminars on Undersea Warfare related topics are offered approximately bi-weekly throughout the program. USW students are expected to attend UW0001 seminars as offered.

Quarter 1

MA1115 (6wks)	(4-0)	Multi-variable Calculus
MA1116 (6wks)	(4-0)	Vector Calculus
PH3401	(3-0)	Introduction to Sonar Equations
OC3230	(3-1)	Descriptive Physical Oceanography

Quarter 2

MA2121	(4-0)	Ordinary Differential Equations
NW3285*	(4-0)	Nat. Sec. Decision Making
OS2103	(4-1)	Applied Probability for Systems Technology
OC2020	(2-2)	Computer Computations

Quarter 3

OC3260	(4-1)	Fundamentals of Ocean Acoustics
ME3720	(3-2)	Intro to Unmanned Systems
MA3132	(4-0)	Partial Differential Equations
OA3602	(4-0)	Search Theory and Detection

Quarter 4

UW2001	(2-0)	History of USW
UW2002	(2-0)	USW Yesterday, Today, Tomorrow
EO2402	(4-1)	Intro to Linear Systems
OS3604	(4-1)	Decision and Data Analysis
NW3230*	(4-2)	Strategy & War

Quarter 5

EO3402	(2-0)	History of USW: Mine Warfare Yesterday, Today, Tomorrow
OA4607	(4-0)	Tactical Decision Making
UW9999	(4-0)	Specialization Elective
PH3002	(4-0)	Non-Acoustic Sensor and Systems

Quarter 6

EC4450	(4-1)	Sonar Systems Engineering
OC4270	(3-4)	Tactical Oceanography
UW9999	(4-0-	Specialization Elective
UW0810	(0-8)	Thesis Research Group/Project

Quarter 7

UW9999	(4-0)	Specialization Elective
UW0810	(0-8)	Thesis Research Group/Project
NW3285*	(4-0)	National Security Decision Making
NW3275*	(4-0)	Joint Maritime Operations I

Quarter 8

NW3276*	(4-0)	Joint Maritime Operations II
UW9999	(4-0)	Specialization Elective
UW0810	0-8)	Thesis Research Group/Project
UW0810	(0-8)	Thesis Research Group/Project

Educational Skill Requirements (ESR)
Undersea Warfare- Curriculum 525
Subspecialty Code: 6301P

Maintaining superiority in Undersea Warfare is an essential goal for our Navy and one of the CNO's top priorities. Small, quiet targets, rising ambient noise levels, technologically sophisticated asymmetric weapons, and an emphasis on the littoral make conducting successful offensive and defensive naval operations in the undersea environment a most challenging task. The Undersea

Warfare curriculum at the Naval Postgraduate School seeks to improve the performance of officers throughout their careers in the operation, evaluation, development, and acquisition of USW systems. To accomplish this requires a broad, interdisciplinary education in the fundamental principles of USW. The conceptual tools and techniques provided by courses in mathematics, physics, oceanography, operations research, signal processing,, and autonomous systems prepare the officer to understand and solve new problems. In addition to the broad education provided by the core courses of the curriculum, each student will obtain their degree in a specific field such as Operations Research, Electrical Engineering, Engineering Acoustics, Applied Physics, Physical Oceanography, Mechanical Engineering, or Applied Mathematics. The combined breadth and depth of this education provide the Navy with a cadre of officers prepared to respond to future challenges in a wide variety of USW-related jobs. The specific ESRs include:

1. **Mathematics**: The officer will master the mathematical principles and techniques necessary to complete graduate level course work and research related to undersea warfare.
2. **Physics**: The officer will understand physical principles applicable to acoustic, non-acoustic USW systems.
3. **Acoustics**: The officer will understand acoustical phenomena affecting the design, performance, and operation of acoustic USW systems.
4. **Oceanography**: The officer will understand atmospheric and oceanographic processes influencing the performance and tactical use of USW systems.
5. **Signal Processing**: The officer will understand principles of signal processing as they apply to USW systems.
6. **Operations Research**: The officer will understand the principles of USW search, detection, and localization. The officer will understand principles of tactical decision aids and data analysis in the evaluation of USW systems.
7. **Unmanned Systems**: The officer will understand the fundamental technologies and capabilities of unmanned underwater systems and tactical robotics.
8. **Joint Professional Military Education**: Graduates will complete the Navy Joint Professional Military Education Phase I requirements. Additionally, they will understand the history of USW and its implications to today's Navy.
9. **Programming and Simulation**: The officer will be able to program solutions to essential engineering problems. The officer will be able to assess models and perform simulations.
10. **Problem Solving and Practical Applicability**: The officer will demonstrate the ability to conduct independent analysis in Undersea Warfare and proficiency in written and oral presentations.

Curriculum Sponsor and ESR Approval Authority

Director, Submarine Warfare Division (N97) Director, Expeditionary Warfare Division (N95)

January 2012

GRADUATE SCHOOL OF OPERATIONAL AND INFORMATION SCIENCES (GSOIS)

Website

www.nps.edu/Academics/GSOIS

Dean

Gordon McCormick, Ph.D.

Naval Postgraduate School
Code 06, Glasgow Hall, Room 220
1411 Cunningham Road
Monterey, CA 93943

(831) 656-2933, DSN 756-2933
GMcCormick@nps.edu

Associate Dean

Robert Burks, COL, USA

Naval Postgraduate School
Code 06, Glasgow Hall, Room 220A
1411 Cunningham Road
Monterey, CA 93943

(831) 656-3116, DSN 756-3116, FAX (831) 656-3828
reburks@nps.edu

The Graduate School of Operational and Information Sciences consists of the following departments:

Computer Science	CS
Defense Analysis	DA
Information Sciences	IS
Operations Research	OR

Overview

The Graduate School of Operational and Information Sciences includes Graduate Resident Programs consisting of 15 technical curricula and awards Master of Science and Ph.D. degrees across four academic departments. The faculty number approximately 100 and educate approximately 600 military and DoD students annually.

In the domains of education and ideas, staying current in these dynamic times is basic to the Graduate School of Operational and Information Sciences. Unlike a civilian university, at GSOIS we know we are educating our students for military related careers. First we teach them scientific principles and mathematical methods, and then we teach them how to apply them to military objectives when they return to service.

Another university could not tailor a curriculum, adapt to change, or transform its courses as swiftly as do the GSOIS faculty. For example, pedagogically, we have embraced the

shift to distance learning, especially in the past five years, as Web-based instruction has become an efficient delivery mode, and we supplement it with Video TeleEducation so that students will benefit in widely dispersed locations, sometimes in ships at sea.

Mission Statement

To deliver graduate-level education and conduct cutting-edge research in four nontraditional knowledge domains in response to the needs of naval and DoD customers. Our four knowledge domains are:
· Information Science and Technology
· Military Computer Science
· Military Operations Analysis and Research
· Special Operations and Related Defense Analysis

Department of Computer Sciences

Chairman

Peter J. Denning, Ph.D.
Code CS, Glasgow East, Room 317

(831) 656-3603, DSN 756-3603, FAX (831) 545-2814
pjd@nps.edu

Associate Chairman

Geoff Xie, Ph.D.
Code CS/Gx, Glasgow East, Room 125

(831) 656-2693, DSN 756-2693, FAX (831) 656-2814
xie@nps.edu

Associate Chairman, Academic Affairs

Thomas W. Otani, Ph.D.
Code CS/To, Glasgow East, Room 307

(831) 656-3391, DSN 756-3391, FAX (831) 656-2814
twotani@nps.edu

Associate Chairman, Research

Joel Young, Ph.D.
Code CS/Jy, Glasgow East, Room 338

(831) 656-3518, DSN 756-3518, FAX (831) 656-2814
jdyoung@nps.edu

Associate Chairman, Administration

Loren E. Peitso
Code CS/Lp, Glasgow East, Room 335

(831) 656-3009, DSN 756-3009, FAX (831) 656-2814

lepeitso@nps.edu

Academic Associate of Computer Science Curriculum

Thomas W. Otani, Ph.D.
Code CS/To, Glasgow East, Room 307

(831) 656-3391, DSN 756-3391, FAX (831) 656-2814
twotani@nps.edu

Academic Associate of MOVES Curriculum

Chris Darken, Ph.D.
Code CS/Cd, Watkins Hall, Room 382

(831) 656-2095, DSN 756-2095, FAX (831) 656-7599
cjdarken@nps.edu

Academic Associate of Software Engineering Curriculum

Thomas W. Otani, Ph.D.
Code CS/To, Glasgow East, Room 307

(831) 656-3391, DSN 756-3391, FAX (831) 656-2814
twotani@nps.edu

Academic Associate of Computing Technology Curriculum

Loren E. Peitso
Code CS/Lp, Glasgow East, Room 340

(831) 656-3009, DSN 756-3009, FAX (831) 656-2814
lepeitso@nps.edu

Academic Associate of Identity Management and Cyber Security Curriculum

Zachery Peterson
Code CS/Zp, Glasgow East, Room 209

(831) 656-2509, DSN 756-2509 FAX (831) 656-3339
znpeters@nps.edu Mailto:znpeters@nps.edu

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

Bruce Allen, Research Associate (2008); B.S., California State University at Sacramento, 1989.

Pranav Anand, Visiting Assistant Professor (2008); Ph.D., Massachusetts Institute of Technology, 2006.

Mikhail Auguston, Associate Professor (2003); Ph.D., Glushkov Cybernetics Institute, 1983.

Eric R. Bachmann, Research Assistant Professor, (1997); Ph.D., Naval Postgraduate School, 2000.

Valdis Berzins, Professor (1986); Ph.D., Massachusetts Institute of Technology, 1979.

Robert Beverly, Assistant Professor (2009); Ph.D., Massachusetts Institute of Technology, 2008.

Karen Burke, Research Associate Professor (2003); M.S., Southern Illinois University, 1979.

Paul Clark, Research Associate (1999); M.S., Naval Postgraduate School, 1999.

Richard S. Cote, Senior Lecturer (2001); M.S., Naval Postgraduate School, 2000.

Chris Darken, Associate Professor (2001); Ph.D., Yale University, 1993.

Rudy Darken, Professor (1996); D.Sc., George Washington University, 1995.

Arijit Das, Research Associate (2003); M.S., University of Nevada, 1989.

Peter J. Denning, Chairman, Department of Computer Sciences, Director of the Cebrowski Institute for Innovation and Information Superiority, and Distinguished Professor (2002); Ph.D., Massachusetts Institute of Technology, 1968.

George W. Dinolt, Professor of the Practice of Cyber Operations (2002); Ph.D., University of Wisconsin at Madison, 1971.

Doron Drusinsky, Associate Professor (2002); Ph.D., Weizmann Institute of Science, 1988.

Chris Eagle, Senior Lecturer (1997); M.S., Naval Postgraduate School, 1995.

John D. (JD) Fulp, Senior Lecturer (2001); M.S., Naval Postgraduate School, 1996.

Simson L. Garfinkel, Associate Professor (2006); Ph.D., Massachusetts Institute of Technology, 2005.

John H. Gibson, Research Associate (2001); B.S., University of California at Santa Barbara, 1969.

Mark Gondree, Research Associate (2009); Ph.D., University of California at Davis, 2009.

Ted Huffmire, Assistant Professor (2007); Ph.D., University of California at Santa Barbara, 2007.

Cynthia E. Irvine, Professor and Director, center for Information Systems Security Studies and Research (1994); Ph.D., Case Western University, 1975.

Jean Khosalim, Research Associate (2011); B.S., University of California at Los Angeles, 1995.

Mathias N. Kölsch, Assistant Professor (2005); Ph.D., University of California at Santa Barbara, 2004.

Timothy E. Levin, Research Associate Professor (2001); B.S., University of California at Santa Cruz, 1991.

Theodore G. Lewis, Professor (1993); Ph.D., Washington State University, 1971.

G.M. Lundy, Associate Professor (1988); Ph.D., Georgia Institute of Technology, 1988.

Luqi, Professor (1986); Ph.D., University of Minnesota, 1986.

Craig Martell, Associate Professor, (2003); Ph.D., University of Pennsylvania, 2004.

Anthony Melaragno, Research Associate (2012); M.S., George Mason University, 2004.

Bret Michael, Professor (1998); Ph.D., George Mason University, 1993.

Eric McMullen, LCDR, USN, Lecturer (2013); M.S., Naval Postgraduate School, 2013.

Thuy D. Nguyen, Research Associate (2002); B.A., University of California at San Diego, 1982.

Thomas W. Otani, Associate Professor (1985); Ph.D., University of California at San Diego, 1983.

Loren E. Peitso, Senior Lecturer (2004); M.S., Naval Postgraduate School, 2002.

Zachary N. J. Peterson, Assistant Professor (2010); Ph.D., Johns Hopkins University, 2006.

Charles Prince, Research Associate (2006); B.S., Oregon State University, 1993.

Justin Rohrer, Research Associate (2011); Ph.D., University of Kansas, 2011.

Neil C. Rowe, Professor (1983); Ph.D., Stanford University, 1983.

Alan Shaffer, CDR, USN, Assistant Professor (2008); Ph.D., Naval Postgraduate School, 2008.

Michael Shick, Research Associate (2012); B.A., George Washington University, 2012.

David Shifflett, Research Associate (2000); B.S., California State University at Northridge, 1985.

Man-Tak Shing, Associate Professor (1988); Ph.D., University of California at San Diego, 1981.

Gurminder Singh, Professor and Director, Center for the Study of Mobile Devices and Communications (2002); Ph.D., University of Alberta, 1989.

Joseph A. Sullivan, CDR, USN, Assistant Professor and MOVES Institute Acting Director (2001); Ph.D., Naval Postgraduate School, 2010.

Michael Thompson, Research Associate (2012); B.S., Marquette University, 1981.

Dennis M. Volpano, Associate Professor (1991); Ph.D., Oregon Graduate Institute, 1986.

Duminda Wijesekera, Visiting Associate Professor (2006); Ph.D., University of Minnesota, 1997.

Joel Young, Assistant Professor (2007); Ph.D., Brown University, 2004.

Geoffrey Xie, Professor (1996); Ph.D., University of Texas at Austin, 1996.

Emeritus Professors

Robert B. McGhee, Professor Emeritus (1986); Ph.D., University of Southern California, 1963.

Degrees

The Department of Computer Science provides graduate training and education in major areas of computer science; thus, both basic and advanced graduate courses are offered. Course work and research lead to either the Master of Science or Doctor of Philosophy degree. The requirements to complete either program are rigorous and are comparable to those of other major universities.

Master of Science in Computer Science

Master of Computing Technology

Master of Science in Modeling, Virtual Environments, and Simulation

Master of Science in Software Engineering

Master of Arts in Identity Management and Cyber Security

Doctor of Philosophy in Computer Science

Doctor of Philosophy in Modeling, Virtual Environments, and Simulation

Doctor of Philosophy in Software Engineering

Laboratories

There are currently 14 laboratories:

Computer Science Learning Resource Center

This laboratory provides a general purpose, networked, PC desktop environment for a variety of programming languages and software packages. It is used both as a

teaching lab for a number of courses and as an open lab for NPS-wide coursework.

Introductory Computer Security Laboratory

This lab is primarily used by the Center for Information Security Studies and Research (CISR). The lab consists of a virtual infrastructure of clients and servers serving the needs of multiple CS department classes such as:

The studies of information assurance, computer security, high assurance system architecture and authentication where it is used to introduce students to studies in high assurance systems, public key infrastructure, mandatory access control, viruses, covert channels and the reference monitor concept.

The security manager's view of diverse management concerns associated with administering and operating an automated information system facility with minimized risk. Also used in certifying that students have met the requirements for educational standards published by the Committee on National Security Systems (CNSS).

The fundamentals of computer forensics in the context of DoN/DoD information operations. Students examine how information is stored and how it may be deliberately hidden and/or subverted.

The basis for understanding the potential vulnerabilities in networked systems by applying a problem-solving approach to obtain information about a remote network and exploit or subvert those systems using various techniques and tools along with discussing vulnerability discovery and mitigation.

Students taking the course this lab primarily serves are from multiple departments across campus. For more information, please contact Professors Cote or Clark.

Computer Information Security Research (CISR) Laboratory

This lab is primarily used by the Center for Information Security Studies and Research (CISR). The lab consists of a virtual infrastructure of clients and servers to allow the student to study network vulnerabilities, intrusion detection, secure system management and computer forensics; where tools used by administrators and hackers can be freely researched and studied. Students are given full administrator privileges on virtual machines so that multiple operating systems and tools can provide a basis for understanding the potential vulnerabilities and their mitigation in networked systems by studying methods to: (1) obtain information about a remote network, (2) to possibly exploit or subvert systems residing on that network and (3) techniques to mitigate risks to networked systems. For more information, please contact Professors Cote or Clark.

Public Key Infrastructure Laboratory

This computer lab is primarily used by the Center for Information Security Studies and Research (CISR). This reconfigurable lab is dedicated to studies of network security, secure computer systems, security policies, modeling, and formal methods.

Additionally through the use of a Virtual Private Network (VPN), it is utilized for the Inter-Service Academy Cyber Defense Exercise (CDX). This annual exercise involving NPS, AFIT, and all four U.S. Service Academies; acting as network defenders (Blue Teams) against network attackers (Red Teams) from NSA, and DoD Information Warfare agencies. Each exercise involves approximately 32 students who spend over 640 man-hours to: install, configure, harden, and operate the defended Blue network against a week-long attack from the Red forces. Installation and configuration starts approximately four months prior to that attack. Students are given administrator/root privileges to install and configure: e-mail, Web, FTP, VTC, DNS, and SQL database servers. Students install and utilize DoD PKI certificates to digitally sign and encrypt sensitive exercise traffic. For more information, please contact Professors Cote or Clark.

Network Research and Experimentation Laboratories

Introductory PC Network Laboratory

Intermediate Local Area Network Laboratory

These two labs support the Networks Track and provide students the opportunity to apply network theory in concrete applications. The Introductory PC Network Laboratory enables students to install network hardware and software, learning firsthand the advantages, limitations, and intricacies of various components and operating systems. The Intermediate Local Area Network Laboratory allows students to participate in ongoing Next Generation INTERNET research, advanced protocol development, future high-speed digital switching systems experimentation, network management, and control design and analysis. These labs also directly support DoD-funded research for the Defense Advanced Research Projects Agency and the National Science Foundation (NSF).

Wireless and Mobile Computing Laboratory

The Wireless and Mobile Computing Lab provides the majority of academic computing needs to support the wireless and mobile computing track within the Department of Computer Science. This lab provides students with the opportunity to program and examine security aspects of mobile computing devices ranging from personal digital assistants (PDAs) through cellular phones.

Autonomous Robotics Coordination Laboratory

This teaching and research computer lab supports graduate students and faculty work on sponsored classes/research projects regarding the coordination between multiple autonomous robots to achieve a coordinated result. The lab is equipped with several types of programmable robots and a wide range of intelligent software tools, including programming languages, planners, language processors, image processors, and neural-computing.

Software Engineering Laboratory

This laboratory provides a state-of-the-art engineering systems environment to support graduate students and faculty work on sponsored classes and projects in software automation. The laboratory provides a test bed for DoD software-intensive systems and software for embedded safety-critical systems can be precisely tested in the lab. Evaluation and assessment on network-based system integration and interoperability, and the risk assessment on systems of systems can be conducted effectively in the lab. The lab also provides support for requirements analysis, prototyping, specification, and computer-aided system architecture design.

Forensics Exploitation Lab

This laboratory provides a state-of-the-art forensics exploitation environment to support graduate students and faculty work on sponsored classes and projects in basic and applied forensics exploitation research projects. Primary work is done with new techniques for automatically processing data recovered from disk drives and other types of storage devices. Using forensic techniques, the data on a hard drive can reveal who used or broke into a computer system, what it was used for or what was done during a break-in, and the identities of those in question.

Biometrics Research Lab

This lab is primarily used by the Center for Information Security Studies and Research (CISR). The lab consists of a virtual infrastructure of clients and servers with is used to support reimbursable and direct funded basic and applied research projects in Biometrics. The lab is used to demonstrate some of the major biometric approaches (fingerprints, facial recognition, etc.) and supports the new NPS Identity Management certificate series jointly hosted between CS and IS. For more information, please contact Professors Clark or Hopfner.

SCIF Security Lab

This laboratory provides a state-of-the-art engineering systems environment to support graduate students and faculty work on sponsored classes and projects in security areas that are required to be conducted in high-security, compartmented classifications and dedicated air-gapped hardware/networks.

Virtual Environments Lab

The Virtual Environments Lab provides the equipment necessary to experience and study virtual and augmented environments. Head-worn displays and associated tracking hardware display the visual content of artificially created environments. The immersive nature of these environments cannot be studied on other hardware such as computer monitors. Virtual and augmented environments are integral to the MOVES Institute's mission goals. They are of instrumental importance to many DoD training applications as well as military operations. Cross disciplinary classes and even student research projects can be performed with this equipment as well, for departments including Computer Science, Mechanical and Electrical Engineering, and Operations Research.

Vision Lab

The NPS Vision Lab is a research and education lab in the MOVES Institute and the Computer Science Department at the Naval Postgraduate School in Monterey, CA. Our expertise is at the crossroads of computer vision, computer graphics and human-computer interaction. We collaborate with NPS-wide efforts on training systems, robotics and autonomous systems, sensor networks and embedded systems. We strive to accomplish projects with educational goals while incorporating and advancing current research into prototype systems.

Computer Science Course Descriptions

CS Refresher Courses

CSR100 Refresher for Beginning Programming (2-2) Winter/Summer
(No credit) An introduction to computer algorithms, programs, and hardware. Using structured programming and stepwise refinement techniques, students receive classroom instruction plus design and test programs in the laboratory. Computer projects of increasing difficulty are assigned. This course is not graded. Prerequisite: None.

CSR101 Refresher for Laboratory Systems (2-1) As Required
Intended for Computer Science majors, to provide an introduction to computer science and computing laboratory facilities. Both Unix and the MS-DOS operating systems are introduced from a user perspective, as well as operation of corresponding workstation and personal computer hardware. Each system's user interface, text processing, programming environment, network and communication facilities are surveyed. Students are exposed to basic principles and procedures for productive software and document development through both lecture and hands-on tutorials. Should be taken concurrently with CSR100. Not graded. No credit. Prerequisite: None.

CS Courses

CS0001 Colloquium (0-1) As Required
(No credit) Departmental lecture series. Attendance is required by students in their fourth quarter. Graded on a Pass/Fail basis. Prerequisite: None.

CS0809 Capstone Project in Computing (0-V) Fall/Winter/Spring/Summer
For degree programs that require a capstone project. Every student in degree programs for which a capstone project is required will register for this course during each quarter of study. This course is intended to provide a set of incremental activities, reports, and presentations that will ensure student progress toward the completion of the capstone project within the time frame of the standard degree program. This course may be repeated for credit. Prerequisite: None.

CS0810 Thesis Research (0-8) Fall/Winter/Spring/Summer
Every student conducting thesis research will enroll in this course. Prerequisite: None.

CS0820 Integrated Project (0-1) Fall/Winter/Spring/Summer
The Naval Postgraduate School provides many opportunities for students to participate in campus-wide interdisciplinary projects. These projects encourage students to conceptualize systems which respond to current and future operational requirements. An integral part of the project involves working with other groups to understand and resolve issues involved with system integration. This course is available to Computer Science students who are participating in a campus-wide integrated project. Graded on a Pass/Fail basis. Prerequisite: None.

CS2000 Introduction to Computer Systems (6-6) Winter/Summer
The objective of this course is to introduce foundational concepts from computing systems by constructing a general-purpose computer system from the ground up. By integrating algorithms, computer architecture, operating systems, and compilers through hands-on projects, the course will explore hardware and software design techniques and balancing tradeoffs between competing design constraints. Students will learn about the engineering of systems across many levels of abstraction, from digital logic to software design. Corequisites: CS2020 (may be enrolled concurrently.)

CS2011 Computing Systems Principles (4-0) Fall/Spring
Designed to provide computer science majors with a basic understanding of computer systems hardware. The course includes the following topics: basic computer concepts, number systems and data representation, digital logic and Boolean algebra, storage devices and organization, basic computer organization and control, and instruction formats, addressing modes and the assembler process. No previous background in computer hardware is assumed. Prerequisite: None.

CS2020 Introduction to Programming (4-2) Fall/Spring
This course teaches the fundamental programming concepts. Topics covered include data types, variables, expressions, parameter passing, control structures, strings, arrays, exception handling, software development, and testing techniques. Python is used in the course, but the focus of the course is not to teach any specific features of Python. The primary focus of the course is to teach core programming concepts that are universally available in modern programming languages. Prerequisite: None.

CS2071 Fundamental Object-Oriented Programming in C++ (4-2) Fall/Spring
This course is an introductory course in program development techniques and the structured and object-oriented programming paradigms using C++. The topics covered include: problem-solving, documentation, C++ Integrated Development Environment (IDE), control flow, native types and statements, operators, structures, functions, pointers, arrays, object-oriented programming, encapsulation (class and objects), and I/O. Weekly programming or written assignments will be assigned. Prerequisite: None.

CS2072 Fundamental Object Oriented Programming in JavaScript (4-2) Fall
This course is an introductory course in program development techniques and the structured and object-oriented programming paradigms using JavaScript. The topics covered include: problem-solving, documentation, control flow, native types and statements, operators, structures, functions, arrays, object-oriented programming, encapsulation, and VO. Weekly programming or written assignments will be assigned. Prerequisite: None.

CS2073 Fundamental Object-Oriented Programming in Java (4-2) As Required
This course is an introductory course in program development techniques and the structured and object-oriented programming paradigms using Java. The topics covered include: problem-solving, documentation, Java Integrated Programming Environment (IDE), control flow, native types and statements, operators, structures, functions, pointers, arrays, object-oriented programming, encapsulation (class and objects), and I/O. Weekly programming or written assignments will be assigned. Prerequisite: None.

CS2121 Fundamentals of Automata Algorithms (4-0) As Required
This course presents the basic concepts in automata and algorithms that are essential to computer professionals. Practical examples are used to illustrate course material. Topics covered include finite state automata, pushdown automata, regular and context free languages, limits of what can be solved on a computer (undecidability), the Halting Problem, algorithms for sorting and searching, binary search trees, hash tables, graph algorithms for shortest paths and minimum spanning trees, as well as measures of algorithm complexities (big-O notation and intractability). Prerequisite: None.

CS2170 ADA as a Second Language (4-2) As Required
A first course in ADA for students experienced in another programming language. Students learn to implement problem solutions using the procedural and object-oriented language features of ADA. The procedural programming topics include: data types, operators, input/output, control structures, repetition structures, functions, arrays, and pointers. The object-oriented topics include: data abstraction and encapsulation, packages, inheritance, polymorphism, and generics. Weekly programming projects will be assigned. Prerequisite: Recent completion of the complete series in another programming language course, or programming experience in another programming language.

CS2171 C++ as a Second Language (4-2) As Required
A first course in C++ for students experienced in another programming language. Students learn to implement problem solutions using the procedural and object-oriented language features of C++. The procedural programming topics include: data types, operators, input/output, control structures, repetition structures, functions, arrays, and pointers. The object-oriented

topics include: data abstraction and encapsulation, classes, objects, operator overloading, inheritance, polymorphism, templates, and reusable class libraries. Weekly programming projects provide students the opportunity to implement techniques covered in class. Prerequisite: Recent completion of the complete series in another programming language course, or programming experience in another programming language.

CS2173 Java as a Second Language (4-2) Winter/Summer

A first course in Java for students experienced in another programming language. Students learn to implement problem solutions using the procedural and object-oriented language features of Java. Topics include: program structures and environment, arrays, exceptions, constructors and finalizers, class extension, visibility and casting, overriding versus overloading, abstract classes and interfaces, files and streams, class loaders, threads, and sockets. Programming projects provide students the opportunity to implement techniques covered in class. Prerequisite: Recent completion of the complete series in another programming language course, or programming experience in another programming language.

CS3000 Great Principles of Computing Technology (4-1) Fall/Spring

An introduction to computing technology that underlies all of information technology (IT). Offers a holistic view of the computing field and its connections with other fields in science, business, and philosophy. Covers deep principles of information technology in the areas of computation, communication, coordination, storage, and automation. Emphasizes the historical development of these principles, why they have stood the tests of time, how they relate to one another, and how they relate to issues in other fields. Prepares students for graduate study in computing-related fields. Prerequisite: None.

CS3004 Human-Computer Interaction (2-1) Fall/Spring

This course studies the principles of human-computer interaction (HCI) and computing system usability. The design of an interactive system is much different than that of a conventional, noninteractive one. A successful software application depends on how well the designer understands the users of the system and how best to design for their needs and capabilities. In addition, an understanding of system design constraints and operational implementation issues are equally important. The primary focus of the course is to build the knowledge and skills needed to develop an effective and usable human interactive system. All students will participate on a design project that will take them through an entire interactive design process, from problem statement and requirements definition through prototyping and implementation, test, and evaluation. The course material will survey the field of HCI including interaction techniques and styles, design methodologies, evaluation techniques, software development, and input/output devices. The student will learn how to approach design problems from the user's point of view, how to study usability issues, and how to consider the strengths and limitations of the user during the design process. Prerequisite: None.

CS3021 Introduction to Data Structures and Intermediate Programming (4-2) Winter/Summer

This second course in the programming practices sequence builds upon the topics covered in CS2020. The first objective of the course is the teaching of data structures and abstract data types. The second objective is the teaching of object-oriented

programming concepts such as inheritance and polymorphism. Topics covered include recursion, file input and output, dynamic memory allocation, lists, binary search trees, balanced binary search trees, and hashing techniques. C++ is used in the course. Prerequisite: CS2020.

CS3022 Programming Paradigms (4-2) Winter/Summer

This is the third course in the programming practice sequence. Based on the knowledge of Java, this course introduces students to other programming paradigms. Many concepts are illustrated using C++ and ADA Functional programming using Lisp and Haskell and logic programming using Prolog are also introduced in the course. Prerequisite: CS3021.

CS3030 Computer Architecture and Operating Systems (4-0) Winter/Summer

(For non-CS students.) This course provides an overview of basic computer hardware concepts and operating systems software. The following topics are covered: basic computer concepts; data representation; elements of computer architecture and operation; processor and process management; multiprogramming; memory management; and file management. Future trends in computer hardware and operating systems will be discussed. Prerequisites: CS2020 and CS2971, or consent of the instructor.

CS3040 Low Level Programming (4-2) Fall/Spring

This course is an accelerated survey of the C programming language for computer scientists. It introduces students to programming practices using the C language, and the tools needed to effectively write and debug C programs. The class illustrates the design decisions associated with the low-level operations not implemented in other modern programming languages, demonstrating C's performance and control capabilities. Topics include function calling convention, dynamic memory allocation, recursion, file 1/0, kernel management of files, searching/sorting, data types, data structures using C (arrays, hash tables, doubly linked lists, etc), and secure programming in C. Prerequisites: Students are expected to know how to program in at least one language, or exempted by permission of the instructor. Familiarity with Linux or another UNIX-like operating system will be helpful. Prerequisites: CS2020.

CS3060 Database Systems (3-1) Winter/Summer

This course presents an up-to-date introduction to database systems including database system architectures, physical file organizations, data models, query languages, and design of databases. Prerequisite: CS2020 or consent of the instructor.

CS3070 Operating Systems (3-2) Fall/Spring

A theoretical and practical treatment of operating concepts. Major course topics include concurrency, Ada tasking, virtual memory including demand paging and segmentation, dynamic linking and loading, file structures, and information security. The laboratory portion of the class will give students the opportunity to write and test components of a modern operating system. Prerequisites: CS2020 and CS3021 and CS2011.

CS3071 Advanced Object-Oriented Programming in C++ (4-2) As Required

This is a course in advanced object-oriented programming using C++ for students having an intermediate-level experience with C++. Students will learn guidelines for using C++ effectively through general design strategies and language specific features to make C++ programs and object-oriented designs more efficient, robust, maintainable and portable. Topics include: Memory management; Constructor and Assignment Operator Issues; Classes and

Functions; Inheritance and Object-Oriented Design; Standard Template Library; Exceptions; Efficiency. Prerequisite: CS2971 or CS2171 or consent of the instructor.

CS3101 Theory of Formal Languages and Automata (4-2) Winter/Summer

This course will cover the Chomsky hierarchy of Formal Languages (regular sets, context-free languages, context-sensitive languages, and recursively enumerable languages) and the types of grammars and automata associated with each class in the hierarchy. Emphasis is placed on the major results of the theory as they apply to language and compiler design. In addition, the major results involving the concept of in decidability are covered. Prerequisite: MA3025.

CS3111 Principles of Programming Languages (4-0) As Required

This course is an introduction to the design, evaluation, and implementation of programming languages. Imperative, functional, logic, and concurrent programming methodologies are investigated, with an emphasis on practical issues. Tradeoffs in choosing different programming languages for a given task are discussed and principles on which an objective assessment of programming language design can be made are presented. Prerequisite: CS2020 or consent of the instructor.

CS3113 Compilers and Translation (3-2) Winter/Summer

This course is intended to explore the basics of modern compiler design and construction techniques. The fundamentals of scanning, parsing, and compiler semantics are developed in the framework of modern compiler-compiler and translator-writing systems technology. The laboratory periods will be used to develop a small model compiler/assembler. Prerequisite: CS3022 and CS3101 or consent of instructor.

CS3130 Software Design for Mobile Computers (3-2) As Required

This course introduces the student to rapid application development environments, programming languages, and operating systems used by commercial off-the-shelf handheld computers running operating systems such as Newton Intelligence, Magic Cap, GEOS, and PalmOS. The course includes a survey of devices, architectures, operating systems, and programming languages. Laboratory programming exercises will be required for at least one PDA-class operating system platform. Prerequisite: CS3021.

CS3140 Low-level Programming II (3-2) Winter/Summer

Assembly language is used as the vehicle to introduce students to the principles of program construction at the machine code and assembly language levels. Students will be exposed to assembly languages as formally documented by CPU designers. By studying real-world processors, the differences between complex and reduced instruction set are illustrated. Students will study the use of assemblers, linkers, and loaders in the program creation process. Common executable file formats are studied as well as standard calling conventions used to interface assembly language functions with high order languages, viz. C, functions and operating system services. The theory of disassembly and tools for disassembling executable files are covered for the purpose of analyzing binary programs. Prerequisites: CS3040 or consent of instructor.

CS3150 Design and Analysis of Algorithms (4-0) Fall/Spring

This course focuses on the design and analysis of efficient algorithms. Techniques for analyzing algorithms in order to measure their efficiency are presented. Control structure abstractions, such as divide and conquer, greedy, dynamic programming, backtrack (branch and bound), and local search methods are studied. The theory of NP-completeness is presented, along with current approaches to NP-hard problems. Prerequisites: CS3021 and MA3025.

CS3200 Computer Architecture (3-2) As Required

This course examines the organization of computer and processor architectures. Instruction set design alternatives, processor implementation, memory system hierarchy, and I/O systems are the main topics of study. A quantitative approach is taken in which different design alternatives are evaluated and compared through analysis and/or experimentation. The course is accompanied by a set of labs which reinforce and extend the lecture subject matter. Prerequisites: CS2011 and either CS2020 or consent of the instructor.

CS3310 Artificial Intelligence (4-1) Fall/Spring

Survey of topics and methods of Artificial Intelligence. Methods include rule-based systems, heuristic search and exploitation of natural constraints, means-ends analysis, semantic networks, and frames. Emphasis is placed on solving problems that seem to require intelligence rather than attempting to simulate or study natural intelligence. Projects to illustrate basic concepts are assigned. Prerequisites: CS2011 and one college-level course in programming.

CS3502 Computer Communications and Networks (4-2) Fall/Spring

This course covers basic computer networking concepts and technology through the study of protocols at each layer of the Internet architecture. Materials taught in class are reinforced through laboratory projects. Prerequisites: CS2011 and CS3030 and a solid background in Computer Architecture, Algorithm and Data Structures; and programming experience with C/C++ or Java are important for success in this class.

CS3505 Introductory Computer Communications (3-2) Winter/Summer

This introductory course in computer networking focuses on high-level core internetworking concepts and the relative merits of different architectures in relation to security, performance, economic, and reliability objectives. Students will develop a deeper understanding of the Internet and Internet applications, and in particular how the end-to-end arguments, robustness principle, layering, naming, and hierarchy have enabled the Internet to scale through orders of magnitude in size and speed while accommodating widespread heterogeneity. It introduces principles of reliable communication, wireless channels, naming and directory services, content distribution networks, networks for cloud computing, overlays, and peer-to-peer communication models. This course is intended for all graduate students. Prerequisite: None.

CS3600 Introduction to Computer Security (4-2) Fall/Winter/Spring/Summer

This course provides a comprehensive overview of the terminology, concepts, issues, policies, and technologies associated with the fields of Information and Software Assurance. It covers the notions of threats, vulnerabilities, risks, and safeguards as they pertain to the desired information security properties of confidentiality, integrity, authenticity, and availability for all information that is processed, stored, or transmitted in/by information systems. This is the entry point prerequisite for all other Computer Security Track courses. Prerequisites: CS2011 or CS3030.

CS3606 An Introduction to Information System Security (4-0) Fall/Winter/Spring/Summer

Due to the rapid development and ubiquitous deployment of computer and information systems, and the very nature of insecurities they may hold, professionals involved with the design, development, deployment, and management of these systems now require a familiarity with information assurance (IA) and security. This course will introduce topics relevant to IA and computer security necessary to create a foundation of knowledge for the information management professional. The domains of knowledge to be introduced during the course include: access control systems and methodology; telecommunications and network security; security management practices; application and systems development security; cryptography; security architecture and models; operations security; business continuity and disaster recovery planning; laws, investigations, and ethics; and physical security. This course is meant to introduce the topics and will lay the foundations for further studies in any of the domains listed. Prerequisite: None.

CS3610 Information Ethics, Crime, and Law (4-0) Fall

This class examines the major controversies affecting today's Internet resulting from the interplay of policy, law, technology and human nature. Topics include computer crime; intellectual property; privacy; encryption; free speech; identity; data mining and additional DoD specific issues. Readings include laws, judicial opinions, popular articles, and academic computer science articles. Assignments include written exercises, a midterm quiz analyzing a public policy problem, and term paper. Prerequisite: None.

CS3621 Applications Project and Research for Identity Management and Cyber Security Students (0-Variable) Fall/Winter/Spring/Summer

This program requires either an Application project or a Thesis. Every student conducting an Applications Project or Thesis research in the Identity Management and Cyber Security degree program will register for this course during each quarter of study. This course is intended to provide a set of incremental activities, reports, and presentations that will ensure student progress toward the completion of the Applications Project or thesis research within the timeframe of the standard degree program. This course may be repeated for credit. Corequisites: Enrollment in the MA in Identity Management and Cyber Security degree program.

CS3633 Data Security (3-2) Fall/Winter/Spring/Summer

Where is my data and how is it being protected? This course examines the major technologies, procedures, and controversies affecting the secure storage and use of data. Historical context; access controls vs. encryption algorithms; computer forensics and media exploitation; privacy and data recovery; security for data-at-rest vs. data-in-flight vs. data-in-computation; translucent databases; private information retrieval; data mining; cloud computing. Prerequisites: CS3600 or equivalent, and CS3505 or equivalent.

CS3636 Data Fusion with Online Information Systems (3-0) Spring

Explores data fusion as applied to personal information in both the online and offline world. Topics include credit and criminal databases, Information Surveillance, GSP, Satellite imagery, online search, text mining, anonymization, reidentification, and privacy policy. Familiarity with statistics useful but not mandatory.

CS3640 Analysis of DoD Critical Infrastructure Protection (3-1) Fall/Spring

The DoD relies on the correct functioning of an extensive information and control infrastructure to accomplish its mission. To assist in ensuring the survivability of assets that comprise this infrastructure, the DoD has formulated a CIP lifecycle, which includes: Analysis and Assessment, Remediation, Indicators and Warnings, Mitigation, Incident Response, and Reconstitution. This course introduces students to this lifecycle, and how the criticality and survivability of mission-critical infrastructures within the DoD are assessed. Prerequisite: CS3600.

CS3645 Cyber Threats and Mitigation (3-0)

This course will cover threats to information systems within the enterprise and will provide students with options for their mitigation. An objective of the course is to allow the student to understand the potential losses associated with today's major threats in terms of data disclosure, alteration or disruption of data, and the costs associated with mitigation techniques. Topics include: current state of the art in virus, worm and Trojan technology; botnets and their uses; common attack vectors and mitigations; data exfiltration techniques; intrusion detection and prevention systems; application log analysis. Prerequisite: CS3600 Security Clearance Required: classified and unclassified versions available.

CS3651 Computability Theory and Complexity (3-1) As Required

This course covers the concepts needed to argue the decidability and computational complexity of problems. Topics include recursive enumerability, undecidability, diagonalization, computational complexity classes, intractability, Turing reduction, and many-one reducibility. Basic techniques are presented for proving undecidability and for establishing a lower bound on the computational complexity of a problem. Prerequisites: CS3101 and CS3150.

CS3660 Critical Infrastructure Protection (4-0) Spring

Open to students of the Center for Homeland Defense and Security. This course examines the critical infrastructure of the USA. Eight sectors of the critical infrastructure are examined: Banking/Finance; Health Care/Health Affairs; Space/ISR; Power/Energy; Logistics/Postal System; Transportation; Telecommunications/Satellites; and Internet/IA. Each sector and its components is characterized in terms of its vulnerabilities, especially its interdependencies and couplings with other sectors. Finally, the course identifies potential counter measures that mitigate sector and system vulnerabilities and assesses their costs and benefits. Prerequisite: NS3180.

CS3670 Information Assurance: Secure Management of Systems (3-2) Fall/Spring

This course provides students with a security manager's view of the diverse management concerns associated with administering and operating an automated information system facility with minimized risk. Students will examine both the technical and nontechnical security issues associated with managing a computer facility, with emphasis on DoD systems and policies. Students have the opportunity to earn the following CNSS (formerly NSTISSI) certifications: INFOSEC Professional, System Administration in Information Systems Security, and ISSO. Prerequisite: CS3600.

CS3686 Identity Management Infrastructure (3-0)

This course covers a broad range of topics related to the standards, protocols, technology, and management infrastructure necessary to field an enterprise-level identity management (IdM) solution.

Lecture and reading assignments span the gamut of IdM issues: from low-level authentication protocol mechanics, to high-level identity federal initiatives. This course is one of several that will collectively compose the requirements for Identity Management specialization tracks in the Information Science and Computer Science degree programs. Completion of four courses: CS3686, CS3699, IS3710, and IS3720, will meet the requirements for earning the Federal/DoD Identity Management Certificate offered by NPS. Prerequisites: None.

CS3690 Network Security (4-1) Winter/Summer
This course covers the concepts and technologies used to achieve confidentiality, integrity, and authenticity for information processed across networks. Topics include: fundamentals of TCP/IP-based networking, core network security principles, traffic filtering types and methodology, packet-level traffic analysis, employment of cryptography, tunneling/encapsulation, Public Key Infrastructure (PKI), remote authentication protocols, and virtual private networks based on the IPSec, L2TP, and SSL protocols. Prerequisites: CS3600 and CS3502 and IS3502.

CS3695 Network Vulnerability Assessment and Risk Mitigation (3-2) Winter/Summer
This course provides a basis for understanding the potential vulnerabilities and their mitigation in networked systems by studying methods to: (1) obtain information about a remote network, (2) to possibly exploit or subvert systems residing on that network and (3) techniques to mitigate risks to networked systems. Labs provide practical experience with current network attack and vulnerability assessment tools, as well as tools and methodologies for a systematic approach to reducing vulnerabilities. A final project that demonstrates skill and knowledge is required. Prerequisite: One of the following: CS3502 or IS3502 or CS3690 or permission of the instructor.

CS3699 Biometrics (3-0) As Required
This course reviews the technical details of biometric identification and verification. The major biometric approaches (fingerprints, irises, etc.) are covered in detail with respect to acquisition of biometric data, matching techniques, anti-spoofing techniques, and current standards. The uses and limitations of biometrics are covered, as well as some of the legal, ethical, and privacy concerns of maintaining and using biometric data. This course is one of several that will collectively comprise the requirements for Identity Management specialization tracks in both the Information Science and Computer Science degree programs. Completion of four courses, CS3686, CS3699, IS3710, and IS3720, will meet the requirements for earning the Federal DoD Identity Management Certificate offered by NPS. Prerequisites: None.

CS3800 Directed Study in Computer Sciences (0-V) As Required
(Variable hours 0-2 to 0-8.) Individual research and study by the student under the supervision of a faculty member. The course is intended primarily to permit interested students to pursue in-depth subjects not fully covered in formal class work. Graded on a Pass/Fail basis only. Prerequisite: Consent of the instructor.

CS3920 Topics in Computer Science (V-V) As Required
(Variable hours 2-4 to 4-1.) Designed to support subject matter of special interest, dependent on faculty availability. Topics will either be drawn from areas not covered by core courses or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor.

Students may repeat this course for credit with a different topic. Prerequisite: Consent of the instructor.

CS4112 Distributed Systems (3-2) Winter
An advanced treatment of distributed systems. Major course topics include models of distributed computing; design and assessment of distributed algorithms, including clocks, mutual exclusion, resolution of conflicts for resources, control and termination of distributed computations, leader election, message ordering, synchronizers, slicers, distributed shared memory, consensus, self-stabilization, and fault tolerance; and current topics in distributed systems, such as distributed operating systems, distributed multimedia systems, sensor and peer-to-peer networks, and web services. Prerequisite: CS3070.

CS4113 Advanced Language Topics (4-0) As Required
This course is designed to explore concepts considered essential to the study of programming languages. These concepts include the lambda calculus, the Church-Rosser Theorem, reduction strategies, continuations, semantics, and recursion. Prerequisites: CS3111 and CS3070.

CS4182 Capstones in Computer Science (4-0) Winter/Summer
This is the capstone course for the CS curriculum. It surveys the transforming effects of seminal papers on ten subject areas within computer science. Each paper illustrates how the introduction of an organizing framework, a suitable form of analysis, or a set of supporting principles was able to change the way problems within the subject area were approached; a change that led to integrated and lasting solutions. Students will be responsible for reading and evaluating key papers that have helped to shape modern computer science. Prerequisite: CS3000.

CS4310 Sensory Artificial Intelligence (4-1) As Required
A study of methods of computational simulation in natural-language processing, computer vision, and sensor networks. Issues in natural-language processing include modeling of syntax, semantics, morphology, discourse, phonetics, and stochastic phenomena. Issues in computer vision include low-level processing, segmentation, shape inference, and object identification. Issues in sensor networks include deployment, local inference, and communications. Prerequisite: CS3310.

CS4312 Advanced Database Systems (3-1) As Required
This course is a sequel to CS3060, Database Systems. The course will provide an in-depth coverage of relational database theory, distributed database systems, semantic data models, query processing and optimization, transaction management, recovery, security, and other advanced topics. Topics will be illustrated using both commercial and prototype database systems. Prerequisite: CS3060 or consent of the instructor.

CS4313 Advanced Robotic Systems (3-2) As Required
AI methods for robots and unmanned vehicles. The first part of the course will discuss generic sensing and control mechanisms, including reactive and hierarchical control. The second part of the course will focus on specialized areas of robotics, swarm robotics and unmanned autonomous vehicles. Prerequisite: CS3310.

CS4315 Learning Systems and Data Mining (3-1) Winter
A survey of methods by which software and hardware can improve their performance over time. Methods include case-based

reasoning, concept learning, neural networks, simulated annealing, and genetic algorithms. Students will do projects with software tools. Prerequisites: CS3000 and one college-level course in programming.

CS4317 Language Systems (3-1) As Required

This course introduces the computational aspects of processing language. Topics include lexicography, morphology, grammars, parsing, semantics, stochastic grammars. Hidden Markov models, speech understanding, language generation and language translation systems. Prerequisites: CS3310, CS3150, CS3101.

CS4322 Internet Information Systems Technology (3-2) Summer

A course exploring the implementation of recent Internet tools for supporting databases, intelligent systems, and information retrieval. Topics include browsers and server technology including servlets, XML, data mining, and data warehousing. Students will do programming to build their own tools. Prerequisites: CS2020, CS3310 or CS3060, or consent of the instructor.

CS4330 Introduction to Computer Vision (3-2) Fall

This course introduces students to the main concepts that allow computers to "see" and understand visual information. It teaches methods and skills in image processing, pattern recognition, statistical analysis, classification, and learning. These are exemplified on applications such as military intelligence, surveillance, object tracking, robotic navigation, human-computer interfaces, and visual effects. Students complete a small class project that demonstrates the use of computer vision for an application of their interest. In laboratory activities, students get hands-on experience with the most important tools for building practical vision systems. Experiments and projects are tightly coupled with the material covered in class. Students must be familiar with a programming language such as C, C++, or Java (CS2020, CS2171, CS2173, etc.). Prerequisites: Helpful, but not necessary, is knowledge of basic linear algebra, probability or game theory, and Matlab (EC1010), or consent of the instructor.

CS4450 Advanced Computer Architecture (4-0) Summer

This course covers advanced topics in computer architecture and the application of concepts in computer architecture to the design and use of computers. The topics discussed include classes of computer architecture, application-oriented architecture, and high performance architecture. Prerequisites: CS2011, and CS3200 or equivalent.

CS4533 Wireless Mobile Computing (3-2) Fall/Spring

This course will focus on a new paradigm in computing: wireless mobile computing. Portable, handheld, computing devices are now being used for many applications previously accomplished by larger desktop computers or dedicated small devices. Some of these devices contain powerful RISC CPUs, user-accessible flash RAM storage, networking and peripheral connectivity, handwriting recognition, and built-in infrared networking capabilities. The goal of this course is to provide a fundamental understanding of the devices, communications, and design and implementation issues in building such mobile networked applications. Students will be required to research, design, and/or implement a project that integrates multiple technologies to solve a real-world problem requiring mobile computing. Prerequisites: CS3502 and CS3021.

CS4535 Mobile Devices (3-2) Spring

There are a large number of mobile devices, including cellular phones, personal digital assistants (PDAs), PDA/cellular phone combinations, pagers, badges, and other wearable devices, in use today in a variety of applications. The number and variety of such devices keeps growing at a fast pace, as new processing, display, and battery and wireless technologies are invented, and as new applications for these devices are envisioned. This is a practical, hands-on course that covers the architecture, usability, and applications of mobile devices. From an application perspective, this course will discuss mobile devices as tools to support homeland security applications, military applications for capability enhancement, and communications and computing needs of mobile professionals. The study of principles is combined with hands-on laboratory exercises to develop applications on mobile devices. The ultimate objective of the course is to show students how they can exploit the capabilities of mobile devices to implement innovative applications to enhance productivity and effectiveness in a variety of domains. Prerequisite: CS2020.

CS4537 Wireless Data Services (3-2) Summer

Tremendous progress has been made in mobile device and wireless networking technologies. Many different PDAs, cell phones, smartphones, and specialized devices have been introduced in the marketplace, and been enthusiastically adopted by millions of people around the world. Wireless networking technology development and adoption has moved even faster! The combination of mobile devices and wireless networking lends itself to data applications that can make a significant difference in a wide variety of application areas. The aim of this course is provide an understanding of the issues, technologies, and applications related to wireless data services. In addition to other topics, this course will cover wireless Internet, SMS, MMS, WAP, iMODE, J2ME, and BREW. Prerequisites: CS4533 and CS4535.

CS4538 Mobile Device and Wireless Security (3-1) Winter

The application of mobile and wireless devices has grown rapidly in military and commercial environments. The functionality and reliability of these devices has grown tremendously. The mobile and wireless nature of these devices raise new and important security challenges not usually present in static environments. This course will address these challenges including the security functionality, protocol, and assurance issues associated with this emerging technology. Prerequisites: CS3600 and CS3690 and CS4537.

CS4550 Computer Networks II (4-0) As Required

This course covers advanced and emerging topics in computer networking. Some topics taught in CS3502 will be reviewed and studied in more detail. Other course subjects may vary from instructor to instructor and they include: multimedia networking, wireless networks, multicasting, peer-to-peer networks, quality of service, network management, network architecture, and security. Prerequisite: CS3502.

CS4552 Network Design and Programming (3-3) Fall/Spring

The course is intended for CS and non-CS majors. Students will develop research and troubleshooting skills through experiments performed on real networks. The networking protocols covered in this course typically include: DNS, HTTP, FTP, SMTP, DHCP, TCP, UDP, RIP, OSPF, EIGRP. BGP, and VPN. Students will explore an emerging networking technology or issue and provide a technical report discussing the selected topic. Prerequisites: An advanced programming course, CS3502 and CS4550, or equivalent with consent of the instructor.

CS4554 Network Modeling and Analysis (4-0) Winter/Summer

The purpose of this class is to learn to formally specify and analyze network protocols, emphasizing wireless protocols, and in the process acquire a thorough understanding of these protocols. Formal protocol models, such as communicating finite state machines and systems of communicating machines, will be used as a tool for this purpose. Some protocols other than wireless protocols may also be covered. Several research papers from recent years will be assigned reading. Cellular networking, IEEE 802.11, Bluetooth, and wireless local loop networks will be covered as well. The class will study these protocols in the context of the network architectures and physical environments they are intended to perform in. Students should acquire an increased knowledge of formal tools, experience in protocol and system analysis, and a better understanding of protocols and networks. At the discretion of the instructor, other advanced topics such as simulation and statistical analysis of networks and network protocols may be added and/or substituted for some of the topics above. The emphasis is on application of mathematical rigor to the analysis and description of networking protocols. Prerequisite: CS3502.

CS4556 Business Economics Network Technology (4-0) Fall/Spring

This class teaches a different side of the networking world—the business and economics areas, which necessarily include relevant laws and government policies. The course reviews the history of telecommunications, including the major inventions and the development of the business and resulting regulations. The importance of capital and investment is taught by studying actual decisions of telecom companies and their results in the ensuing years. In this way, the students learn how the telecom industry developed and how the current regulatory structure came about. All of the major telecom laws and court decisions are studied. Basic business and economics principles are also studied, and numerous real-life examples are given. Students learn to write business plans and to analyze a telecom company or industry. The influence of the stock market on major companies is shown. The results of having either too much capital or too little are examined. The divestiture of AT&T in 1984, the resulting competition, the Telecom Act of 1996, and the telecom boom and bust of 1996-2003 are all examined in detail. Students in this class will gain a thorough understanding of the telecom industry, the major companies, and the effects of government regulation (too much or too little) and capital investment. Prerequisite: None.

CS4558 Network Traffic Analysis (3-2)

Explores fundamentals of packet-switched network traffic analysis at the network layer and above as applied to problems in traffic engineering, economics, security, etc. Explores the design and integration of analytic tools and techniques into the fabric of the network including: spatial and temporal anomaly detection, origin-destination matrix estimation, application mix determination, deep-packet inspection, fingerprinting, intrusion detection and insider threat mitigation. Finally, the course covers active defense and offensive methods reliant on traffic analysis. Prerequisites: CS3502 and CS4550 or equivalent.

CS4600 Secure System Principles (3-2) Fall/Spring

An advanced course that focuses on key principles of a constructive approach to secure systems. A brief review of operating systems and computer architecture is provided. Major topics include threat characterization and subversion; confinement; fundamental abstractions, principles, and mechanisms, such as reduced complexity, hierarchical relationships, least privilege, hardware protection, resource management and virtualization, software security, secure system composition, mutual suspicion, synchronization, covert and side-channel analysis, secure metadata, secure operational states, usability, and life cycle assurance. Current developments will include advances in security hardware, components, and systems. Prerequisites: CS3600, CS3070 and CS3502.

CS4603 Database Security (3-1) Spring

Course topics include: policies for information integrity and confidentiality of database (DB) systems, modeling of secure DB systems, security in statistical DBs, security approaches for object-oriented DBs, multitier architecture security issues, privacy, aggregation and inference, military applications of secure DBs, and other important implementation issues, such as atomicity, serialization, and view-based controls. Prerequisites: CS3600, CS3060 and CS3070.

CS4605 Security Policies, Models, and Formal Methods (3-1) Winter/Summer

This course covers the methods used to specify, model, and verify the access control mechanisms of computational systems. The identification of the security policy and its interpretation in terms of a technical policy is covered. Several security policy and access-control models are explored. Prerequisites: CS3150, CS3600 and CS3101.

CS4610 Information Ethics (3-0) Fall

Rapid and revolutionary advances in IT confront society with novel choices and opportunities. This course attempts to identify the kinds of ethical choices that may arise from its use. While a few may be clear choices, most will be between the greater of goods or the lesser of evils. These choices will be difficult because the values are difficult to identify, the right choices are more difficult than the wrong, and their consequences are neither certain nor easily predicted. Prerequisite: None.

CS4614 Advanced Topics in Computer Security (3-1) Winter/Summer

This course applies graduate-level knowledge and reasoning skills in written essays and verbal discussion of current topics in computer security. Students read academic papers regarding information assurance topics, and discuss issues that they derive from the readings. This pedagogical approach is constructivist in encouraging the students to develop their own viewpoints and conclusions. Prerequisites: CS3600 and CS4600 and CS4605, or consent of the instructor.

CS4615 Formal Analysis of Cryptographic Protocols (3-1) Spring

Cryptographic protocols (such as key-exchange and mutual-authentication protocols) are essential to the security of all distributed computer networks. Such protocols are often simple, but they also often fall to "structural" attacks (attacks that do not need to break the underlying cryptography). This course considers the "protocol analysis problem": finding structural attacks against a protocol (if they exist) or proving their absence (if they do not). We will examine several protocol-analysis techniques and compare their strengths and weaknesses. Advanced topics include (as time permits) protocol-design heuristics, trust-management and higher-level protocol goals, interactions between protocols, computational soundness, and decidability results. Prerequisites: CS3600 or permission of instructor.

CS4648 Advanced Cyber Munitions (3-2) As Required

This course will explore how malware is constructed through the analysis of existing malware. Techniques to provide attribution to malware will be explored. Topics include: malware obfuscation, insertion, dynamic updates, encryption and key management, and the use of malware to drive covert channels. The construction and operation of malware such as large scale distributed Botnets will be used in case studies. Prerequisites: CS2011, CS3070, and CS3140 or consent of the instructor.

CS4650 Fundamentals of Information Systems Security Engineering (3-1) Spring

This course presents the fundamental principles and processes of information systems security engineering (ISSE). The ISSE life cycle model consists of five stages: requirements definition, design, implementation, testing and deployment. The processes involved in these stages are explained in the context of a Defense-in-Depth protection strategy, with an emphasis on the role of security requirements engineering (SRE) in the construction of a secure system. This course covers the concepts and techniques needed to systematically elicit, derive and validate security requirements. It introduces how these techniques can be used in practice, and addresses the relationship between SRE and secure system design. Course work will be a combination of lectures, case studies and a team-based SRE project. Prerequisite: CS4600.

CS4652 Applied Information Systems Security Engineering (3-2) Fall, Spring

This course focuses on the key concepts and practices of information systems security engineering from a system life cycle perspective. Core topics include security architecture and design analysis, system implementation assessment, requirements/implementation traceability correspondence, security test and evaluation strategy, certification and accreditation (C&A) requirements analysis, and risk management. The Systems Thinking approach is introduced for assessing system security behaviors based on dependencies, interactions and emergent properties of its components in the context of functionality, scalability, interoperability and maintainability. Case studies and laboratory projects will demonstrate security engineering practices through the life cycle of a secure system. Prerequisite: CS4650.

CS4670 Quantum Computing (4-0) Spring

This interdisciplinary survey course explores the evolution and direction of quantum computing technology. Topics include quantum circuits, quantum algorithms (including factoring and search), and quantum key distribution. Jointly listed as PH4670. Prerequisites: familiarity with basic notions of computing, quantum theory, and linear algebra, consistent with the material covered in CS3000, PH2652, MA3042 or PH3991.

CS4675 Intrusion Detection and Response (3-1) Winter/Summer

This is an introduction to methods of intrusion detection in computer systems and networks and the possible methods of automatic responses to those events. It will cover types of intrusion detection, inference of suspicion, implementation, and management, and will examine at least one specific product. A special focus in response management will be the use of deliberate deception in defense of systems, including the psychology and ethics of deception in general. Prerequisite: CS3600.

CS4677 Computer Forensics (3-2) Fall/Spring

This course covers the fundamentals of computer forensics in the context of DoN/DoD information operations. Students examine how information is stored and how it may be deliberately hidden and/or subverted. Coverage includes: practical forensic examination and analysis, techniques of evidence recovery, legal preparation of evidence, common forensic tools, principle of original integrity, disk examination, and logging. Prerequisites: CS2011 and CS3600 and CS3670.

CS4678 Advanced Vulnerability Assessment (4-2) Winter/Summer

This course provides a basis for understanding the potential vulnerabilities in networked systems by applying a problem-solving approach to: (1) obtaining information about a remote network, (2) possibly exploiting or subverting systems residing on that network, (3) understanding the theory of operation of existing tools and libraries, along with how to measure the effectiveness of those tools, and (4) understanding tools and techniques available for vulnerability discovery and mitigation. Labs provide practical experience with current network attack and vulnerability assessment tools as well as development of new tools. Foot printing, scanning, numeration, and escalation are addressed from the attacker's perspective. A final project that demonstrates skill and knowledge is required. Prerequisites: CS3140 and CS3070 and CS3690, or consent of the instructor. Classification: UNCLASSIFIED FOUO, U.S. only.

CS4679 Advances in Cyber Security Operations (4-1) As Required

Unfettered by rules, ethics, or government acquisition politics, the cyber underground has created sophisticated and innovative mechanisms for digital crime. Spanning all layers from hardware and firmware to human-computer interfaces, these command and control systems are both clandestine and dynamic. Using case studies, this course explores the techniques, tactics and procedures of cyber security operations used to identify and track emerging adversarial behavior. By addressing computer network attack, defense, and exploitation topics associated with disruptive technologies, students will gain an understanding of the threats, vulnerabilities, and appropriate mitigating security controls. Sample topics include: supply chain attacks; driving forces of the cyber underground; operations involving a variety of cyber technologies and infrastructures; tracking, location, and identification: security implications of new hardware and firmware interfaces; and covert and side channels. Based upon the choice of case studies, this course will be taught at either the unclassified or TS/SCI levels. Prerequisite: CS3690 or consent of instructor.

CS4680 Introduction to Certification and Accreditation (3-2) Fall/Spring

This course provides an in-depth instruction on the DoD/DoN security certification process. It provides an introduction to the Certification and Accreditation (C&A) process as applied to procurement and lifecycle management of DoD and federal government information systems, with a focus on the role of the Certifier. Topics include the principal C&A roles, functional components, and output documents of the C&A process. Also included is a comparison of the Government C&A process specifications currently in use (DITSCAP/NIACAP, FIPS, DCID 6/3) and the emerging effort aimed at producing a unified specification. In the laboratory portion of the course, students will do 2 or 3 case studies of information systems that have been evaluated under the current DoD criteria in preparation for accrediting to carry sensitive information. The students will study each system from concept through final system certification and accreditation. They will look at and evaluate such things as the

security policies, system architecture, the system security architecture, design, implementation, deployment, management, evolution, assurances, etc. through available documentation and other evidence, to determine whether the systems were secure enough to handle the classified information at the appropriate levels of assurance. The case studies will be based on the information available about deployed systems. Prerequisites: CS3670 and either CS3690 or consent of the instructor.

CS4684 Cyber Security Incident Response and Recovery (3-2) As Required

This course defines the nature and scope of cyber security incident handling services, including intrusion/incident detection, damage control, service continuity, forensic analysis, service/data restoration, and incident reporting. Material covers policy, planning, operations, and technology issues involved in related cyber incident handling plans; i.e., Business Continuity, Disaster Recovery, and Continuity of Operations. Specific incident types addressed include, natural disasters, denial of service, malicious code, malicious misuse of hardware and firmware, unauthorized access, data compromise and inappropriate use, including insider attacks. Emphasis is given to the detection and analysis of infiltration and exfiltration techniques employed during cyber attacks, thus enabling the incident handler to detect low noise attacks, and to deconstruct particularly insidious attacks. Based upon the choice of case studies, this course will be taught at either the unclassified or TS/SCI levels. Prerequisites: CS3690 or consent of instructor.

CS4800 Directed Study in Advanced Computer Science (0-V) Fall/Winter/Spring/Summer

Advanced group studies in computer science on a subject of mutual interest to students and faculty member. Intended primarily to permit students to pursue in-depth subjects not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. Graded on a Pass/Fail basis only. Prerequisite: Consent of the instructor.

CS4900 Technology and Transformation I (2-0) Winter/Summer

This is a two-quarter course that supports students in the selection of thesis topics with potential for transformation. The thesis process is a microcosm of transformation processes. Topics include: meaning of transformation and innovation, innovation process, skills of innovation, selection of thesis topic, design of an effective thesis document, and organizing an effective writing process. Frequent faculty guest speakers will discuss different research areas and current problems under study. The emphasis in the first quarter is on the range of possible research, and in the second quarter on the transformation process as it applies to theses. Includes weekly readings and exercises. Prerequisite: None.

CS4901 Technology and Transformation II (2-0) Fall/Spring

This is a two-quarter course that supports students in the selection of thesis topics with potential for transformation. The thesis process is a microcosm of transformation processes. Topics include: meaning of transformation and innovation, innovation process, skills of innovation, selection of a thesis topic, design of an effective thesis document, and organizing an effective writing process. Frequent faculty guest speakers will discuss different research areas and current problems under study. The emphasis in the first quarter is on the range of possible research, and in the second quarter on the transformation process as it applies to theses. Includes weekly readings and exercises. Prerequisite: None.

CS4902 Practices of Transformation (0-2) As Required

This course will examine the current and planned research of Computer Science faculty in multiple fields of study. The course is designed to support Computer Science students in their third quarter of study in the selection of an emphasis track and an area for thesis research. Completion of this course requires submission of an approved thesis proposal during finals week. Prerequisite: Computer Science students in third quarter or consent of the department chairman.

CS4910 Advanced Readings in Computer Science (0-V) Fall/Winter/Spring/Summer

(Variable hours 0-2 to 0-8.) Directed readings in computer science on a subject of mutual interest to students and faculty member. The course allows in-depth study of advanced topics not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. Prerequisite: Consent of the instructor.

CS4920 Advanced Topics in Computer Science (V-V) Fall/Winter/Spring/Summer

(Variable hours 2-4 to 4-1.) Designed to support advanced group study of a subject matter of special interest, dependent on faculty availability. Topics will be drawn from areas not covered by other advanced courses, or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

CS4921 Advanced Topics in Computer Science I (V-V) As Required

(Variable hours 2-4 to 4-1.) Designed to support advanced group study of a subject matter of special interest, dependent on faculty availability. Topics will be drawn from areas not covered by other advanced courses, or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

CS4922 Advanced Topics in Computer Science II (V-V) As Required

(Variable hours 2-4 to 4-1.) Designed to support advanced group study of a subject matter of special interest, dependent on faculty availability. Topics will be drawn from areas not covered by other advanced courses, or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

CS4923 Advanced Topics in Computer Science III (V-V) As Required

(Variable hours 2-4 to 4-1.) Designed to support advanced group study of a subject matter of special interest, dependent on faculty availability. Topics will be drawn from areas not covered by other advanced courses, or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

CS5810 Dissertation Research (0-8) As Required

Dissertation research for doctoral studies. Required in the quarter following advancement to candidacy and then continuously each quarter until dissertation is approved by the Academic Council.

MV Courses

MV0810 Thesis Research (0-8) As Required
MOVES Thesis Research. Prerequisite: None.

MV0820 Integrated Project (0-12) As Required
The Naval Postgraduate School provides many opportunities for students to participate in campus-wide interdisciplinary projects. These projects encourage students to conceptualize systems which respond to current and future operational requirements. An integral part of the project involves working with other groups to understand and resolve issues involved with system integration and to lend MOVES-specific expertise to these projects. This course is available to Modeling, Virtual Environment and Simulation Students who are participating in a campus-wide integrated project. Course is grade on a Pass/Fail basis. Prerequisite: None.

MV1000 Becoming a Master Learner (3-2) As Required
This course teaches fundamental skills associated with success in higher education, with a focus on improving learning strategies and self-management skills to help students better organize, prepare, and perform effectively in an academic or work environment. The course teaches students to improve study habits, develop critical thinking skills, use time management principles, hone communication skills, and develop their own individual success strategies. The course helps students understand their own cognitive processes, and what strategies work for best for them in order to improve their learning and lead them to successes academically, personally, and in their careers. Graded on a Pass/Fail basis only. Prerequisite: None.

MV2920 Introductory Topics in Modeling, Virtual Environments, and Simulation (V-V) As Required
(Variable hours 2-4 to 4-1.) This course is designed to support introductory subject matter of special interest and is dependent on faculty availability. Topics will typically augment those offered in the basic core courses. This course may be lecture- or lab-oriented, or self-paced, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic. Prerequisite: None.

MV2921 Introduction to Modeling, Virtual Environments, and Simulation (2-0) Fall
This course is an introduction to the Modeling, Virtual Environments, and Simulation discipline. Topics include Combat Modeling, Networked Visual Simulation, Web-Based Simulation, Agents and Cognitive Modeling, Training Systems, Human Factors, Physically Based Modeling, and Optimization. Graded on a Pass/Fail basis only. Prerequisite: None.

MV3101 Introduction to Department of Defense Modeling and Simulation (4-0) Fall
This course serves as an important overview course for all students enrolled in the MOVES curricula, in addition to other curricula at NPS. It covers the origin, evolution, breadth and importance of DoD modeling and simulation (M&S), and the utilization of M&S in DoD system acquisition life cycle. The course focuses on the functional areas of DoD M&S, which are: Training, Analysis, Acquisition, Planning, Test, and Evaluation. This course also is offered as SE3101. Prerequisite: None.

MV3202 Introduction to Computer Graphics (3-2) Winter
This course introduces you to computer graphics — its powerful capabilities, a history of its technologies as well as up-to-date developments, to its far-reaching potentials across the consumer, industrial, and military domains, and how to achieve these potentials. You will learn about the principles of hardware and software used to create computer-generated images, about basic rendering and raytracing, 3D graphics programming in OpenGL, lighting and shading, textures, and scene graph architectures. MV3202 prepares you to design and implement 3D graphics simulations and to understand the theory of modern graphics rendering. The course is intended for students who have taken a basic course in, or have recent programming experience in, a programming language such as C++ or Java. Prerequisite: None.

MV3203 Graphical Simulation (3-2) Spring
Teaches the theory and techniques relevant to rapid construction of small to medium sized graphical simulations using existing simulation platforms, such as Delta3D, VBS2, Unreal, etcetera, including web browsers with plug-ins for Flash or X3D: For use as a stimulus for human performance experiments; as partial task trainers; as visualizations to support analysis; as testbeds for new hardware or software technology. Prerequisite: MV3202.

MV3204 Computer Graphics Modeling Using X3D/VRML (4-0) Fall
This course provides an introduction to the principles of hardware and software used for computer-generated 3-D graphics via the World Wide Web. The focus of the course is authoring interactive 3-D scenes and a major design project. The course is intended for MOVES and Computer Science students working in visual simulation, or students in other majors interested in the basics of 3-D modeling and rendering. Prerequisites: CS2971 and CS2073, or equivalent.

MV3250 Introduction to Extensible Markup Language (XML) (4-0) Fall
XML and related technologies provide platform independent representation, description, and validation of data. This is necessary for the data communication among different networks, computers, and applications that is essential for contemporary military and civilian applications. The course will present the benefits of XML and how to use software tools to construct and process XML documents using XML editors, XML parsers, XML Schema for validation, XSLT to transform documents, and DOM, SAX, and JDOM to access and manipulate XML documents within a computer program. Much of the programming code in contemporary computer applications that is used to construct data files, access databases and spreadsheets, check and validate data values, and output data can be replaced by these more general software tools. Prerequisite: None.

MV3302 Introduction to Discrete Event Simulation Modeling (4-1) Summer
This course provides an introduction to Discrete Event Simulation (DES) methodology, modeling, and analysis. Use of DES formalism, such as Event Graph methodology, for design of models. Component-based implementation of event graph models on a platform such as Simkit. Use of simulation components for building models using composition. DES modeling of movement and sensing. Random variate generation. Simple output analysis. Prerequisites: Java programming, at the level of CS2973, CS3773, or equivalent; or permission of instructor; Basic Probability and Statistics at the level of OA3101 and OA3103.

MV3403 Research Methods and Statistics for Healthcare Simulation (3-1) Fall
This course focuses on common research and statistical methods used to assess performance in simulated healthcare environments. Research methods covered include differences between surveys,

observational studies, and experiments, sampling procedures, instrumentation, reliability and validity, ethical requirements in conducting human subjects research, and the components of a grant proposal. Statistical methods include hypothesis testing, t-tests, z-tests, ANOVA, regression, and chi square methods. Labs will be conducted using appropriate statistical software that will provide students with hands-on understanding of many of the statistical methods covered in lecture. Prerequisites: None.

MV3472 Graphical Simulation of Physical Systems in Virtual Worlds (3-2) Spring

Design and construction of reusable software modules for real-time computer simulation of physical systems in graphical virtual worlds. Rigid body kinematics and dynamics, perspective transformations, and wire-frame graphical models. Time domain and transform domain analysis of linearized dynamic systems. Laboratory is concerned with development and testing of software. Prerequisites: CS2020 or CS2971 or CS2973 or equivalent; MA3042 or consent of the instructor.

MV3500 Internetwork Communications and Simulation (3-2) Summer

An introduction to network communications in simulation applications. Topics include an introduction to the TCP/IP protocol stack; TCP/IP socket communications, including TCP, UDP, and multicast; and protocol design issues, with emphasis on Distributed Interactive Simulation and High Level Architecture. The emphasis will be on Windows and Web-browser applications. Prerequisites: CS2971 and CS2173.

MV3800 Directed Study in Modeling, Virtual Environments, and Simulation (0-V) As Required

Individual research and study by the student under the supervision of a member of the faculty. The course is intended primarily to permit interested students to pursue in-depth subjects not fully covered in formal class work. Graded on Pass/Fail basis only. Variable hours 0-2 to 0-8. Prerequisite: Consent of the instructor.

MV3920 Topics in Modeling, Virtual Environments, and Simulation (V-V) As Required

(Variable hours 2-4 to 4-1.) Designed to support s subject matter of special interest, dependent on faculty availability. Topics will either be drawn from areas not covered by core courses or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic. Prerequisite: Consent of the instructor.

MV3922 Introduction to Virtual Environmental Technology (2-0) Winter

This course is an introduction to the technology used in virtual environments and discusses applications that use virtual environments. It is intended to give the students an introduction to the items they are likely to use throughout the master's degree program in Modeling, Virtual Environments, and Simulation (MOVES). Graded on a Pass/Fail basis only. Prerequisite: MV2921.

MV3923 Introduction to Research in Modeling, Virtual Environments, and Simulation (2-0) Spring

This course will examine the current and planned research of Modeling, Virtual Environments, and Simulation (MOVES) faculty in multiple fields of study. The course is designed to support MOVES students in the selection of emphasis blocks and an area for thesis research. Includes readings and exercises. Prerequisite: MV3922.

MV4000 Hamming: Learning to Learn (3-2) Summer

Richard W. Hamming's original capstone course, EC4000, "Learning to Learn: Future of Science and Engineering" has been fully digitized and placed online. This course presents the distilled career insights of a preeminent thinker. In 1968, Dr. Hamming was the recipient of the Turing Award, the highest honor in computer science, for his work on numerical methods, automatic coding systems, and error-detecting and error-correcting codes. This course is intended to instill a "style of thinking" that will enhance one's ability to function as a problem solver of complex technical issues. With respect, students sometimes called the course "Hamming on Hamming" because he relates many research collaborations, discoveries, inventions, and achievements of his own. This collection of stories and carefully distilled insights relates how those discoveries came about. Most importantly, these presentations provide objective analysis of the thought processes and reasoning that took place as Dr. Hamming, his associates, and other major thinkers in computer science and electronics progressed through the grand challenges of science and engineering in the twentieth century. Prerequisite: None.

MV4001 Human Factors of Virtual Environments (4-1) Fall

This course focuses on human factors issues in virtual environments (VEs). While the similarities of VEs to the real world can often make VE interfaces intuitive and easy to use, the differences between VEs and the real world can often be the cause of serious performance problems and physical inability to effectively use a system. The design of effective VE systems depends on an understanding of humans and their interaction with their environment. Only then can a VE system hope to achieve reasonable performance levels and acceptability. This course will survey the VE literature on issues of human performance, perception, cognition, multimodal interfaces, locomotion, wayfinding, object selection and manipulation, visualization, simulator sickness, and performance differences between individuals. Prerequisite: None.

MV4002 Simulation and Training (4-1) Winter

This course focuses on training issues in virtual environments (VEs). VEs have often been considered to be general purpose trainers. However, systems are often built without an understanding of how to build a trainer that can verify that it improves subsequent performance without forming bad habits or other reverse training artifacts. This course will first investigate VE training systems from a theoretical perspective, focusing on learning, memory, and cognition. From this framework, actual training systems will be studied with the focus being on an actual study of training transfer of a real training system. Prerequisite: None.

MV4003 Technology and Simulation in Healthcare Education (3-1) Spring

This distance learning course exposes students to the full breadth of medical simulation technologies used to train healthcare-related tasks, recreate physiologic conditions and disease states, assess domain knowledge, and support review and/or archiving. An integral part of the course is participation in a hands-on simulation practicum. The course combines structured asynchronous independent study, on-line discussion forums, post-and-assess peer-learning exercises, and weekly synchronous 'office hours' with subject matter experts (physicians, nurses, medical technology specialists) and the NPS course facilitator. Prerequisites: None.

MV4015 Agent-Based Autonomous Behavior for Simulations (4-2) Winter

Covers the concepts and skills required to apply agent-based programming to models and simulations of complex adaptive systems (CAS). Concepts covered will include: complex systems—especially their properties of path dependence, sensitivity to initial conditions, emergence of self-organized structure, adaptation to a changing environment, and criteria for evaluation model or simulation fidelity; distinctions between agent-based methods and other kinds of programming; goal-directed behavior and decision making; situational reasoning and the elements of rational behavior. The course will survey specific works and key contributors to this subject: John Holland, Complexity Science at the Santa Fe Institute, Artificial Life, Brian Arthur (the El Farol Problem and Bounded Rationality), SWARM, Sugarscape, ISAAC, Daniel Dennett (Intentionality), and Richard Dawkins. Within this conceptual and historical framework, the course will emphasize design, specification, and programming skills that will equip the student to know when and how to apply agent-based methods to models and simulations. The programming skills will involve genetic algorithms, classifier systems, applications of game theory and reinforcement learning, and the treatment of collaboration and defection in groups. Finally, the course will discuss agent-based simulations in the context of distributed, virtual environments. Prerequisite: None.

MV4025 Cognitive Behavioral Modeling for Simulations (3-2) Summer

This course focuses on the primary technologies used to model cognition and behavior in order to create agents that represent human beings in simulations. Topics include the dominant technologies in use, the tools used to support them, and their application to the various capabilities required of an agent. The modeling technologies covered include the production-system approaches common in artificial intelligence/cognitive science/psychology, as well as the finite-state, automata-inspired approaches that are part of engineering practice in computer-generated force simulations and the computer entertainment industry. The full scope of the modeling problem will be addressed, from sensation and perception through situation awareness and action selection, to action execution. Approaches to modeling communication and behavior moderators (e.g., experience, emotion, fatigue) will also be discussed. Prerequisite: CS3310.

MV4030 Modeling and Simulation in Ocean Environments (3-2) Spring

This course focuses on modeling and simulation (M&S) issues in ocean environments. While virtual environments (VEs) serve as M&S tools, the design of effective VE systems needs realistic physical environments. This course will cover the basic physics of ocean environments, visualization of the ocean from satellites, visualization of the ocean from Navy METOC model output, METOC information flow in M&S, the impact of the environment on human behavior, and physically-based modeling. Prerequisite: None.

MV4100 Cognitive Engineering (4-1) Winter

This course is about a cognitive approach to engineering systems. It is partly about artificial intelligence and agent-based technologies, and partly about human-computer interaction. The objective is to build intelligent interactive systems where we maximize the performance and capabilities of the combined human-machine system. Prerequisite: None.

MV4205 Advanced 3-D Modeling with X3D/VRML (4-0) Winter

This course teaches advanced principles and practice of web-based 3D computer graphics using X3D (formerly the Virtual Reality Modeling Language, VRML). Examples and class projects are typically oriented to problems of military or scientific interest. Topics include event scripting, optimized geometry representations, prototype extensibility, X3D Earth geospatial models, humanoid animation and IEEE Distributed Interactive Simulation (DIS) networking. Prerequisite: MV3204 or approval of the instructor.

MV4250 Advanced Extensible Markup Language (XML) Authoring and Design (4-0) Summer

MV4250 presents advanced principles and practices for Web-based document design and authoring using XML data structures, XML applications, and XML-based languages. Examples and class projects are typically oriented to problems of broad Navy, military, or scientific interest. Because this new course deals with principles of all Web-based languages, and since XML authoring tools are becoming more intuitive and accessible, MV4250 will be of interest to many other departments and curricula. Prerequisites: OA3250 and MV3250, or sufficient background knowledge of XML.

MV4302 Advanced Discrete Event Simulation Modeling (3-2) Winter

This course is an in-depth study of modern methods of Discrete Event Simulation (DES) modeling. The focus will be on learning advanced methods for designing and implementing DES models using the most current methodologies, including component-based simulation modeling, listener design patterns, XML and Web-based models. Students will implement a nontrivial DES model of military relevance as a final project. Prerequisite: OA3302.

MV4460 Management of Modeling and Simulation Development (4-0) Summer

The purpose of this course is to prepare MOVES students to manage large-scale modeling and simulation projects. The course traces the development life cycle of modeling and simulation systems, including, but not limited to, project management, measurement, life cycle models, requirements, implementation, testing, verification, and deployment of large-scale systems typical of DoD acquisition. Prerequisite: None.

MV4470 Image Synthesis (3-2) Spring

This course covers advanced topics in computer image generation. The focus of the course is quality and realism in computer image synthesis. Topics include illumination, shading, transparency, antialiasing, shadows, raytracing, radiosity, texture mapping, and parametric surfaces. Labs are directed towards providing students with experience working with scene graph architecture. Prerequisites: CS2173 and MV3202, or consent of the instructor.

MV4471 Computer Animation (3-2) Winter

This course covers advanced topics in state-of-the-art, animated, 3-D, computer models. Computational techniques for real-time animation, motion control, interactive key-frame systems, kinematic methods for figure animation, dynamics for figure animation, soft object animation, procedural animation and other high-level approaches will be examined. Labs utilize state-of-the-art animation software and equipment. Prerequisite: MV3202 or MV3204 or consent of the instructor.

MV4472 Physics for Game Developers and Virtual Environments (3-2) Spring

This course enables you to produce convincing graphical virtual reality representations of the motion of vehicles and human actors or avatars. Basic linear algebra and vector-matrix calculus are explained, and the ANSI Common Lisp programming language is used, in the context of examples. This is a hands-on, project-oriented course. After studying basic topics, each student will focus on developing and presenting an individual project during the second part of the course. Prerequisite: MV3472 or equivalent.

MV4474 Virtual Environment Network and Software Architecture (3-2) Spring

This course covers the design and implementation of network and software architectures for real-time, interactive 3-D virtual environments (VEs). Network architecture topics include a taxonomy for networked virtual environments, distributed interactive simulation protocols (DIS and HLA), virtual reality modeling language (VRML), agent-based network protocols (Java/Telescript), proposed solutions for large-scale networked virtual environments (area of interest managers and object brokers), multicast backbone tools and developments, and virtual reality transfer protocol proposals. Software architecture topics include representative software architectures for VEs (NPSNET, DIVE, MASSIVE, etc.), commercial toolkits for VE development (WorldToolKit, Division's dvs, Performer, etc.), lag in multiprocessor virtual environments, and the HCI implications on VE network and software architectures. Prerequisite: MV3500 or consent of the instructor.

MV4501 Simulation Application Practicum (2-4) Summer

This course provides students with extensive laboratory experience applying simulations to address a defense capability gap using simulation-based system. The application domain will be selected from a representative simulation application domains (e.g. training, analysis, acquisition, experimentation). Students will analyze a specified need, develop requirements, objectives, and standards of system and human performance, select a simulation platform, develop additional infrastructure and environments needed to accomplish identified needs and objectives, test their solution, analyze its effectiveness and define recommendations for potential system re-design. Prerequisite: MV4002.

MV4502 Simulation Development Practicum (2-4) Fall

This course provides the students the opportunity to work directly with a full scale, deployed combat simulation. This class has two main objectives. The first is to gain a deeper understanding of the inner structure of modern combat simulation systems. This goes beyond just looking at conceptual descriptions of the components to looking at the implementation intricacies that make such systems work. The second is as a practicum to provide students experience with all of the processes involved in the development of simulation software. This includes requirements definition, test and evaluation and software design and implementation. The intent is to have the students gain hands on experience in all aspects of these processes. By looking at a deployed system that is being used by the Marine Corps and Army, the students will develop an appreciation for the issues that are encountered in the real world that are often masked in purely pedagogical examples. Prerequisites: MV4025, MV3302.

MV4503 Simulation Interoperability Practicum (2-4) Winter

This course provides students with hands-on experience with the issues around connecting live, virtual, and constructive simulations into a single federation. Students will deepen their understanding of High Level Architecture down to the Federation Object Model and Simulation Object Model level. They will encounter data and timing incompatibility issues, and learn the tools and techniques currently used to resolve them. They will develop a practical understanding of information assurance requirements on simulations and how they can be addressed. Prerequisite: MV3500.

MV4655 Introduction to Joint Combat Modeling (4-0) As Required

This course covers the basic tools and concepts of joint combat modeling. Both the science and the art are emphasized. Topics include: the role of combat modeling in analyses, taxonomies of models, an introduction to some important models and organizations, measures of effectiveness, approaches to effectively using models to assist decision making, object-oriented approaches to designing entities to simulate, firing theory, one-on-one and few-on-few engagements, introduction to aggregated force-on-force modeling (including the basic Lanchester model and some of its derivatives), sensing algorithms, simulation entity decision making, simulating C4ISR processes, terrain and movement algorithms, verification, validation, and accreditation (VV&A), stochastic versus deterministic representations, hierarchies of models, and variable resolution modeling. The primary course objective is for you to understand the enduring fundamentals of how combat models are built and used to support decision making. This will be done, in part, through several small projects that will require students to design, implement, and analyze models. Prerequisites: Probability and Statistics (through third course in the sequence), familiarity with a programming language (Java recommended), Stochastic Models (OA3301), Calculus, and concurrent instruction in computer simulation (e.g., OA3302).

MV4657 Modeling and Simulation for Stability, Security, Transition, and Reconstruction (SSTR) Operations (3-2) Fall/Spring

The purpose of this course is to explore the challenges of modeling non-traditional combat for today's war fighters. This course investigates issues, challenges, and opportunities for application of modeling and simulation (M&S) to military support for Stability, Security, Transition, and Reconstruction (SSTR) operations. The course considers application of M&S for SSTR from the perspectives of analysis, training, acquisition, and mission planning/rehearsal. Students are given hands-on experience with current and emerging SSTR M&S simulations and computational tools. Meet prerequisites or consent of the instructor. Prerequisite: MV4655.

MV4800 Directed Studies in Advanced Modeling, Virtual Environments, and Simulation (0-V) As Required

Advanced group studies in modeling, virtual environments, and simulation on a subject of mutual interest to students and faculty member. The primary intent of this course is to permit students to pursue in-depth subjects not fully covered in formal class work or thesis research. This course may be repeated for credit with a different topic. Graded on Pass/Fail basis only. The variable credit hours are 0-2 to 0-8. Prerequisite: Consent of the instructor.

MV4900 Research Seminar in Modeling, Virtual Environments, and Simulation (0-2) As Required

A seminar series designed to give a broad-brush introduction to MOVES. Presentations include the major areas of MOVES and are presented by subject matter experts within MOVES. Also covered are ongoing research projects within MOVES at NPS and around the world. All first and second quarter MOVES students are required to take this course. Prerequisite: None.

MV4910 Advanced Readings in Advanced Modeling, Virtual Environments, and Simulation (0-V) As Required

(Variable credit hours 0-2 to 0-8.) This course is centered on directed readings in modeling, virtual environments, and simulation on a subject of mutual interest to students and faculty member. The course allows in-depth study of advanced topics not fully covered in formal class work or thesis research. This course may be repeated for credit with a different topic. The course can be taken either Pass/Fail or graded. Prerequisite: Consent of the instructor.

MV4920 Advanced Topics in Advanced Modeling, Virtual Environments, and Simulation (V-V) As Required

(Variable credit hours 2-4 to 4-1.) This course is designed to support the advanced group study of a subject matter of special interest, dependent on faculty availability. Topics will be drawn from areas not covered by other advanced courses, or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

MV4924 Current Topics in Modeling, Virtual Environments, and Simulation (1-1) Fall/Winter/Spring/Summer

The course is designed to provide breadth in MOVES not normally provided by other classroom material, as well as focus in major areas of MOVES. Faculty and research staff attend class sessions, providing the opportunity to interact with a broad group once a week, and with a focused group of the student's choosing once a week. Course is expected to be repeated and is required of all MOVES students every quarter starting with their fourth quarter in the curriculum. Graded on a Pass/Fail basis only. Includes student presentations and readings. Prerequisite: MV3923.

MV4925 Advanced Rendering Techniques for Visual Simulation (2-3) Summer

Currently, the number of transistors on a certain consumer-level graphics processing units exceeds the number of transistors on a Pentium IV processor. Until recently, however, programming these powerful units has been done using a limited assembly-like instruction set targeted for a specific vendor's hardware. This has made cinematic effects difficult to program, update, and transport. Recent developments such as High Level Shading Language (HLSL), Nvidia's C for Graphics (CG), and the OpenGL 2.0 specification could revolutionize the process of programming GPUs. This class will provide an overview of current technology and will explore in-depth its application to DoD. Prerequisite: MV4470 or consent of the instructor.

MV4930 Advanced Topics in Advanced Modeling, Virtual Environments, and Simulation (0-2) As Required

This course is part of the seminar series in advanced research topics in MOVES. Topics are drawn from current student thesis research, funded research projects, proposed research projects, and other research directions within the MOVES Institute. This course is required by all MOVES students in their second quarter and beyond, as well as all CS Graphics Track students. Presentations are made by M.S. and Ph.D. students, as well as by MOVES faculty and researchers. This course may be repeated multiple times. Prerequisite: None.

MV5810 Dissertation Research (0-8) As Required

Dissertation research for doctoral studies. Required in the quarter following advancement to candidacy and then continuously each quarter until dissertation is approved by the Academic Council.

SW Courses

SW0810 Thesis Research (0-8) As Required

Every student conducting thesis research will enroll in this course.

SW2920 Introductory Topics in Software Engineering (V-V) As Required

(Variable hours 2-4 to 4-1.) Designed to support introductory subject matters of special interest in software engineering, dependent on faculty availability. Topics will typically augment those offered in the basic core courses. This course may be lecture- or lab-oriented, or self-paced, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic. Prerequisite: Consent of the instructor.

SW3460 Software Methodology (2-1) Winter/Summer

The course is designed to teach students the basic concepts of software engineering and methods for requirements definition, design, and testing of software. Specific topics include introduction to the software life cycle, basic concepts and principles of software engineering, object-oriented methods for requirements analysis, software design, and development. Prerequisite: OO programming experience (CS2020) or consent of instructor.

SW3800 Directed Study in Software Engineering (0-V) As Required

(Variable hours 0-2 to 0-8.) Individual research and study by the student under the supervision of a member of the faculty. The course is intended primarily to permit interested students to pursue in-depth subjects not fully covered in formal class work. Graded on Pass/Fail basis only. Prerequisite: Consent of the instructor.

SW3920 Topics in Software Engineering (V-V) As Required

(Variable hours 2-4 to 4-1.) Designed to support subject matters of special interest in software engineering, dependent on faculty availability. Topics will either be drawn from areas not covered by core courses, or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic. Prerequisite: Consent of the instructor.

SW4150 Programming Tools and Environments (4-0) As Required

This course covers the design and implementation of tools to aid software development, including syntax-directed editors, version-control systems, language-oriented debuggers, symbolic execution vehicles, programming databases, type checkers, and automatic programming tools. These topics are discussed in the context of an integrated, language-oriented, programming environment. Prerequisite: SW3460 or consent of the instructor.

SW4500 Introduction to Formal Methods in Software Engineering (3-1) Fall

This course covers formal methods for specification and analysis of software systems. The course introduces application of mathematical logic to software design, program verification, and formal specification languages. The laboratory sessions will cover special topics and case studies. Prerequisite: SW3460 or consent of the instructor.

SW4510 Computer-Aided Prototyping (3-0) As Required

This course covers the concept and application of computer-aided prototyping to the development and acquisition of DoD software systems. Specific topics include the prototyping software life cycle, system models, design methods, automatic code generation, prototyping languages and tools, and their unique systematic

system for increasing productivity, reliability, and portability of software development in comparison with other development methods. Prerequisite: SW3460 or consent of the instructor.

SW4520 Advanced Software Engineering (3-0) As Required
This course covers methods for specifying, designing, and analyzing software systems, with emphasis on automatable techniques and their mathematical basis. The techniques are applied to construct and check programs using a formal specification language. The course concludes with a summary of current research areas in software engineering. Prerequisite: SW4500 or consent of the instructor.

SW4530 Software Engineering Research and Development in DoD (3-1) Summer
This course builds on the material covered in SW4500. Fundamental principles of computer system/network security and distributed computing are covered, along with advanced methods, techniques, and standards aimed at improving the development and acquisition of DoD software systems. Specific topics include: the application of software engineering principles for designing large, secure, embedded real-time computer systems; the application of software engineering principles for the design of distributed systems; automated tools for the specification, design, and generation of code for applications; and existing and emerging standards for software development, security, and acquisition. Prerequisite: SW3460 or consent of the instructor.

SW4540 Software Testing (3-1) Spring
This course covers the theory and practice of testing computer software with the intent of preventing, finding, and eliminating bugs in software. Planning and executing software tests are covered, including requirements-based testing, functional testing, static analysis, code reading, symbolic testing, structural testing, and advanced testing techniques. These topics are discussed in the context of a realistic development environment, illustrated using a variety of software testing tools. Prerequisite: SW3460 or consent of the instructor.

SW4555 Engineering Network Centric Systems (3-1) As Required
This course covers the concepts, methods, techniques, and tools for engineering the development of network centric systems. Specific topics include the evolution of client/server models to distributed objects, an introduction to and comparison of CORBA/OpenDoc and OLE/COM, intelligent software agents, application development in distributed environments, security issues in network centric computing, and DoD software system development. Prerequisite: SW4500.

SW4560 Software Evolution (3-0) Fall
This course covers the concepts, methods, techniques, and tools for supporting the evolution and maintenance of software systems. Specific topics include the use of formal specifications to support software evolution, design databases, configuration management, software change merging, and software re-engineering. Prerequisite: SW3460 or consent of the instructor.

SW4570 Software Reuse (3-0) Spring
This course covers the concepts, methods, techniques, and tools for systematic reuse of software components and systems. Specific topics include design and re-engineering for reuse, mechanisms for enhancing reuse, domain specific reuse and software architectures, reuse of requirements models, specifications and designs, tools for reuse, software library organization, and methods for component search. Prerequisite: SW3460 or consent of the instructor.

SW4580 Design of Embedded Real-Time Systems (3-0) Summer
This course covers the concepts, methods, techniques, and tools for supporting the design of embedded real-time systems. Specific topics include real-time systems and concurrency models, object-oriented methods for real-time system design, real-time scheduling, and programming language support for concurrent and real-time systems. Prerequisite: SW3460 or consent of the instructor.

SW4581 Software Reliability (3-1) Fall
This course covers the concepts, methods, and techniques for evaluating and improving the engineering of software reliability. Specific topics include system-level dependability and reliability modeling concepts; software reliability prediction and estimation models and metrics; and techniques for model evaluation, fault/failure forecasting, fault removal, fault prevention, and fault tolerance. Prerequisite: SW3460 or consent of the instructor.

SW4582 Weapon System Software Safety (3-1) Fall
This course provides an introduction to software system safety. The course covers the principles and processes of system safety engineering, including the basics of hazard analysis and risk assessment. Emphasis is placed in this course on both planning and managing acquisition programs involving safety-critical software. Concepts and principles are applied to the acquisition of weapon systems. An advanced course in system safety is offered as SW4920. Prerequisite: SW3460 or consent of the instructor.

SW4583 Principles of Software Design (3-1) Winter
The course is designed to teach students the role of design in software engineering. Specific topics include the software system design process, design qualities, principles and strategies, design models, design methods, and the use of patterns in the design of object-oriented software systems. Prerequisite: SW3460 or consent of the instructor.

SW4590 Software Architecture (3-1) Winter
This course covers both high- and low-level software architectures, including software patterns and pattern-oriented architectures, from the module level through the enterprise level. Where appropriate, we examine formalisms, and actual software architecture practice. Special attention is given to interoperability of architectural components. Case studies of existing DoD systems are used throughout the course. Prerequisite: SW3460 or consent of the instructor.

SW4591 Requirements Engineering (3-1) Spring
This is an in-depth treatment of requirements engineering concepts, methods, and tools. The role of requirements engineering within software engineering is explored, as well as consistency, cost-benefit analysis, resolving multiple viewpoints, dependency tracing, and automated decision support. Topics are reinforced with examples from DoD applications. Prototyping is introduced as a means of assessing requirements early in the design process. Prerequisite: SW3460 or consent of the instructor.

SW4592 Software Risk Assessment in DoD (3-1) Summer
This course introduces concepts, techniques, and tools for software risk management. The course examines various risks of software practice and evaluates them in terms of mathematical models (e.g., probability theory). Students learn techniques for mitigating, avoiding, and handling risks throughout the software life cycle. The course depends on software metrics; we also look at reliability

theory and its application to software risk management. Prerequisite: SW3460 or consent of the instructor.

SW4593 Advanced Logic and Algebra for Software R&D in DoD (3-1) As Required

The aim of this course is to present fundamentals of advanced logic and algebra for software R&D. Specific topics include equational specifications, algebra, characterization of equation classes, the equation calculus, term rewriting, first and second order logic, temporal logic, model theory, and generalized induction. Prerequisite: SW4500 or consent of the instructor.

SW4594 Formal Models for Software Automation (3-1) As Required

This course covers the concepts, methods, techniques, and tools for designing and developing systems. Specific topics include the use of knowledge-based tools for software evolution and techniques for specification, methods for program derivation and generation, domain-specific program synthesis techniques, and cognitive and planning approaches to software design. Prerequisite: SW4500.

SW4595 Lightweight Inference Techniques (3-1) As Required

This course covers the fundamental principles and technologies for automated decision support and automated software evolution with an emphasis on techniques for lightweight inference. Specific topics include: decision support systems, software evolution systems, gaps in existing technology that prevent automation, models and methods for lightweight inference, and state of the art theory and practice. Prerequisite: SW4500 or consent of the instructor.

SW4596 Algorithm Design and Analysis in Software Engineering (3-1) As Required

This course covers algorithm design and analysis in software engineering. Specific topics include advanced data structures (such as Binomial Heaps and Fibonacci Heaps), graph algorithms (such as minimum spanning trees, maximum flow, all-pairs shortest paths, and single-source shortest paths), and advanced design and analysis techniques (such as dynamic programming, greedy algorithms, linear programming, and amortized analysis). Prerequisite: SW4500 or consent of the instructor.

SW4597 Robust Generation of Control Software (3-1) As Required

This course covers the concepts, methods, techniques, and tools needed to methodically generate robust software for system control. Specific topics include specification and analysis of control requirements, hard and soft real-time constraints, embedded software control, code generation, software reliability through software reuse and redundancy, and DoD requirements for control systems. A survey of computer-aided tools that support the generation of robust systems is provided. Prerequisite: SW4500 or consent of the instructor.

SW4598 Software Merging and Slicing Techniques (3-1) As Required

The fundamental concepts, methods, and tools for software merging and slicing are covered in this course, with applications to software evolution, configuration management, and testing. This is followed by advanced topics including recent advancements in this field. Prerequisite: None.

SW4599 Automated Software/Hardware Integration in DoD (3-1) As Required

Automated software/hardware integration is a key problem for current software development in DoD. This course covers some important aspects of this field, including software prototyping, interface integration, data integration, and control integration. Automatable decision support methods for software/hardware integration are also discussed. Prerequisite: SW4500 or consent of the instructor.

SW4600 Automata, Formal Specification, and Run-Time Verification (3-1) Fall

This course focuses on run-time monitoring and verification, a practical software verification technique based on automata and formal specifications. The automata section consists of finite automata (deterministic and nondeterministic), languages, and regular expressions. The formal specification section consists of temporal logics, real-time and time-series constraint specification, statecharts, and TLCharts. The run-time verification section will cover the practical application of formal specifications to monitoring and verification of safety critical systems. The course combines theory, examples, and practical, student-driven projects. After taking this course, students will know how to apply formal specifications and run-time verification to improve the dependability of defense systems. Prerequisites: CS3150 and MA2025.

SW4800 Directed Study in Advanced Software Engineering (0-V) As Required

(Variable hours 0-2 to 0-8.) Advanced group studies in software engineering on a subject of mutual interest to students and faculty member. Intended primarily to permit students to pursue in-depth subjects not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. Graded on a Pass/Fail basis only. Prerequisite: Consent of the instructor.

SW4900 Research Seminar in Advanced Software Engineering (0-2) As Required

This course will examine the current and planned research of software engineering faculty. The course is designed to support software engineering students in the selection of an area for thesis research. Completion of this course requires submission of an approved thesis proposal during finals week. Graded on a Pass/Fail basis only. Prerequisite: None.

SW4910 Advanced Readings in Software Engineering (0-V) As Required

(Variable hours 0-2 to 0-8.) Directed readings in software engineering on a subject of mutual interest to students and faculty member. The course allows in-depth study of advanced topics not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. Can be taken Pass/Fail or graded. Prerequisite: Consent of the instructor.

SW4920 Advanced Topics in Software Engineering (V-V) Winter

(Variable hours 2-4 to 4-1.) Designed to support advanced group study of a subject matter of special interest in software engineering, dependent on faculty availability. Topics will be drawn from areas not covered by other advanced courses, or be focused treatments of subjects of limited scope. This course may be lecture- or lab-oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

SW4931 Core Area of Software Engineering Doctoral Studies (3-2) As Required

Designed to prepare Ph.D. students for the core area of the Software Engineering written qualifying examination - software development process and techniques. It introduces the most important references from each subject areas, highlights the

important issues in each area, and helps students become familiar with the Software Engineering research. Topics covered include: software life cycle models; software engineering concepts and principles; specification and verification of software - modeling, analysis, and assessment; design of large software systems - architectures, patterns, and protocols; maintenance of large software systems - reengineering, transformations, recovering specs and rationale. Intended for Software Engineering PhD students. Prerequisite: SW4930 or consent of instructor. Graded on Pass/Fail basis only.

SW4932 Advanced Area of Software Engineering Doctoral Studies (3-2) As Required

Designed to prepare Ph.D. students for the advanced area of the Software Engineering written qualifying examination - software automation. It introduces the most important references from each subject areas, highlights the important issues in each area, and helps students become familiar with the Software Engineering research. Topics covered include: reducing coding efforts - program generation, synthesis techniques, static checking; computer-aided prototyping - models, languages, methods; software reuse - search methods, library organization; software evolution - models, automation methods, merging and slicing; domain specific systems - real-time systems. Intended for Software Engineering PhD students. Prerequisite: SW4931 or consent of instructor. Graded on Pass/Fail basis only.

SW4933 Supporting Areas of Software Engineering Doctoral Studies (3-2) As Required

A seminar designed to prepare Ph.D. students for the supporting areas of the Software Engineering written qualifying examination. Topics covered include: Computer science - mathematical fundamentals, algorithms and data structures, compilation technology, artificial intelligence, and security: management and economics - project planning and management, quality assurance, software economics, knowledge bases, decision support, and fundamentals for system modeling; computer systems - real-time systems, networks and distributed systems, hardware/software integration, interoperability of network based systems, computer graphics and interfaces and signal processing and embedded control systems. Intended for Software Engineering PhD students. Prerequisite: SW4932 of consent of instructor. Graded on Pass/Fail basis only.

SW4934 Application of Advanced Concepts in Software Engineering (3-2) Spring

An advanced seminar designed to assist Ph.D. students to prepare for their written qualifying examination through a combination of lectures and problem-solving sessions. Intended for Software Engineering Ph.D. students. Students may repeat this course for credit. Graded on Pass/Fail basis only. Prerequisite: Consent of the instructor.

SW4935 Software Engineering Dissertation Proposal Preparation (3-0) As Required

A seminar designed to introduce Ph.D. students to the open problems in software engineering and teach students the skills to identify research topics; find, read and analyze relevant parts of the research literature; and present their findings in the form of research proposals. Intended for Software Engineering Ph.D. students. Prerequisite: SW4934.

SW4936 Seminar on Solving Software Engineering Research Problems (3-0) As Required

A seminar designed to assist Ph.D. students in preparing for their oral qualifying examination through a combination of lectures, assigned readings, student presentations, and problem-solving sessions. Intended for Software Engineering Ph.D. students. Prerequisite: SW4934.

SW4937 Software Engineering Dissertation Research (4-0) As Required

A seminar designed to provide a forum for Ph.D. students to present work in progress and critique each other's results. Intended for Software Engineering Ph.D. students. Prerequisite: None.

SW4938 Communicating Research Results in Software Engineering (4-0) As Required

A seminar designed to provide a forum for Ph.D. students to present their dissertations and critique each other's work. Intended for Software Engineering Ph.D. students. Prerequisite: None.

SW5810 Dissertation Research (0-8) As Required

Dissertation research for doctoral studies. Required in the quarter following advancement to candidacy and then continuously each quarter until dissertation is approved by the Academic Council.

Healthcare Modeling & Simulation Certificate – Curriculum 240 (DL)

Program Officer

CDR Joseph Sullivan, USN, Ph.D.
Code CS/Js, Watkins Hall, Room 271

(831) 656-7562, DSN 756-7562
sullivan@nps.edu

Academic Associate

Rudy Darken, Ph.D.
Code CS/Rd, Watkins Hall, Room 384

(831) 656-7588, DSN 756-7588
darken@nps.edu

Brief Overview

The Naval Postgraduate School, in collaboration with the Uniformed Services University of the Health Sciences, have collaborated to design and deliver a distance learning educational program for healthcare simulation professionals. This program focuses on the effective use of modeling and simulation in the healthcare domain. The materials developed have been reviewed and incorporated into an efficient, interactive, fast-paced certificate program for working professionals.

The certificate requires the completion of four courses, comprising 16 credit hours of work at the graduate level. These courses form a coherent sequence to equip the certificate student with the core skills necessary to manage a modeling and simulation education and research program which can be completed in 12 months.

Convenes

Fall

Required Courses

· OA3402 (4/0), Research Methods for Performance Assessment
· MV4002 (4/0), Simulation & Training
· MV4003 (4/0), Technology in Simulation Healthcare Education
· MV4460 (4/0), Management of Modeling & Simulation Development

Cyber Security Fundamentals Certificate – Curriculum 256 (DL), Curriculum 257 (RES)

Program Manager

Cynthia Irvine, Ph.D.
Code CS/Ic, Glasgow East, Room 211

(831) 656-2461, DSN 756-2461
irvine@nps.edu

Brief Overview

The Cyber Security Fundamentals graduate certificate is intended to provide a technically rigorous foundation upon which to build knowledge and skills in computer network defense, attack and exploitation. Each course is comprised of both instruction and laboratory exercises involving cyber security aspects of computers and networks. These synergistic activities allow students to internalize key concepts in cyber security. The courses and material covered in the Cyber Security Fundamentals certificate satisfy prerequisite requirements for advanced courses in cyber security offered in the Computer Science Department of the Naval Postgraduate School. In addition, the Cyber Security Fundamentals certificate satisfies requirements for the following Committee on National Security Systems (CNSS) certificates: CNSSI 4011, CNSSI 4013, and CNSSI 41014 for which NPS was recertified on 31 July 2008.

All four of the courses in the sequence are extracted from the current set of graduate courses in the Computer and Network Security specialization track offered by the CS Department. Of these, three are core track courses. The total number of NPS graduate credits obtained for the certificate is up to 13.5, where laboratory credits are counted as half. This certificate program can also be applied toward a master's degree program, e.g. Curriculum 368.

Convenes

Fall, Winter, Spring, Summer

Required Courses

CS3600 or	(4-2)	Introduction to Computer Security
CS4600	(3-2)	Secure System Principles
CS3670	(3-2)	Secure Management of Systems
CS3690 or	(4-1)	Network Security
CS3695	(3-2)	Network Vulnerability Assessment

Cyber Security Defense Certificate – Curriculum 258 (DL), Curriculum 259 (RES)

Program Manager

Cynthia Irvine, Ph.D.
Code CS/Ic, Glasgow East, Room 211

(831) 656-2461, DSN 756-2461
irvine@nps.edu

Brief Overview

Using the foundation established through the Cyber Security Fundamentals certificate, students enrolled in Cyber Security Defense graduate certificate, will obtain a detailed understanding of and ability to function in real operational situations involving cyber security. They will gain the technical depth required to actively prepare for and respond to attacks. Students will learn to analyze network traffic to extract the observable characteristics of networks and network devices, thus providing a basis for defensive strategies. They will learn to build tools and how to configure systems and networks to permit systems to foster resiliency and continuity of operations, perhaps with reduced capacity, through attacks. Students will learn how to construct systems and tools to mitigate the impact of malicious software. Students will learn forensic techniques to retrieve and analyze stored information that may be corrupted or hidden. Considerable programming and hands-on work with systems and networks will be required. Entire courses, or units within them, may be taught at the classified level, thus facilitating classroom discussions on emerging challenges and capabilities.

Students entering this program are expected to have a strong foundation in cyber security and networking. In addition, entering students will be expected to understand and use the languages and techniques of operating system and network component development: the C programming language, assembly, shell scripting, use of linkers, loaders, and debuggers.

The total number of NPS graduate credits obtained for the certificate is 12, where laboratory credits are counted as half. This certificate program can also be applied toward a master's degree program, e.g. Curriculum 368.

Convenes

Fall, Winter, Spring, Summer

Required Courses

CS4558	(3-2)	Network Traffic Analysis
CS4677	(3-2)	Computer Forensics
CS4684	(3-2)	Cyber Security Incident Response
or		and Recovery
CS4600	(3-2)	Secure Systems Principles

Cyber Security Adversarial Techniques Certificate – Curriculum 260 (DL), Curriculum 261 (RES)

Program Manager

Cynthia Irvine, Ph.D.
Code CS/Ic, Glasgow East, Room 211

(831) 656-2461, DSN 756-2461
irvine@nps.edu

Brief Overview

Using the foundation established through the Cyber Security Fundamentals certificate, students enrolled in Cyber Security Adversarial Techniques graduate certificate, will obtain a detailed understanding of and ability to function in real operational situations in which adversarial techniques are being used. An understanding of overarching principles, computer and network architectural concepts, and exemplar cases will allow students to analyze current and future malware. Students will learn how to use network traffic analysis to extract the characteristics of ongoing attacks and to identify exploitable vulnerabilities. They will learn how to decipher subtle, clandestine host-based attack mechanisms and how these mechanisms are inserted into target systems. They will learn, in detail, how attack and exploitation software mechanisms are built and deployed, including the distributed command and control techniques used to manage large-scale malware networks. Considerable programming and hands-on work with systems and networks will be required. Entire courses, or units within them, may be taught at the classified level, thus facilitating classroom discussions on emerging challenges and capabilities.

Students entering this program are expected to have a strong foundation in cyber security and networking. In addition, entering students will be expected to understand and use the languages and techniques of operating system and network component development: the C programming language, assembly, shell scripting, use of linkers, loaders, and debuggers.

The total number of NPS graduate credits obtained for the certificate is 13.5, where laboratory credits are counted as half. This certificate program can also be applied toward a master's degree program, e.g. Curriculum 368.

Convenes

Fall, Winter, Spring, Summer

Required Courses

CS4558	(3-2)	Network Traffic Analysis
or		
CS4648	(3-2)	Advanced Cyber Munitions
CS4678	(4-2)	Advanced Cyber Vulnerability Assessment
CS4679	(4-1)	Advances in Cyber Security Operations

Master of Computing Technology (MCT) - Curriculum 357 (Distance Learning)

Program Manager and Academic Associate

Loren E. Peitso
Code CS/Lp, Glasgow East, Room 335

(831) 656-3009, DSN 756-3009, FAX (831) 656-3238
MCTDegProg@nps.edu

Brief Overview

The MCT degree offers its graduates the knowledge and skills necessary to specify, evaluate, and manage computer system development, as well as the ability to provide technical guidance in the analysis, design, and application of software and firmware used in the Navy. The MCT program consists of 12 courses selected to provide breadth and depth in the latest computing technologies. Four courses provide a foundation in computing for those without a Computer Science background. Four specialization fundamentals courses provide breadth in computing technologies and techniques examined with respect to a consistent specialization theme, and the final four specialization depth courses develop strong expertise in the specialization area. A capstone paper completes the degree.

The MCT degree provides a graduate education for those in unique circumstances. State-of-the-art distance learning (DL) technology is used to bring the MCT program straight to the student on duty. With fully Web-based courses, there is no required "class time"-no need to get off the flight schedule, miss any watches, or adjust a duty schedule. MCT offers a seamless transition from duty station to duty station; when you move the program goes with the student, even on the road. For organizations that desire to sponsor groups of students, we can arrange to deliver courses at an accelerated pace via video tele

education (VTE), this option requires scheduled on-duty classroom time.

The MCT degree is fully accredited and taught by the same faculty that teaches NPS resident courses. All courses are web-based conversions of existing NPS courses. These fully-online versions are taught by faculty that teach the courses in residence and have also completed the Interactive Distance Learning faculty development course offered by the NPS Center for Educational Design, Development, and Distribution (CED3).

MCT is an excellent fit for those officers and government service (GS) personnel whose career track would not otherwise lend itself to receiving a resident technical graduate education. Available anywhere in the world, at home, on detachment, and at sea.

Requirements for Entry

A baccalaureate degree, or the equivalent, with above average grades in mathematics, (including differential and integral calculus) resulting in an academic profile code (APC) of at least 325 is required. Undergraduate degrees in applied science or engineering are highly desirable. Students lacking these prerequisites may be acceptable for the program, providing their undergraduate records and/or other indicators of success, such as the Graduate Record Examination (GRE), indicate an ability to work in quantitative subjects. While previous academic or practical experience in computer science is certainly helpful and can enhance the applicant's potential for admission, such experience is not a prerequisite. Active/Active Duty Reserve U.S. military and GS personnel are eligible.

Entry Date

The MCT is a 12-quarter (one course per quarter), fully-online curriculum with entry dates in January/July. If further information is needed, contact the Program Officer or the Academic Associate for this curriculum.

Degree

Master of Computing Technology

The Master of Computing Technology program is awarded after the satisfactory completion of a program which satisfies, as a minimum, the following degree requirements:
· At least 40 quarter-hours of graduate-level work, of which at least 12 quarter-hours must be at the 4000 level.
· Completion of an approved sequence of courses constituting specialization in an area of computing technology.
· Completion of a capstone paper.

Subspecialty

None currently assigned. DL students desiring a computer science subspecialty code (6203P) may be able to arrange a resident assignment at NPS with their sponsor/community detailer to add a research element to their degree program and complete the ESR requirements for a computer science subspecialty code. Six months of resident study will be required.

If a transition to a MS in Computer Science (MSCS) degree is also desired, the research element must be arranged before the MCT curriculum is finished. A MSCS (in lieu of the MCT degree) will be granted after completion of the research element and thesis. The MSCS cannot be granted if the MCT has been awarded for the same coursework.

Typical Course of Study

1st Year Computer Science Foundations

CS2020	(4-2)	Introduction to Programming
CS3030	(4-0)	Computing Architecture and Operating Systems
CS2121	(3-2)	Essential Automata and Algorithms
CS3502	(4-1)	Computer Communications & Networks

2nd Year Specialization Fundamentals

Four-course sequence, all courses at the 3000 or 4000 level, in one of the listed specializations:

3rd Year Specialization Depth

Four-course sequence, minimum 12 credits at the 4000 level, continuing the specialization sequence:

Specialization Options

Information Security Systems Engineering (ISSE)

The role of Information Systems Security Engineering (ISSE) is to help ensure that the security requirements of systems are met. Lacking proper security engineering, systems fail to be certified and accredited, causing costly delays or failures. Ideally the Information Systems Security Engineer (also known as an ISSE) will be a member of the system development team throughout its lifecycle; however, for preexisting systems, the ISSE may be required to assess existing system vulnerabilities and determine mitigating strategies. As systems have grown more complex and adversaries continue to successfully exploit numerous vulnerabilities, the need for improved secure system engineering and the formation of a larger cadre of skilled ISSEs has become more acute. The ISSE course sequence will provide the knowledge and analytical skills required to contribute productively in system developments and assist in building a larger cadre of skilled ISSEs to combat adversaries.

Principles of Cyber Defense

The Principles of Cyber defense fundamentals sequence is comprised of the courses offered in the Cyber Security Fundamentals graduate certificate. It is intended to provide a technically rigorous foundation upon which to build knowledge and skills in computer network defense, attack and exploitation. Each course is comprised of both instruction and laboratory exercises involving cyber security aspects of computers and networks. These synergistic activities allow students to internalize key concepts in cyber security. The specialization depth sequence will give the student a detailed understanding of and ability to function in real operational situations involving cyber security sharing courses with the Cyber Security Defense Certificate. They will gain the technical depth required to actively prepare for and respond to attacks. Students will learn to analyze network traffic to extract the observable characteristics of networks and network devices, thus providing a basis for defensive strategies. They will learn to build tools and how to configure systems and networks to permit systems to foster resiliency and continuity of operations, perhaps with reduced capacity, through attacks. Students will learn how to construct systems and tools to mitigate the impact of malicious software. Students will learn forensic techniques to retrieve and analyze stored information that may be corrupted or hidden. Considerable programming and hands-on work with systems and networks will be required.

Networking

The Computer Networks specialization is designed to provide knowledge of computer architecture, networks, and system software for real-time and multicomputer systems and in the rapidly growing areas of wireless networking, mobile devices, and related topics, including mobile computing and wireless security.

Generalist

The generalist specialization concentrated on understanding a broad cross section of the computing field with respect to the technologies in defense communications and weapons systems the unrestricted line officer will work with in the near to medium term. Topic areas include computer and network security, autonomous and robotic systems, networked distributed systems including cloud technologies and emerging wireless mobile computing technologies.

Computer Science - Curriculum 368 (Resident), Curriculum 376 (Distance Learning)

Program Officer

LCDR Eric McMullen, USN
Code CS/Em, Glasgow East, Room 309

(831) 656-7980, DSN 756-7980
FAX (831) 656-3681
elmcmull@nps.edu

Academic Associate

Thomas W. Otani, Ph.D.
Code CS/To, Glasgow East, Room 307

(831) 656-3391, DSN 756-3391
FAX (831) 656-2814
twotani@nps.edu

Program Manager for CS Degree Program via Distance Learning
Loren E. Peitso
Code CS/Lp, Glasgow East, Room 335

(831) 656-3009, DSN 756-3009
FAX (831) 656-3238
lepeitso@nps.edu

Brief Overview

The Computer Science curriculum is designed to provide the officer with the technical knowledge and skills necessary to specify, evaluate, and manage computer system design; to provide technical guidance in applications ranging from data processing to tactical embedded systems; to educate the officer in the analysis and design methodologies appropriate for hardware, software, and firmware; and provide practical experience in applying modern computer equipment and research techniques to solve military problems.

The principles presented in the curriculum have two layers: computing mechanics deals with the workings of computations, communications, computers, and memories; and computing design deals with the ways of organizing software systems for simplicity, reliability, performance, security, and value.

Our curriculum also provides for concrete experience in computing practices—the skills and ways of thinking that mark a computing professional. These include programming, engineering of systems, modeling, and innovating. We offer a unique course called Technology, Innovation, and Leadership that teaches the practices and discipline of innovation.

The two dimensions—computing principles and practices—define the space in which the core technologies of computing exist and serve application domains: algorithms, architecture, artificial intelligence, database, networking, operating systems, security, and more.

Requirements for Entry

A baccalaureate degree, or the equivalent, with above average grades in mathematics, (including discrete math, and differential and integral calculus) resulting in an APC

of at least 325 is required for direct entry. Undergraduate degrees in applied science or engineering are highly desirable. Students lacking these prerequisites may be acceptable for the program, through a "foundations" 12-week refresher quarter, provided that their undergraduate records and/or other indicators of success, such as the Graduate Record Examination (GRE), indicate an ability to work in quantitative subjects. While previous academic or practical experience in computer science is certainly helpful and can enhance the applicant's potential for admission, such experience is not a prerequisite.

Entry Date

Computer Science is a six-quarter course of study with entry dates in March and September. Prospective students requiring a 12-week "foundations" refresher will begin study one quarter prior to those entry dates. If further information is needed, contact the Academic Associate or Program Officer for this curriculum.

Degree

Master of Science in Computer Science

The degree of Master of Science in Computer Science is awarded after the satisfactory completion of a program which satisfies, as a minimum, the following degree requirements:

· At least 40 quarter hours of graduate-level work, of which at least 12 quarter hours must be at the 4000 level.
· At least 28 of the 40 graduate-level credit hours listed above must be CS, MOVES, SW courses.
· To ensure a sufficient breadth across the field of Computer Science, the following course topics must be satisfied as part of the course of study or through validation prior to graduation: Artificial Intelligence (CS3310), Networks (CS3502), Automata (CS3101), and Introduction to Computer Security (CS3600).
· Completion of an approved sequence of courses constituting specialization in an area of computer science.
· Completion of an acceptable thesis or a capstone project.

Requirements for the Master of Science in Computer Science degree are met as a milestone en route to satisfying the Educational Skill Requirements established by the sponsor for the curricular program.

Doctor of Philosophy in Computer Science

Specifics on the Ph.D. in Computer Science program are found in the linked CS Department Ph.D. Handbook.

Subspecialty

Completion of curriculum 368 qualifies a USN officer as a Computer Science Subspecialist with a subspecialty code of 6203P.

Typical Subspecialty Jobs

Computer Science Instructor, U.S. Naval Academy
Preoperational Test and Evaluation, SPAWAR, Washington, D.C.
Computer Systems Analyst, COMNAVSECGRU, Washington, D.C.
ADP Systems Director, Naval Security Group, Pensacola, FL
Chief SEID, Joint Staff, Washington, D.C.
Operational Test and Evaluation, COMOPTEVFOR
ADP System Security, NSA/CSS, Ft. Meade, MD

Typical Course of Study (24-Month Track)

Refresher Quarter 0 (Optional)

CS2020	(4-2)	Introduction to Programming
MA2025	(4-1)	Logic & Discrete Math
CS2000	(6-6)	Intro to Computer Systems

Quarter 1

CS3021	(4-2)	Introduction to Data Structures and Intermediate Programming
CS3502	(4-2)	Computer Communications and Networks
CS3070	(3-2)	Operating Systems
OS3307	(4-1)	Modeling Practices for Computing

Quarter 2

CS3310	(4-1)	Artificial Intelligence
CS3600	(4-2)	Introduction to Computer Security
CS3200	(4-2)	Large Scale Architecture
CS3150	(4-0)	Design and Analysis of Algorithms
CS4900	(2-0)	Technology and Transformation I

Quarter 3

CS3101	(4-2)	Theory of Formal Lang & Automata
CS3060	(3-1)	Database Systems
SW3460	(2-1)	Software Development
CS3004	(2-1)	Human-Computer Interface
NW3230	(4-2)	Strategy & Policy
CS4901	(2-0)	Research Methods

Quarter 4

CS0810/ CS0809	(0-8)	Thesis/Capstone Research
-	-	Track Requirement
-	-	Track Requirement
-	-	Track Elective (Students on the 18-month track will take NW3285)

Quarter 5

CS0810/ CS0809	(0-8)	Thesis/Capstone Research

-	-	Track Requirement
-	-	Track Requirement
-	-	Track Elective (Students on the 18-month track will take NW3275)

Quarter 6

CS0810/ CS0809	(0-8)	Thesis/Capstone Research
-	-	Track Requirement
-	-	Track Requirement
-	-	Track Elective (Students on the 18-month track will take NW3276)

Quarter 7 (optional for 24-month students)

CS0810/ CS0809	(0-8)	Thesis/Capstone Research
-	-	Track Elective
-	-	Track Elective
MN3331	(5-1)	Principles of Acquisition and Program Management

Note: Track Core Requirement courses will be determined by the selection of one of the following specialization track options.

Specialization Track Options

Track Core Requirement courses will be determined by the selection of one of the following specialization track options.

- **Information Security and Assurance -** provides knowledge in all areas of Information Security (INFOSEC) and develops the necessary skills for those who will be involved in development, evolution, or implementation of secure computer systems.
- **Network and Mobile Systems -** provides fundamental and advanced knowledge in network architecture and system software for real-time and multicomputer systems and in the rapidly growing areas of wireless networking, mobile devices, and related topics, including mobile computing and wireless security.
- **Autonomous Systems -** provides an understanding of artificial intelligence and human factors techniques for creating highly capable software agents that interact effectively with human users.
- **Software Engineering and Architecture -** provides knowledge of all aspects of software development and develops skills needed to efficiently and reliably implement military systems and application software using the best available tools and techniques.
- **Cyber Systems and Operations** - provides knowledge in all areas of security provisions, information assurance and situational awareness for computer systems, networks and ICS, and their integration with Defensive Cyber Operations, Offensive Cyber Operations, and DoD Global Information Grid Operations.

- **CS-MOVES Option -** Students interested in an MSCS degree with a focus on modeling, simulation, and virtual environments may choose the CS-MOVES Option as their track. Specialization sequence course work will be coordinated by the student working with his/her MOVES thesis advisor, and must be approved as part of the thesis proposal.

Educational Skill Requirements (ESR)
Computer Science - Curriculum 368
Subspecialty Code: 6203P

The Computer Science and System Design subspecialty code (6203) is intended to serve the Navy by providing commands with officers who possess expertise related to the specification, development, installation, maintenance, evaluation, and security of hardware and software computer systems and networks. The officer must have the theoretical knowledge and practical expertise to perform technical and oversight responsibilities related to computer systems as required by the Department of Defense. Particular skills and competencies that constitute this subspecialty are detailed below:

1. **Fundamental Computer Science:** Architectures, operating systems, computer networks, high- and low-level languages and their translation, software systems, human-computer interaction.
2. **Software Development:** Planning and development of large software projects to include specification of requirements, design, technical documentation, implementation, risk analysis, testing, quality assurance, maintenance, process metrics, and measures of effectiveness through the use of modern software engineering techniques and tools.
3. **Analysis:** Application of scientific methods to determine reliability, efficiency and performance of computer systems; modeling, simulation, and analysis of algorithms, processes, and systems in support of Naval operations.
4. **Data Systems and Management:** Devices, interfaces and interconnects; storage architectures and data organizations, addressing and indexing; continuity, backup and recovery; resilience; models, analytics, and visualization; large data sets, and data mining.
5. **Autonomous Systems:** Design, construction, and operation of autonomous systems including unmanned vehicles; analysis tools for security, forensics and intelligence. Basic skills include artificial intelligence, knowledge management and representation, machine learning, heuristic search, and data mining.
6. **Cyber-Systems and Operations:** Development, implementation and management of security provisions, information assurance and situational awareness for computer systems, networks and ICS,

and their integration with Defensive Cyber Operations, Offensive Cyber Operations, and DoD Global Information Grid Operations.

7. **Networking and Distributed Computing:** Modeling, design and implementation of network infrastructures for distributed and mobile systems. Application of distributed multi-core and multi-processor systems in High Performance Computing (HPC) and cloud computing configurations to support analysis, forensics, engineering, management, and other "big data" applications, such as operations, intelligence and meteorological/oceanographic.

8. **Specialization:** In addition to the breadth obtained from the collection of previous items, the officer will complete a series of advanced courses that integrate computer science in DOD systems, software, and operations. This in-depth study conveys essential real-world complexities and details that are required to make informed decisions during every stage of computer systems' lifecycles. Knowledge is deepened through a thesis or capstone project in a framework that exercises the practices of innovation, problem solving, systems-thinking, and real-world application.

Joint Professional Military Education (JPME)

Per community requirements, the officer will have an understanding of warfighting within the context of operational art to include: strategy and war, theater security decision making, and joint maritime operations. Confers JPME Phase I certification.

Software Engineering - Curriculum 369 (Resident and Distance Learning)

Program Officer

LCDR Eric McMullen, USN
Code CS/Em, Glasgow East, Room 309

(831) 656-7980, DSN 756-7980
FAX (831) 656-3681
elmcmull@nps.edu

Academic Associate

Thomas W. Otani, Ph.D.
Code CS/To, Glasgow East, Room 307

(831) 656-3391, DSN 756-3391
FAX (831) 656-2814
twotani@nps.edu

Program Manager for Software Engineering Degree Program via Distance Learning

Loren E. Peitso

Code CS/Lp, Glasgow East, Room 335

(831) 656-3009, DSN 756-3009
FAX (831) 656-3238
lepeitso@nps.edu

Brief Overview

The software engineering curriculum is designed to address the seemingly never-ending "software crisis" within the defense community. It builds on the student's knowledge of both computer science and engineering sciences, in addition to leveraging the student's real-world, problem-solving experience working with software-intensive systems. The curriculum introduces the students to the theory, principles, and practices of software engineering. These engineering practices enable acquisition professionals to procure highly dependable, trustworthy software-intensive systems on schedule, within budget, and with the correct functionality. The program offers both M.S. and Ph.D. degrees in Software Engineering.

Requirements for Entry

The Software Engineering program is no longer accepting new entries into the degree programs. Students interested in Software Engineering are referred to the Computer Science (Curric 368) degree program's Software Engineering and Architecture Track.

Entry Date

The Software Engineering program is no longer accepting new entries into the degree programs. Current students will be matriculated through graduation.

Degree

Master of Science in Software Engineering (MSSwE)

The degree of Master of Science in Software Engineering is awarded after the satisfactory completion of a program which satisfies, as a minimum, the following degree requirements:
· At least 12 graduate-level Software Engineering courses.
· Completion of an acceptable thesis in addition to the required course work.

Requirements for the Master of Science in Software Engineering degree are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

Doctor of Philosophy in Software Engineering

The Ph.D. program in Software Engineering is designed for DoD software practitioners who want to acquire the skill and knowledge to perform state-of-the-art research on issues related to the development and evolution of large, complex, software systems, and to intelligently manage the research of other software practitioners. It offers the

software professionals a unique program of study and advances software engineering principles and technology vital to DoD researchers and program managers.

The Ph.D. degree is awarded after successful defense of a dissertation that advances the state of the art in Software Engineering. Ph.D. seminars are available to assist students in reaching that goal. See the online handbook for details on admission, requirements, and procedures:

Software Engineering Ph.D. Handbook

Typical Course of Study

(Ph.D. SwE Program)

Quarter 1
SW4931	(3-0)	Core Area of Software Engineering Doctoral Studies
SW5810	(0-8)	Dissertation Research

Quarter 2
SW4932	(3-0)	Advanced Area of Software Engineering Doctoral Studies
SW5810	(0-8)	Dissertation Research

Quarter 3
SW4933	(3-0)	Supporting Area of Software Engineering Doctoral Studies
SW5810	(0-8)	Dissertation Research

Quarter 4
SW4934	(3-0)	Application of Advanced Concepts in Software Engineering Doctoral Studies
SW5810	(0-8)	Dissertation Research

Quarter 5
SW4935	(3-0)	Software Engineering Dissertation Preparation
SW5810	(0-8)	Dissertation Research

Quarter 6
SW4936	(3-0)	Seminar on Solving Software Engineering Research Problems
SW5810	(0-8)	Dissertation Research

Quarter 7
SW4937	(4-0)	Software Engineering Dissertation Research
SW5810	(0-8)	Dissertation Research

Quarter 8
SW4938	(4-0)	Communicating Research Results in Software Engineering
SW5810	(0-8)	Dissertation Research

Typical Subspecialty Jobs

Students who graduate from the M.S./Ph.D. Software Engineering programs typically hold senior technical and acquisition positions, such as chief system engineer, technical director, and program/project manager.

Typical Course of Study

(Full-Time MSSwE Program)

Quarter 1
SW3460	(3-1)	Software Methodology
SW4581	(3-1)	Software Reliability
MN3301	(4-0)	Acquisition of Defense Systems
IS4300	(3-2)	Project Management for Enterprise Systems

Quarter 2
SW4500	(3-1)	Introduction to Formal Methods
SW4530	(4-0)	Software Engineering Research and Development
SW4591	(3-0)	Requirements Engineering
CS3600	(4-2)	Introduction to Computer Security

Quarter 3
SW4520	(3-0)	Advanced Software Engineering
SW4583	(3-1)	Principles of Software Design
SW0810	(0-8)	Thesis Research
SW0810	(0-8)	Thesis Research

Quarter 4
SW4540	(3-1)	Software Testing
SW4590	(3-1)	Software Architecture
SW0810	(0-8)	Thesis Research
SW0810	(0-8)	Thesis Research

Educational Skill Requirements (ESR)
Software Engineering - Curriculum 369

None currently assigned.

Master of Arts in Identity Management and Cyber Security (MAIDMCS) – Curriculum 377 (Hybrid)/Curriculum 378 (Resident)

Identity Management and Cyber Security - Curriculum 377 (Hybrid - 18 months)

Identity Management and Cyber Security - Curriculum 378 (Resident - 12 months)

Program Manager

Cynthia Irvine, Ph.D.
Code CS/Ic, Glasgow East, Room 211

(831) 656-2461, DSN 756-2461
FAX (831) 656-3339
irvine@nps.edu

Academic Associate

Zachery Peterson
Code CS/Zp, Glasgow East, Room 209

(831) 656-2509, DSN 756-2509
FAX (831) 656-3339
znpeters@nps.edu Mailto:znpeters@nps.edu

Direct inquiries to: MAIDMCSDegProg@nps.edu
Mailto:MAIDMCSDegProg@nps.edu

Overview

The Master of Arts in Identity Management and Cyber Security (MAIDMCS) degree provides individuals whose organizations depend upon cyberspace a broad overview of cyber security technology and how to create a balance between risks and benefits based upon the physical and virtual assets requiring protection. The program focuses on cyber security as enabling technology for a broad range of enterprise initiatives and is intended for leaders in a wide range of government activities regardless of organizational specialization. The MAIDMCS program consists of 12 courses selected to provide breadth and depth in the latest security technologies.

Designed to accommodate busy individuals, the Master of Arts degree program is offered in a hybrid mode that requires participants to be in residence (at the Naval Postgraduate School in Monterey, California or possibly another location to be determined) two weeks each quarter (for a total of 12 weeks). Participants complete the balance of their coursework via network-based distance learning methods. The program can also be taken entirely at NPS and is of shorter duration in this mode. Participants complete an applications project for which a written report is required.

The degree provides participants with the knowledge and skills to:

- Understand the synergistic nature of many aspects of cyber security. These include the interrelationships between cyber defense, cyber operations, cyber attack, and cyber exploitation, as well as major security objectives for next generation cyber systems.
- Develop strategies and plans for securing information assets on IT systems in the face of cyber attacks.
- Understand the impact of acquisition and architectural decisions on the security of information and systems.
- Appreciate the nature of cyber threats and how coherent and holistic choices can support requirements for sharing and productivity.
- The MAIDMCS degree is fully accredited and taught by the NPS faculty.

Requirements for Entry

A baccalaureate degree, or the equivalent, resulting in an academic profile code (APC) of at least 344 is required.

While previous academic or practical experience in computer science or a related field is not a prerequisite. Active/Active Duty Reserve U.S. military, DoD civilian, and US Government civilian personnel are eligible.

Entry Date

The MAIDMCS degree is designed to be either a 6-quarter (two courses per quarter) hybrid mode or a 4-quarter fully resident model. For further information, contact the Program Manager or Academic Associate for this curriculum.

Degree

Master of Arts in Identity Management and Cyber Security

The Master of Arts in Identity Management and Cyber Security degree is awarded after the satisfactory completion of a program that satisfies, as a minimum, the following degree requirements:

- At least 40 quarter-hours of graduate-level work, per NPS requirements.
- Completion of the specific sequence of courses satisfying the breadth and subject matter requirements of Identity Management and Cyber Security.
- Completion of an applications project.

Subspecialty

None currently assigned.

Typical Course of Study

(*The typical 6 quarter (18-month) hybrid course of study is shown below.*)

Quarter 1

CS3699	(3-0)	Biometrics
IS3710	(3-0)	Identity Management Operations
CS3621	(0-4)	Applications Project and Research for Identity Management and Cyber Security Studies

Quarter 2

CS3686	(3-0)	Identity Management Infrastructure
IS3720	(3-0)	Identity Management Policy
CS3621	(0-4)	Applications Project and Research for Identity Management and Cyber Security Studies

Quarter 3

CS3600	(4-2)	Introduction to Computer Security
CS3505	(3-2)	Introductory Computer Communications
CS3621	(0-4)	Applications Project and Research for Identity Management and Cyber Security Studies

Quarter 4

CS3670	(3-2)	Information Assurance: Secure Management of Systems
CS3610/or	(4-0)	Information Ethics, Crime and Law
DA3105	or	or
	(4-1)	Conflict in Cyberspace
CS3621	(0-4)	Applications Project and Research for Identity Management and Cyber Security Studies

Quarter 5

CS3636	(3-0)	Data Fusion with Online Information
CS3633	(4-0)	Data Security
CS3621	(0-4)	Applications Project and Research for Identity Management and Cyber Security Studies

Quarter 6

CS3640	(3-1)	Analysis of DoD Critical Infrastructure Protection
CS3645	(3-0)	Cyber Threats and Mitigation
CS3621	(0-4)	Applications Project and Research for Identity Management and Cyber Security Studies

Typical Course of Study

(Accelerated 12-month Format Hypothetical Schedule.)

Quarter 1

CS3699	(3-0)	Biometrics
IS3710	(3-0)	Identity Management Operations
CS3505	(3-2)	Introductory Computer Communications
CS3621	(0-4)	Applications Project and Research for Identity Management and Cyber Security Studies
-	-	Elective

Quarter 2

CS3686	(3-0)	Identity Management Infrastructure
IS3720	(3-0)	Identity Management Policy
CS3621	(0-4)	Applications Project and Research for Identity Management and Cyber Security Studies
CS3600	(4-2)	Information Assurance: Intro to Computer Security
-	-	Elective

Quarter 3

CS3670	(3-2)	Information Assurance: Secure Management of Systems
CS3610/or	(4-0)	Information Ethics, Crime and Law
DA3105	or	or
	(4-1)	Conflict in Cyberspace
CS3621	(0-4)	Applications Project and Research for Identity Management and Cyber Security Studies
CS3633	(4-0)	Data Security
-	-	Elective

Quarter 4

CS3640	(3-1)	Analysis of DoD Critical Infrastructure Protection
CS3636	(3-0)	Data Fusion with Online Information
CS3645	(3-0)	Cyber Threats and Mitigation
CS3621	(0-4)	Applications Project and Research for Identity Management and Cyber Security Studies

Modeling, Virtual Environments, and Simulation (MOVES) - Curriculum 399

Program Officer

LCDR Eric McMullen, USN
Code CS/Em, Glasgow East, Room 309

(831) 656-7980, DSN 756-7980
FAX (831) 656-3681
elmcmull@nps.edu

Chair, MOVES Academic Committee and Academic Associate

Chris Darken, Ph.D.
Code CS/Cd, Watkins Hall, Room 382

(831) 656-2095, DSN 756-2095
FAX (831) 656-7599
cjdarken@nps.edu

Brief Overview

The Modeling, Virtual Environments and Simulation (MOVES) Academic Program of the Naval Postgraduate School provides the MS and Ph.D. student both fundamental and specialized courses in applied visual simulation technology, combat models and systems, and the application of quantitative analyses to training and simulation technology.

The MS program is a seven-quarter program (eight quarters for students requiring JPME) whose core covers the fundamentals of modeling and simulation, data analysis, visual simulation, intelligent systems, training, and human performance. These topics include object-oriented programming, probability, statistics, stochastic modeling, data analysis, acquisition and program management, artificial intelligence, computer graphics, simulation and training, and combat modeling systems. The MS student demonstrates depth by the completion of a written thesis.

The MOVES Academic Program also has a program leading to the degree Doctor of Philosophy. Areas of special strength amongst the MOVES Academic Faculty are combat modeling and analysis, networked and web-based visual simulation, agents and cognitive modeling,

training systems and human factors, and discrete-event simulation.

Requirements for Entry

A baccalaureate degree, or the equivalent, with above average grades in mathematics (including differential and integral calculus), resulting in an APC of at least 325 is required for entry. Undergraduate degrees in applied science or engineering are highly desirable. Students lacking these prerequisites may be acceptable for the program, through the 12-week technical refresher or 12-week Engineering Science program, providing their undergraduate records and/or other indicators of success, such as the Graduate Record Examination (GRE), indicate an ability to work in quantitative subjects. While previous academic or practical experience in modeling, virtual environments, and simulation is certainly helpful and can enhance the applicant's potential for admission, such experience is not a prerequisite.

Entry Date

MOVES is an seven-quarter (eight quarters for students requiring JPME) course of study starting annually in September. Those requiring the 12-week refresher will begin study in July. If further information is needed, contact the MOVES Academic Associate or the MOVES Program Officer for this curriculum.

Degree

Master of Science in Modeling, Virtual Environments, and Simulation

The degree of Master of Science in Modeling, Virtual Environments, and Simulation is awarded after satisfactory completion of a program which satisfies, as a minimum, the following degree requirements:

· Completion of the seven quarter sequence of courses constituting the Modeling, Virtual Environments, and Simulation Masters curriculum as described below.
· Completion of an acceptable thesis in addition to the required course work.

Requirements for the Master of Science in Modeling, Virtual Environments, and Simulation are met as a milestone en route to satisfying the Educational Skill Requirements established by the sponsor for the curricular program.

Doctorate in Modeling, Virtual Environments, and Simulation

The Ph.D. degree requires the equivalent of at least three academic years of study beyond the baccalaureate level (some of which may be for another post-baccalaureate degree), with at least one academic year (or its equivalent) being spent in residence at NPS. The student must complete, in order, the following steps, which are detailed at www.movesinstitute.org.

1. Form a dissertation committee
2. Pass a written qualifying examination
3. Declare a secondary specialization
4. Pass an oral qualifying examination
5. Pass a final examination
6. Complete a dissertation

No courses are required for the Ph.D. degree besides the secondary specialization unless the student's doctoral committee so stipulates.

Ph.D. Minor in Modeling, Virtual Environments, and Simulation

A Ph.D. minor in Modeling, Virtual Environments, and Simulation consists of:

1. Three courses at the 4000 level that form a coherent sequence relating to Modeling, Virtual Environments, and Simulation.
2. The courses must be from at least two departments or academic groups.
3. The head of the MOVES Ph.D. program will write a letter attesting that the student has fulfilled the requirements upon request of the student.

Subspecialty

Completion of this curriculum qualifies an officer as a modeling, virtual environments, and simulation subspecialist with a subspecialty code of 6202P.

Typical Subspecialty Jobs

TBD

Course of Study
(MOVES (399) Matrix, All Students)

Refresher – if required (Summer)

CSR100	(2-2)	Refresher for Beginning Programming
MA2025	(4-1)	Logic and Discrete Mathematics
MA1113	(4-0)	Single Variable Calculus I
MA1114	(4-0)	Single Variable Calculus II with Matrix Algebra

Quarter 1 (Fall)

CS2072	(4-2)	Fundamental Object-Oriented Programming in JavaScript
OS3111	(4-1)	Probability and Statistics
MA3042	(4-0)	Linear Algebra
MV3101	(4-0)	Introduction to Department of Defense Modeling and Simulation
MV2921	(2-0)	Introduction to MOVES

Quarter 2 (Winter)

CS2173	(4-2)	Java as a Second Language
OS3113	(4-1)	Data Analysis for HSI and MOVES
MV3202	(3-2)	Computer Graphics Programming
MV4002	(4-1)	Simulation and Training
MV3922	(2-0)	Introduction to Virtual Environmental Technology

Quarter 3 (Spring)

MV3302	(4-1)	Introduction to Discrete Event Modeling
OS3112	(4-2)	Statistics and Design of Experiments
MV3203	(3-2)	Graphical Simulation
CS3310	(4-1)	Artificial Intelligence
MV3923	(2-0)	Introduction to Research in Modeling, Virtual Environments, and Simulation

Quarter 4 (Summer)

MV4025	(3-2)	Cognitive and Behavioral Modeling for Simulations
OS3311	(4-0)	Probability Models for Military Applications
MV4501	(2-4)	Simulation Application Practicum
MV4657	(3-2)	Modeling and Simulation for Stability, Security, Transition and Reconstruction (STTR)
MV4924	(1-1)	Current Topics in Modeling, Virtual Environments, and Simulation

Course of Study

(MOVES (399) 2nd Year Matrix, All Students)

Quarter 5 (Fall)

MV3500	(3-2)	Internetwork Communications and Simulation
MV4502	(2-4)	Simulation Development Practicum
MV4001	(4-1)	Human factors of Virtual Environments
MV4924	(1-1)	Current Topics in Modeling, Virtual Environments, and Simulation

Quarter 6 (Winter)

MV4503	(2-4)	Simulation Interoperability Practicum
MN3331	(5-1)	Principles of Acquisition and Program Management*
SE3100	(3-2)	Fundamentals of System Engineering**
MV0810	(0-8)	Thesis Research

MV4924	(1-1)	Current Topics in Modeling, Virtual Environments, and Simulation

*DOD students only. Non-DOD students take GB3031 instead.
**Students requiring JPME take NW-3275 instead and complete optional 8th quarter below.

Quarter 7 (Spring)

MV0810	(0-8)	Thesis Research
MV0810	(0-8)	Thesis Research
OA/MV4655	(4-0)	Introduction to Joint Combat Modeling
MV4460	(4-0)	Management of Modeling and Simulation
MV4924	(1-1)	Current Topics in Modeling, Virtual Environments, and Simulation

Quarter 8 (Summer)

SE3100	(3-2)	Fundamentals of Engineering
NW3230	(0-8)	Thesis Research
NW3276	(4-0)	Management of Modeling and Simulation Development
NW3285	(1-1)	Current Topics in Modeling, Virtual Environments, and Simulation

Educational Skill Requirements (ESR) Modeling, Virtual Environments, and Simulation (MOVES) - Curriculum 399 Subspecialty Code: 6202P

6202 Subspecialists are the Department of Defense's (DoD) experts in Modeling, Virtual Environments and Simulation. Modeling and Simulation (M&S) is a discipline that uses models – including emulators, prototypes, simulators, and stimulators – either statically or over time, to develop the data needed for making managerial or technical decisions. Such data and phenomena are often visualized in virtual and augmented environments, facilitating efficient data manipulation and the users' perceptual immersion, all essential for effective analysis, training and operation.

All 6202 Subspecialists can design, build, manage and apply Modeling, Virtual Environments, and Simulation best practices and tools in support of training, analysis, acquisition, testing and operational capabilities. The Subspecialists have highly developed analytical and critical thinking skills, and the ability to innovate and solve domain problems. They have also completed a program of original research, culminating in a Master's Thesis. 6202 Subspecialists are proficient in the general principles of M&S and have acquired in-depth knowledge about select areas of concentration.

6202 Subspecialists can, for example:
· Manage virtual environment technology and help solve human-machine interaction problems;

· Employ virtual environments for treating post-traumatic stress disorders;
· Define and apply next-generation combat models to real-world problems;
· Apply modeling and simulation to facilitate the DoD acquisition process;
· Evaluate operational and training effectiveness and human performance in virtual environments and apply this to performance in real environments.

All subspecialists earning an advanced degree in compliance with the 6202 subspecialty code obtain skills and competencies in the following areas:

1. **History and Fundamentals of M&S:** The officer will have competence in the history and fundamental concepts of Modeling and Simulation (M&S), with a focus on DoD M&S.

2. **Applied Mathematics:** The officer will have a practical understanding of linear algebra, discrete mathematics, statistics, data analysis, stochastic modeling and experimental design, as well as their effective application in the domain of M&S.

3. **Computer Systems:** The officer will have a sound understanding of computer programming, software development, networks, and distributed simulations.

4. **Virtual Environments:** The officer will be knowledgeable in computer graphics, virtual and augmented reality, visualization, and simulation systems.

5. **Training and Human Systems:** The officer will have a sound understanding of human systems engineering, training systems, human behavior modeling and human performance evaluation.

6. **M&S Systems Life-Cycle Management:** The officer will be knowledgeable in systems engineering management, requirements analysis, program management and policy, and acquisition.

7. **Modeling:** The officer will be knowledgeable in system modeling, combat modeling and modeling physical phenomena, including verification, validation and accreditation (VV&A).

8. **Joint Professional Military Education (JPME) per community requirements:** The officer will develop an understanding of warfighting within the context of operational art, to include: national military capabilities and command structure, joint and service doctrine, joint planning and execution, and joint and multinational forces and systems integration at the operational level of war. This requirement is fulfilled by completing the Naval War College four-course series leading to Service Intermediate-level Professional Military Education and Phase I JPME credit.

Specialization: Each 6202 Subspecialist will select a number of areas of specialization that integrate Modeling, Simulation, and Virtual Environments in DoD systems, practices and operations. These specializations require further emphasis in particular areas of study, both through completing the appropriate sequences of courses and conducting original research for a Master's thesis.

Area specializations might include:
· Environmental models, 3D modeling, and web-based technologies;
· Game-based systems, computer animation and computer vision;
· Discrete event simulation;
· Advanced combat modeling, including social, cultural and behavioral modeling;
· Training systems and human factors.

Curriculum Sponsor and ESR Approval Authority

Director, Navy Modeling and Simulation Office (NMSO).

Information Assurance Certificates

Program Manager

Cynthia Irvine, Ph.D.
Code CS/Ci, Glasgow East, Room 211

(831) 656-2461, DSN 756-2461
irvine@nps.edu

Brief Overview

The NPS Computer Science Department is authorized to award five Committee on National Security Systems (CNSS) Information Assurance Certificates. The certificates are awarded to students who successfully complete specified sets of Computer Science and Information Assurance courses.

The certificates are based on training and education standards that were established by the National Security Telecommunications and Information Systems Security Committee (NSTISSC).

The standards address duties and responsibilities of Information System Security Professionals, Senior System Managers, System Administrators, Information Systems Security Officers, and System Certifiers.

Certificate Sponsor

Committee on National Security Systems (CNSS), www.cnss.gov

Certificates Awarded
· NSTISSI 4011 - Information Systems Security Professionals
· CNSS 4012 - Senior System Managers
· CNSS 4013 - System Administrators
· CNSS 4014 - Information System Security Officers
· NSTISSI 4015 - System Certifiers

Required Courses

NSTISSI 4011 - Information Systems Security Professionals
· CS3030 or CS2011 (Basic Computer Architecture)
· IS3502 or CS3502 (Basic Computer Networks)
· CS3600 Information Assurance: Introduction to Computer Security
· CS3670 Information Assurance: Secure Management of Systems

CNSS 4012 - Senior System Managers
· CS4680 Introduction to Certification and Accreditation

CNSS 4013 - System Administrators
· CS3030 or CS2011 (Basic Computer Architecture)
· IS3502 or CS3502 (Basic Computer Networks)
· CS3600 Information Assurance: Introduction to Computer Security
· CS3670 Information Assurance: Secure Management of Systems

CNSS 4014 - Information System Security Officers
· CS3030 or CS2011 (Basic Computer Architecture)
· IS3502 or CS3502 (Basic Computer Networks)
· CS3600 Information Assurance: Introduction to Computer Security
· CS3670 Information Assurance: Secure Management of Systems

NSTISSI 4015 - System Certifiers
· CS4680 Introduction to Certification and Accreditation

Information Systems Security Engineering (ISSE) Certificate – Curriculum 270

Program Manager

Cynthia Irvine, Ph.D.
Code CS/Ci, Glasgow East, Room 211

(831) 656-2461, DSN 756-2461
irvine@nps.edu

Brief Overview

The role of Information Systems Security Engineering (ISSE) is to help ensure that the security requirements of systems are met. Lacking proper security engineering, systems fail to be certified and accredited, causing costly delays or failures. Ideally the Information Systems Security Engineer (also known as an ISSE) will be a member of the system development team throughout its lifecycle; however, for preexisting systems, the ISSE may be required to assess existing system vulnerabilities and determine mitigating strategies.

As systems have grown more complex and adversaries continue to successfully exploit numerous vulnerabilities, the need for improved secure system engineering and the formation of a larger cadre of skilled ISSEs has become more acute. The ISSE course sequence will provide the knowledge and analytical skills required to contribute productively in system developments and assist in building a larger cadre of skilled ISSEs to combat adversaries.

Certificate Sponsor

National Security Agency (NSA)

Required Courses
· CS3690 Network Security
· CS3695 Network Vulnerability and Risk Mitigation
· CS4600 Secure System Principles
· CS4650 Fundamentals of Information Systems Security Engineering
· CS4652 Applied Information Systems Security Engineering

Identity Management Certificate – Curriculum 278

Program Manager

Cynthia Irvine, Ph.D.
Code CS/Ci, Glasgow East, Room 211

(831) 656-2461, DSN 756-2461
irvine@nps.edu

Brief Overview

Identity Management (IDM) is a growing concern throughout defense, government, and private sector organizations. It includes an infrastructure that supports the identification of humans in physical space, and the logical identification of human and non-human subjects, hardware, and software in cyber space.

The IDM Certificate is offered each academic quarter and is conducted in a hybrid mode that involves a one-week program of intense IDM education at NPS followed by 9 weeks of remote learning, and culminates with an on-site (NPS campus) course work at the end of the academic

quarter. The hybrid approach reduces student attrition and has resulted in considerable esprit de corps and camaraderie among the students who represent a mixture of military and government civilians. The IDM Certificate takes 2 quarters, or 6 months, to complete.

Upon completion of the courses with adequate grades, students may apply IDM course credits toward Identity Management specialization tracks in either the Computer Science or Information Sciences degree programs. For more information, please visit the IDM website at: imep.nps.edu.

Certificate Sponsor

Biometrics Task Force

Required Courses
· CS3686 Identity Management Infrastructure
· CS3699 Biometrics
· IS3710 Identity Management Operations
· IS3720 Identity Management Policy

Department of Defense Analysis

Chairman

John Arquilla, Ph.D.
Code DA, Root Hall, Room 214

(831) 656-3691, DSN 756-3691
FAX (831) 656-2649
jarquilla@nps.edu

Associate Chairman, Instruction

Sean Everton, Ph.D.
Code DA, Root Hall, Room R-205C

(831) 656-2709, DSN 756-2709
sfeverto@nps.edu

Associate Chairman, Operations

Brian Greenshields
Code DA, Root Hall, Room 209

831-656-3998
bhgreens@nps.edu

Associate Chairman, Research

David Tucker, Ph.D.
Code DA, Root Hall, Room 215

(831) 656-3754, DSN 756-3754
dctucker@nps.edu

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

John Arquilla, Chairman, Defense Analysis Department and Professor (1993); Ph.D., Stanford University, 1991.

Mark T. Berger, Visiting Professor (2006); Ph.D., University of New South Wales, 1992.

Leo Blanken, Assistant Professor (2008); Ph.D., University of California, Davis, 2006.

Douglas Borer, Associate Professor (2004); Ph.D., Boston University, 1993.

Randy Burkett, National Intelligence Chair; Central Intelligence Agency Representative (2010); M.A., Naval Postgraduate School, 1989.

Dorothy Denning, Professor (2002); Ph.D., Purdue University, 1975.

Jennifer J. Duncan, Program and Research Manager (1992); M.S., City University of New York, 1985.

Sean Everton, Assistant Professor (2007); Ph.D., Stanford University, 2007.

William P. Fox, Professor (2006); Ph.D., Clemson University, 1990.

Michael Freeman, Associate Professor (2005); Ph.D., University of Chicago, 2001.

Frank Giordano, Professor (2002); Ph.D., University of Arkansas, 1975.

Brian Greenshields, Senior Lecturer (2009); M.A., Naval Postgraduate School, 1989.

Heather S. Gregg, Assistant Professor (2006); Ph.D., Massachusetts Institute of Technology, 2003.

Erik Jansen, Senior Lecturer (1994); Ph.D., University of Southern California, 1987.

Michael Jaye, Associate Professor (2009); Ph.D., Rensselaer Polytechnic, 1998.

Doowan Lee, Visiting Lecturer (2008); ABD, University of Chicago.

Guy Lemire, COL, USA, Chair of Special Operations (2005); M.S., School of Advanced Military Studies, 2002.

George Lober, Senior Lecturer (1998); M.A., California State University at Fresno, 1986.

Gordon H. McCormick, Professor (1992); Ph.D., Johns Hopkins University, 1986.

Siamak Naficy, Visiting Professor (2011); Ph.D., UCLA, 2010; affiliated faculty.

Guillermo Owen, Professor (1983); Ph.D., Princeton University, 1962.

Robert O'Connell, Visiting Professor (2004); Ph.D., University of Virginia, 1976.

Nancy C. Roberts, Professor (1986); Ph.D., Stanford University, 1983.

Glenn Robinson, Associate Professor (1991); Ph.D., University of California at Berkeley, 1992.

Hy Rothstein, Senior Lecturer (2002); Ph.D., Tufts University, 2003.

Kalev (Gunner) Sepp, Senior Lecturer (2003); Ph.D., Harvard University, 1992.

Anna Simons, Professor (1998); Ph.D., Harvard University, 1992.

Bradley J. Strawser, Assistant Professor (2012); Ph.D., University of Connecticut, 2012.

Kristen Tsolis, Lecturer (1999); M.S., Monterey Institute of International Studies, 1999.

David Tucker, Associate Professor (1998); Ph.D., Claremont Graduate School, 1981.

Camber Warren, Assistant Professor (2012); Ph.D., Duke University, 2008.

Brief Overview

The Department of Defense Analysis is an interdisciplinary association of faculty, representing a wide range of academic and operational specialties. The Department has two curricula: the Special Operations/Irregular Warfare curriculum and the Joint Information Operations curriculum.

The Special Operations/Irregular Warfare curriculum provides a focused course of instruction in irregular warfare, sub-state conflict, terrorism and counterterrorism, and other "high leverage" operations in U.S. defense and foreign policy. The core program also provides every student with a strong background in strategic analysis, decision modeling, organization theory, and formal analytical methods. The student's program is built around a common set of core courses and a selected specialty track. Currently the tracks offered are: Irregular Warfare, Information Operations, Terrorist Operations and Financing, Strategic Forecasting and Decision making, Operations Analysis, Combat Systems, Financial Management, C4I Systems, National Security Affairs (Stability / Reconstruction), and National Security Affairs (Regional Studies). The individual student, depending on his or her interests and academic background, chooses the specialty track. In selected cases, students are also able to develop a tailored area of specialization to satisfy a particular interest or requirement. Graduates are awarded a Master of Science in Defense Analysis, with their specialty track so specified.

While the Special Operations/Irregular Warfare curriculum is sponsored by U.S. Special Operations Command, the curriculum actively solicits student participation from across the services, regardless of branch or specialty code. International students are an important element of the program. Students are encouraged to apply for the Winter or Summer Quarter, permitting them to take maximum advantage of the program's sequenced course of instruction. Exceptions are approved by the Academic Associate. The program is 18 months long and requires a completed thesis.

The goal of the Joint Information Operations curriculum is to educate military personnel and civilian officials of the United States and its Allies in the strategic and operational dimensions of information relative to the use of force as an instrument of statecraft.

The curriculum is designed for both the specialist who will be assigned to an information operations position and the generalist who will be assigned to an operations directorate. The curriculum includes a core of military art and operations, the human dimension of warfare emphasizing psychological warfare and military deception, analytical methods, and a technical sequence customized for each student that may include concentrations in cyber systems and operations, electronic warfare, intelligence support to JIO and computer network operations. Additional areas of concentration are available to meet specific student and organizational requirements. Finally, each student will write a thesis relevant to the field of information operations. The JIO curriculum is designed to develop the following competencies in its graduates:

·   Analyze the global information environment and assess its impact on national security strategy.
·   Analyze the role of information operations in national military strategy and maximize it contributions to national military power.
·   Analyze information operations' role in national information strategy and maximize its contributions to the non-military elements of national power.
·   Evaluate the relationships, linkages and dependencies between intelligence and information operations.
·   Analyze the contributions of the interagency community to information operations and vice versa.
·   Analyze non-US approaches to, capabilities, and doctrines for information operations.
·   Analyze the use of information operations to achieve desired effects across the spectrum of national security threats.
·   Analyze how information operations are integrated to support the national military and security strategies and the interagency process.
·   Analyze how information operations apply at the operational and strategic levels of war and how they support the operations of a networked force.

- Evaluate the national security technological environment as an enabler for current and future competitive advantage.
- Detect enemy cyber fires and plan defensive and offensive cyber operations.
- Analyze the principles, capabilities and limitations of information operations across the range of military operations, to include pre and post-conflict operations.

This program is open to all branches of the military, federal employees, international military officers and government sponsored civilians.

Army, Air Force, Navy, and USMC graduates who also complete the approved 4-course Naval War College JPME curriculum also receive credit for JPME 1 and their Service-particular Intermediate Level Education (ILE/IDE).

Degree

Master of Science in Defense Analysis

Master of Science in Information Operations

Defense Analysis Course Descriptions

DA Courses

DA0810 Thesis Research (0-8) Fall/Winter/Spring/Summer
This is a thesis research block. Prerequisite: None.

DA2010 Technical Writing and English Composition (4-0) Winter
This course provides a review of the rhetorical and grammatical principles necessary for successful academic writing. Course content emphasizes standard English grammar and syntax, as well as mastery of two rhetorical modes: comparison and contrast; and persuasion. Emphasis is also placed on the correct use of both parenthetical and traditional footnote notation and documentation for traditional and electronic sources. Prerequisite: None.

DA2410 Modeling for Military Decision Making, I (4-0) Winter/Summer
This course introduces mathematical modeling processes and concepts. Deterministic models in a graphical setting will be emphasized, including experimental modeling, curve fitting, and optimization. Applications include arms race models, Lanchester combat models, exponential growth and decay models, the Logistic model for social diffusion, supply/demand economic models, and inventory models. The computer is used as a tool with emphasis on the Excel spreadsheet package. Prerequisite: College algebra.

DA3010 Technical Writing and English Composition II (4-0) Fall
This course provides an in-depth analysis of the rhetorical principles applied in effective academic writing. Course content emphasizes rhetorical analysis, research, formal academic documentation, and a further review of English grammar and syntax. This course is writing intensive and intended to further the principles introduced in DA2010. Prerequisite: DA2010.

DA3101 Conflict in the Information Age (4-0) Fall/Winter
Given that the emerging Information Age heralds stark changes in future military and security policy, this course begins with a survey of the literature on the current revolution in military affairs (RMA), as well as studies of similar periods earlier in history. While significant attention is focused on information technologies, the principle emphasis in this course lies in an endeavor to understand the ways in which new technologies affect military strategy, doctrine, and organization. In particular, the rise of networked organizations, nonlinear military operations, and the further blurring of the line between war and peace are examined. Prerequisite: None.

DA3102 Psychological Warfare and Deception (4-0) Summer/Fall
This course surveys current theories of behavior, cognition, and perceptual bias, linking them to applied military issues across the spectrum of conflict, from irregular to high-intensity warfare. The effects of increased information flows on the prospects for accurate assessments in crisis and war are also considered in detail. Case studies and experimentation complement the theoretical framework initially advanced, with students working in teams during this portion of the course. Prerequisite: None.

DA3104 Computer Network Attack and Defense (4-1) Winter
This course introduces the basic principles of attacking and defending computer networks. On the attack side, it covers system intrusions, denial of service attacks, viruses, worms, and Trojan horses. On the defense side, it covers security policies and objectives, access control, authentication, firewalls, intrusion detection, cryptography, security management, and incident response. Basic networking concepts, including TCP/IP, are also covered. No background in computer science or networking is required. The course includes some hands-on work with hacking and security technologies. Prerequisite: DA3101.

DA3105 Conflict and Cyberspace (4-1) Summer
This course examines how cyberspace, particularly the Internet, can serve as a tool, target, and source of conflict for both state and nonstate actors. Topics include: characteristics of cyberspace, technology trends, power in cyberspace, cyber-based information operations (IO), cyber surveillance, domestic and international laws governing cyber operations, cyber crime, cyber activism and hacktivism, cyber terrorism, cyber warfare, and cyber defense. Prerequisite: None.

DA3120 Jihadi Information Operations (4-0) Spring
This course traces the rise and evolution of the Jihadi movement since its birth in the 1960s; analyzes the symbols, discourses, and media that Jihadis use in their own information operations, primarily vis-à-vis the larger Muslim community; and examines the impacts on and receptiveness of the broader Muslim community to these information operations. The focus of the course is on the transnational Jihadi movement, but some examples of local Jihadism will be discussed as well. Prerequisite: None.

DA3180 Warfare in the Electromagnetic Spectrum: Principles and Applications (4-0) Fall
This course provides students an introduction to the electromagnetic spectrum (EMS) and how we operate and conduct warfare within it. The class will include information up to and

including SECRET-US ONLY; Clearance is required. No other courses are required as a prerequisite.

DA3201 Strategic Decision Making for Special Operations (4-0) Winter/Summer

This course examines the unique relationships and associated risks between strategic, operational, and tactical decision makers during the conduct of unconventional warfare (with emphasis on military special operations). The course begins by surveying popular models and theories of U.S. Government decision making and bureaucracy, while using selected case studies to improve the student's diagnostic skills. Roles and relationships between key strategic and political stakeholders in this decision-making process are examined to better understand the practical environment. Lastly, students will develop alternative methods of high risk/high payoff decision making based on the course subject matter. Prerequisites: None.

DA3210 The Unconventional Threat to HLS (4-0) Spring

The purpose of this course is to provide an introduction to the operational and organizational dynamics of terrorism. It considers those who act as individuals, in small groups, or in large organizations; it considers indigenous actors, as well as those who come to the United States to raise money, recruit, or commit their acts of violence. In every instance, its focus is on violent clandestine activity that, whatever its motivation, has a political purpose or effect. The course addresses such specific topics as suicide terrorism, the role of the media, innovation and technology acquisition, the decline of terrorism, and ways of measuring the effect of counterterrorism policies and strategies. The course also looks briefly at sabotage. By the end of the course, students should be able to design effective measures for countering and responding to terrorism based on an understanding of its organizational and operational dynamics. Prerequisite: None.

DA3250 Anatomy of Intelligence (4-0) Spring

This course will be devoted to providing students with an improved understanding of the structure, capabilities, and shortcomings of U.S. intelligence, with particular emphasis being placed on Special Operations (SO) and Information Operations (IO). In general, the course approach will be from the general to the specific—beginning with an orientation aimed at familiarizing students with the basic nature of the U.S. Intelligence Community (IC), followed by a closer look at the issues surrounding the provision of intelligence to SO and IO. Prerequisite: None.

DA3260 Human Intelligence in Irregular Warfare (4-0) Fall

The course examines human intelligence operations in irregular warfare. It covers espionage, various source operations, counterintelligence, and covert action. It also briefly discusses the intelligence community and issues of coordinating the various human intelligence activities of the U.S. government. A central purpose of the course is to understand what changes may be necessary to human intelligence operations in order to increase their effectiveness in irregular warfare. Prerequisite: None.

DA3270 Intelligence in the Information Age (4-0) Spring

The course examines intelligence in light of the information revolution. It examines collection, analysis, covert action and counterintelligence. It also discusses the intelligence community and issues of coordinating the various intelligence activities of the U.S. government. A central purpose of the course is to increase understanding of the relationship between intelligence and information operations. Prerequisite: DA3101.

DA3410 Modeling for Special Operations II (4-0) Summer/Fall

This course continues the mathematical modeling process and concepts introduced in DA2410. Models will now entail the use of probability to find solutions. Introductory probabilistic models will be discussed, along with rudimentary statistical concepts needed to analyze data generated from those models. The course will also introduce simulation modeling. Decision modeling includes decision making under both risk and uncertainty. Use of Excel and the Minitab statistical package continues from DA2410. Prerequisite: DA2410.

DA3600 Geographical and Temporal Dimensions of Dark Networks (4-0) Winter/Summer

Using a task-based approach, the first course introduces a terror network that students analyze using Google Earth, ArcGIS, and software tools that elicit temporal and geospatial aspects of terror network activity. This class will teach students to think critically and creatively about how different forms of spatial data can be integrated into their research. While the class will briefly cover fundamentals of remote sensing and coordinate systems, this lab-intensive course primarily focuses on real world situations that students will face in the field. No prerequisite.

DA3610 Visual Analytics (4-0) Fall

Visual Analytics is the first course in the CORE Lab sequence. It addresses a common problem we all face-the collection of data at a faster rate than our ability to analyze it. The course's purpose is to introduce methods to examine and analyze massive, multidimensional, multi-source, time-varying data. It offers new tools and technology to integrate and fuse data to support the analytical process so we are better prepared to make decisions in a time-critical manner. Ultimately, the course opens the door to what some consider a new multidisciplinary field:
• Visual representations and interaction techniques that enable us to see, explore, and understand large amounts of information at once
• Data representations and transformations that convert all massive, multidimensional, multi-source, and time varying information in ways that support visualization and analysis
• Analytical reasoning techniques that enable us to obtain deep insights that directly support assessment, planning, and decision making
• Techniques that support the production, presentation, and dissemination of analytical results and the communication of information to a variety of audiences (Thomas and Cook,2005:4). Prerequisite: None.

DA3701 Choice, Chance, and Consequence (4-0) Fall

This course examines the dynamic relationship that exists between Choice, Chance, and Consequence. Specifically, this course examines many of the influential factors associated with effective decision making in stochastic environments, and explores the reasons why choices made in such environments often produce a host of unintended consequences. Incorporating Molton's Theory of The Unanticipated Consequences of Purposive Action, Machiavelli's The Prince, and Kahneman and Tversky's Prospect Theory, the course draws on case studies and examples from ancient Western literature, philosophy, American history, modern literature, and biography. Prerequisite: None.

DA3720 The Rise of Religious Violence (4-0) Fall/Winter

This course aims to explore the conditions under which religious groups engage in violent activity as a means of achieving various political, social and religious goals. In particular, this course will a) offer an introductory foundation in the world's major religious

traditions; b) investigate how religion influences conflict, violence and war; c) compare the rise and fall of religious groups engaging in violent activity with the intent of better understanding the conditions under which religious groups resort to and abandon violence; d) compare other examples of religious violence with the current rise of Islamic militancy; e) consider ways in which religiously motivated violence can be mitigated; f) investigate how the United States and the U.S. military can address religiously motivated violence directed at its government, military, citizens and other interests. Prerequisite: Student must have completed at least one full quarter.

DA3721 Religion, Politics and Collective Action (4-0) As Required

The relationship between religion and political behavior is not as straightforward as many people assume, and there is considerable debate as to what the relationship between religion, politics and civil society should be. Some think that particular religious traditions should play no part; others believe that they should. In this class, we will briefly consider these arguments, but we will spend the majority of our time exploring the interplay between religion and collective action, introducing students to the major theories, topics and debates in the field of social movements and collective action. It seeks to discover the conditions under which social movements emerge, thrive, and decline, and why some people get involved in social movements and others do not. It also explores why religious traditions are often at the center of collective action. Prerequisite: Must have completed two quarters of coursework.

DA3750 Anthropology of Conflict (4-0) Fall/Spring

The focus of this course is cross-cultural conflict and violent confrontation with a view to considering how anthropology might be better used to study modern warfare and large-scale ethnic conflict. For instance, military historians, political scientists, and foreign policy analysts increasingly refer to "culture" and religion, identity politics, and ideology to help explain the new world disorder. From an anthropological perspective, are they using these social science concepts correctly? This course is designed to not only expose students to anthropological concepts useful for understanding the motivations of combatants from other cultures and the nature of warfare as fought by different people(s), but the extent to which cross-cultural miscommunication can complicate the role of U.S. military personnel abroad. Prerequisite: None.

DA3760 The Soul of the Sword: the History of Weapons (4-0) Fall/Spring

This course examines the evolution of weapons primarily from a cultural and anthropological perspective: the aim being to provide military professionals with a more basic insight into how and why arms are and were chosen; how the use of weaponry and the concept of courage have manifested themselves over time, and the manner in which the institution of war has been influenced by the nature of the armaments extant at the time conflict took place. The course will place special emphasis on not only the roots of weaponry very early in human existence, but also the characteristics and use of "weapons" (i.e., teeth, claws, antlers, etc.) by other species. This course will cover a vast sweep of history; expect to cover rocks and rockets, along with everything in between. Prerequisite: None.

DA3800 Theory and Practice of Social Revolution (4-0) As Required

This course provides an overview of insurgency and counterinsurgency. It reviews the theoretical literature and offers an operational focus on social revolution by examining the alternative models of insurgency provided by the doctrine of "people's war," "foco theory," and the urban guerrilla. The course goes on to examine the development of U.S. counterinsurgency doctrine, the difference between the "hearts and minds" and "systems" prescriptions of counterinsurgency, and alternative British, French, and Russian concepts of counterinsurgency. Prerequisite: None.

DA3801 International Terrorism (4-0) Summer/Fall

This course provides an in-depth examination of the origins, nature, and political/military roles of contemporary international terrorism. It briefly examines the early history of terrorism, the contending theories that purport to explain the sources of terrorist behavior, the different types of terrorism and terrorist actions, and the challenge international terrorism poses for American interests and foreign policy. Functional topics, such as the special problems posed by state-sponsored terrorism, the relationship between terrorism and the media, and the range of possible military responses to terrorism are also examined. The course will conclude by comparing and contrasting different national responses to the problem of international terrorism, and examining the difficulties faced by the United States in its efforts to find an effective policy response. Prerequisite: None.

DA3802 Seminar in Guerrilla Warfare (4-0) Winter/Summer

Have you ever wanted to seize state power from below? Have you ever been responsible for keeping others from doing so? This reading seminar is designed to examine the strategy and operational art of substate conflict. It examines the problems of social mobilization; underground organization, command and control, and security; alternate strategies of internal war, and competing theories of counterinsurgency. These and related issues are examined analytically and historically. Comparative cases are discussed and evaluated. Throughout the course, attention is also given to the manner in which such wars are conducted in the future. Prerequisite: None.

DA3880 History of Special Operations (4-0) Summer/Fall

What constitutes a "special" operation? This course considers special operations in a historical context, with emphasis given to their impact on war outcomes, the necessary conditions for their success, and the patterns of civil-military relations that emerge when elite forces are formed. Successes and failures in air, ground, and naval actions are equally considered. Historical studies from World War II to the present will provide the principle means of analysis to gain insights into the theory, practice, and effects of special operations and irregular warfare. Prerequisite: None.

DA3882 Deterrence, Coercion, and Crisis Management (4-0) Summer/Winter

This course surveys current theories of deterrence and coercive diplomacy, relating them to a variety of applied problems in crisis management. Special attention is given to political psychological factors, crisis communication styles, extended deterrence, and the implications of proliferation of weapons of mass destruction for conventional deterrence. Prerequisite: None.

DA3883 The Rise, Transformation and Future of the Nation-State System (4-0) Spring

This course provides students with a broad overview of the rise, proliferation, and possible fall of the major international organizing tool of the modern era: the nation-state. The course examines the rise of the nation-state in Europe, focusing on the specific political and economic factors that shaped the nation-state; the adoption of the nation-state system around the world, where it did not emerge

organically; and the possible decline of the nation-state in the age of globalization. Does globalization mean the end of the nation-state, and if so, what kinds of organizational arrangements are likely to compete with and perhaps replace the nation-state? Prerequisite: None.

DA3900 Directed Studies in Special Operations and Low-Intensity Conflict (4-0) Fall/Winter/Spring/Summer

Supervised study in selected areas of special operations and low-intensity conflict to meet the needs of individual students. Format and content vary. Normally involves extensive assigned readings, individual discussions with the instructor, papers, projects, and/or examinations. May be repeated for credit if course content changes. Variable 1.0 - 4.0. Prerequisite: Consent of the instructor.

DA4101 Concepts in Information Operations (4-0) As Required

The emergence of information operations (IO) signaled a broadening of the original concept of information warfare (IW) beyond its early emphasis on electronic warfare and/or cyberspace-based attack and defense, to also include such notions as managing others' perceptions, public diplomacy, and the media. This broadening implied a new emphasis on content-based concepts of information operations as opposed to conduit-oriented issues of attack and defense of communications. This course surveys the entire scope of IO, keeping in mind the critical importance of IW, but also emphasizing the more conceptual issues having to do with strategy, doctrine, and organization. Applied issues are also examined, including such topics as the methods for sharing sensitive data with semitrusted allies, and the impact of information attack and defense on the future of force projection. Prerequisite: DA3101 or DA3103.

DA4102 Special Information Operations (4-0) Summer

This course serves as a project-oriented culmination of the studies of those specializing in the SOLIC "IO track." Students are given a specific, real-world problem and challenged to find the place for IO in developing solutions. The goal is both to mobilize the knowledge amassed from previous study and to use practical experience to gain insight into the issues of how IO can support special operations, and how special operations can support IO. Another key element of the course is the requirement that the students work as a team, employing either organizational concepts they have learned about or developing new ones that may be most suitable to the particular problem at hand. The course concludes with briefings to the sponsors of the given project undertaken. Prerequisite: None. Classification: TOP SECRET.

DA4104 Militaries and Technological Change (4-0) Summer

Technological advances have always influenced developments in military affairs, particularly fighting doctrines and forms of organization. This course surveys the major technological changes that accompanied industrialization: including advances in weapons, transportation, and communications systems; and examines the ways in which professional militaries adapted to these developments. Special attention is given to advances in information systems, as the goal of the course is to derive insights into how militaries might respond, doctrinally and organizationally, to an extended period of information-technology-driven changes in military affairs. Prerequisite: DA3101 or consent of the instructor.

DA4105 Special Topics in Information Operations (4-0) As Required

This course will focus on special topics in information and special operations. The list of topics to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. Prerequisite: None.

DA4106 Trust, Influence, and Networks (4-0) Summer

This course examines the underlying nature of trust and influence, especially as they shape and are shaped by social networks. Students will acquire a theoretical foundation for these concepts and how they apply to a broad spectrum of activity, including work processes, military operations, underground movements, information and intelligence operations, governance, and the media; how trust and influence are established, maintained, exploited, and lost; and the functions they serve for individuals, organizations, and societies. Concepts will be illustrated with examples drawn from a variety of contexts. The course is aimed especially at students concerned with unconventional warfare, information operations, network-centric warfare, nation building, civil and military affairs, public affairs, terrorism, and intelligence. Prerequisite: None.

DA4107 Public Diplomacy to Psychological Operations (4-0) Fall

A nation uses various tools to minimize its weaknesses and limitations, and to maximize its strengths and capabilities in the international arena. This course aims to stimulate serious thought about a forgotten aspect of strategy and lay the groundwork for a revival of political-psychological planning and operations within a larger framework of U.S. national security strategy. Topics include: a historical overview of the sources of American diplomacy and values; strategic public diplomacy and the war of ideas; military public affairs and the media; and the power and utility of psychological operations. Case studies will be used throughout the course to reinforce important concepts. Prerequisite: None.

DA4108 Deception, Denial, Surprise, and Counterdeception (4-0) Summer/Fall

An impression about the threats a nation faces shapes its policies and actions in both war and peacetime. Consequently, information has a vital role in understanding threats and creating impressions. At the same time, it is uncertain whether the proliferation of communications technologies and the dissemination of vast amounts of information will keep senior leaders better informed or simply create more confusion. This course aims to stimulate serious thought about how deception, denial, and counterdeception can influence the outcome of a war or contribute to the favorable resolution of an international crisis. Topics include: the theory and process of deception; the role of intelligence; the process of protecting information that could be used by opponents to uncover some truth; and detecting deception. Case studies will be used throughout the course to reinforce important concepts. Prerequisite: None.

DA4110 Culture and Influence (4-0) Quarterly

This seminar aims to provide analytical tools for thinking about culture and the ways in which interacting with different cultures affects U.S. actions abroad, including military operations, democratization, economic development and foreign relations. The first section of the course offers a theoretical overview of academic debates about culture, drawing on literature from the fields of anthropology, political science, and economics. It includes topics

such as the role of ethnicity, nationalism and identity in politics, efforts to democratize, economically develop and nation-build in other countries, and the possibility of a current global "clash of civilizations" in international affairs. The second section of the course aims to use first-hand experiences of students' interactions with various cultures - especially Iraq and Afghanistan - as case studies to apply and test the theoretical debates on culture presented in the first section of the class. Prerequisite: DA3101 and must have completed at least one full quarter of classes.

DA4120 Seminar on Jihadi Information Operations (4-0) Winter/Summer

This advanced seminar is designed as a follow-on course to DA 3120 for students pursuing theses or advanced research projects relevant to the field of Jihadi information operations. Course material will provide a more robust examination of the nature and types of IO campaigns used by both local and transnational Jihadi groups, but will also allow students to pursue and present specialized research on the topic. Prerequisites: DA3120 and a one-page statement of research.

DA4301 Fighting Undeclared Wars: American Approaches (4-0) Spring

How do the United States Government and its armed forces engage in undeclared wars, expeditions, and conflicts below the threshold of wars for the survival of the United States? This course examines those elements of American strategic culture that affect the United States' capacity to fight these "savage wars of peace." Historical studies from the American colonial period to the present will enable students to determine the defining aspects of the American approaches to small wars. Prerequisite: None.

DA4303 The Scientific Study of War (4-0) Winter

This course is designed to treat the 'scientific study of war' as a debate. Can we study war and warfare using science as a model? If so, why is there such seeming reticence to doing so among policy circles, significant portions of the military community, and general public? What are the strengths and weaknesses of various scientific tools and what do we risk by eschewing science altogether? The course proceeds in two parts. In the first part of the class we examine the history of military thought as it pertains to the question of 'scientism'. In the second part of the course we look at various methodological approaches to understanding organized conflict and assess their strengths and limitations. These will include theory building (both rhetorical and formal), hypothesis testing using quantitative and qualitative approaches, as well as various forms of simulation. The substantive issues covered include the outbreak of war, the conduct of war, the termination of war, and the relationships between war, civil society, and economics. Prerequisite: Student must have completed at least two full quarters.

DA4410 Models of Conflict (4-0) Summer/Winter

This course deals with the problems faced by a rational decision maker, trying to maximize some payoff in a social setting. A distinction will be made between Type I behavior (optimization in a game against nature), Type II (optimization when faced with agents who react against the decision maker's perceived behavior), Type III (optimizations against strategic agents), and Type IV (cooperation with other agents). Applications include arms race models, treaty inspections problems, monopolistic behavior, coalition formation, and pursuit games. The computer is used as a modeling tool. Prerequisites: DA2410.

DA4450 Analytical Methods (4-0) Summer/Winter

This course will provide a basic understanding of social science research methodology. The emphasis will be on qualitative research methods to balance the analytical course sequence (including DA2410 and DA3410). The course will also discuss the key concepts of theory, law, and hypotheses. Finally, paying particular attention to case study methodology, we will focus on how theories should be tested. In the end, students will learn how to develop an argument; how to marshal evidence to support your argument; how to test your hypotheses; and how to anticipate and address counter-arguments. Prerequisite: DA2410.

DA4460 Alternate Research Methods and Defense Analysis (4-0) Fall/Spring

This course is the first in a two-quarter sequence intended to familiarize students with a range of methodological approaches applicable to graduate research across the spectrum of topics included within the concept of defense analysis. Both qualitative and quantitative methods are considered in this course, with equal emphasis given to case studies, heuristics, sociological approaches, statistical analyses and formal modeling and game theory. More esoteric approaches will also be briefly considered, as will the blending of methodologies, with the degree of attention given to these approaches being dependent upon specific student interest and need. Beyond the conceptual study of research methods, students will also be exposed to many examples of scholarly works that employ one or more of the methods being studied. The course, though focused on methods, also introduces the concept of research design to help prepare students for the second course in the sequence. Prerequisite: permission of instructor.

DA4470 Designing Operationally Oriented Research Studies (4-0) Winter/Summer

A wide range of concepts of research design are studied in this course, the goal of which is to bring the student to the point of crafting a thesis proposal to guide his or her own master's level research. The close ties between choices about methodological approach and the forms of research design employed are considered, but the course's clear emphasis is on design. The larger concepts examined begin with strategic choices about the "placement" of studies on axes that range from pure theoretical to more policy-oriented applied research, and also reflect choices about pursuing research by quantitative or qualitative means, or some blending of the two. Many examples from scholarly works are used. Further design questions that are explored relate to the nuances of time-based "longitudinal" research of one or a few types of phenomena, and more "latitudinal," cross-sectional studies of a wider range of phenomena observed roughly simultaneously. Other detailed issues considered include how to avoid "selection bias," skewed analysis, omission of relevant variables at the inception of a research project. The ultimate focus of the course is on fostering research designs and methods that are rigorously fair-minded, thorough and impartial in application. Prerequisite: DA4460.

DA4500 Special Topics in Strategic Analysis (4-0) As Required

This course will focus on special topics in special operations and low-intensity conflict. The list of topics to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. Prerequisite: DA3802.

DA4600 Tracking and Disrupting Dark Networks (4-0) Spring/Fall

This course focuses on dark networks—covert and illegal activity such as drug-trafficking and terror networks. The course's first objective is to identify and describe these networks. We use various social network software packages (e.g., UCINET, NetDraw, Pajek) to aid our identification and description efforts. The second objective is to design intervention strategies to disrupt, destabilize and possibly destroy dark networks once they have been identified and described. The course's focus is on the tactical and operational levels, although the implications for strategic and policy levels also may inform our discussions. Prerequisite: DA2410 or consent of the instructor.

DA4601 Terrorist Financing (4-0) Summer

This course will examine how terrorists fund their activities and how they can be tracked and thwarted through their financial networks and footprints. It will cover sources and methods of terrorist financing, including the role of charities, legitimate businesses, and crime; the use of both formal banking systems and informal hawala systems to transfer funds; and money laundering. It will also cover national and international structures, regulations, tools, and efforts to identify, track, capture, and eliminate terrorists and their financial support through their financial transactions. Concepts will be illustrated with case studies of terrorist groups and regions where terrorism is present. Prerequisite: DA3801.

DA4610 Dynamic Network Analysis (4-0) Winter/Summer

This course builds on DA4600 (Dark Networks) by offering additional substantive and methodological tools for analyzing relational networks. The course is pragmatically oriented in that it pays particular attention to issues concerning the collection and preparation
of relational data in software programs such as Palantir, Analysts Notebook, Microsoft Excel and Microsoft Access and moving to traditional social network analysis tools such as UCINET, Pajek and ORA (Organizational Risk Analyzer). This course will also explore what is being called dynamic network analysis where users not only examine the effects of actual ties (e.g., friendship, kinship) but also "virtual" ties (e.g., shared ideology, skills, knowledge, etc.). Finally, the course will introduce students to techniques using social network data (regression) and geospatial data (geospatial statistics) that will help students tease out which variables (e.g., centrality, education level) are causally related from those that are not. Prerequisite: DA4600 and with permission from instructor.

DA4620 Network Design (4-0) Fall/Winter

In 21st century operational and policy environments, more and more people operate in networks to get things done—community networks, policy networks, inter-agency networks, business networks, international networks etc. Defined as sustained relations between two or more social actors (e.g. individuals, groups, organizations, or nations), networks can be formal or informal and serve a range of purposes. Reliant on readings and cases, this course helps students develop a basic understanding of networks and the skill set to operate effectively within them. Primary networks of interest are those whose members come from different cultural, ethnic, organizational, and national backgrounds. Prerequisite: Must be two quarters into a program.

DA4710 Critical Thinking and Ethical Decision Making (4-0) Fall

This course explores both the contemporary and classical Western frameworks used to define effective ethical leadership and decision making. Emphasis is placed on the development of critical thinking and decision-making skills, the recognition of logical fallacies, the analysis of both civilian and military case studies, and the exploration of current ethical issues. Readings for this course span classical selections from such writers as Plato, Rousseau, Kant, and Mill through contemporary papers from the Joint Services Conferences on Professional Ethics. Prerequisite: None.

DA4760 The Military Advisor (4-0) As Required

This course examines the many roles of the military advisor-as leader, trainer, liaison—in a wide variety of settings, among very different groups of people, and under significantly different conditions. Lessons will be drawn from first-person accounts. What field craft lessons can be learned from past endeavors? What challenges might advisors expect to encounter in the future? This course is open to Department of Defense Analysis students only or by consent of the instructor. Prerequisite: Consent of the instructor.

DA4770 Ethnic Conflict (4-0) As Required

This course poses a series of questions, such as "what is a state?" and "what is a nation?", in order to better understand when and why ethnic conflict erupts and persists. Often cited as the most prevalent form of warfare today, "ethnic conflict" as a term may conceal more that its reveals. For instance, strife in Northern Ireland and in Israel is often explained away as ethno-nationalist and ethno-religious in nature. On the face of it, both cases would seem to have much in common. However, once local histories and regional politics are considered, the two represent radically different models of (and for) ethnic conflict. This course will examine a series of such examples in order to better understand the origins, trajectory, and virulence of ethnic conflict. Prerequisite: DA3750.

DA4780 Political Anthropology: Methods of Social Control (4-0) Winter

The aim of this course is to examine in greater detail a variety of methods of controlling: social interactions, resources, societies, states, liberties… whatever it is that humans feel a need to—or discover they can—control. Questions that will lurk throughout the course are: Why does control matter? To whom does it matter most? Can we draw any generalizations cross-culturally? And to what extent might control differ across societies, strata, time, and space? The course is designed to be comparative and will draw on a series of case studies. Prerequisite: DA3750.

DA4810 Countering International Terrorism (4-0) Winter

This course examines the U.S. government's response to international terrorism. It examines policy, strategy, bureaucracy, the role of intelligence, and the media and information campaigns, as well as specific responses to terrorism, such as military force, covert operations, policing, economic sanctions, and diplomacy. The purpose of the course is to provide students a sound basis for developing and evaluating responses to terrorism. Prerequisite: None.

DA4820 Regional Seminar in Low-Intensity Conflict: Africa (4-0) Winter

This course teaches students how to analyze the nature of conflict in sub-Saharan Africa—who is likely to fight, where, why, and when, with special attention paid to the significance of regional complexities and local particularities. Eight cases are presented with two aims: to present a history of post-colonial conflict and to achieve regional balance. Students are specifically taught how to compare and contrast among different sets of factors that tend to feed conflict in Africa. Students also learn about sources of information to which they can turn in the future should conflict flare up in places with which they are unfamiliar. Prerequisite:

Student must have completed at least two quarters of instruction in the Defense Analysis Department or NSA or consent of the instructor.

DA4830 Regional Seminar in Low-Intensity Conflict: Middle East (4-0) Spring

As part of the regional seminar series, this course examines political violence in the Middle East. The course focuses on the major systemic causes of violence in the Middle East at both the state and nonstate levels. At the state level, sources of violence include the consolidation of state power in fragmented societies, survival strategies by weak states, and competition for scarce regional resources. Violence by nonstate actors is also examined, including violence associated with the Jihadist movement and with the conflict over Palestine. Prerequisite: None.

DA4840 Regional Seminar in Low-Intensity Conflict: Europe and the Transcaucasus (4-0) Spring

As part of the regional seminar series, this course examines low-intensity conflict issues in Europe and the Caucasus. The seminar reviews the theoretical literature on political violence and analyzes the recent history of European and Caucasus-based terrorism and insurgency. It offers a series of detailed case studies of local organizations and conflict, and focuses on functional issues in Europe and the Caucasus. Prerequisite: None.

DA4850 Regional Seminar in Low-Intensity Conflict: Latin America (4-0) Spring

As part of the regional seminar series, this course examines insurgencies in Latin America. The seminar reviews the history of the continent and the Caribbean from colonial times to the present; examines theoretical literature on political violence; and analyzes the recent history of Latin American-based terrorism and insurgency. It offers a series of detailed historical case studies of insurgent organizations and conflicts. Prerequisite: None.

DA4860 Regional Seminar in Low-Intensity Conflict: Far East (4-0) Spring

As part of the regional seminar series, this course examines low-intensity conflict issues in the Far East. The seminar reviews the theoretical literature on political violence and analyzes the recent history of Asian-based terrorism and insurgency. It offers a series of detailed case studies of local organizations and conflict, and focuses on functional issues in the Far East. Prerequisites: None.

DA4883 Networks and Nation-States (4-0) Summer

This course focuses in detail on the relationship between transnational networks and the contemporary nation-state system. It emphasizes that transnational networks manifests themselves in many forms: social; political; philanthropic; criminal. Whatever the future holds for the nation-state system it is clear that transnational networks have taken on an important new (or reconfigured) role with the rise and uneven consolidation of globalization since the 1970s. The course begins with some basic definitional and conceptual issues. This is followed by sections on the history and contemporary significance of regional and global networks of various types. The overall objective of this course is to gain a better understanding of the structure and dynamics of transnational networks; those of a malevolent political character or organized criminal syndicates, as well as benevolent networks of differing types. This is done in a fashion that tries to retain a relatively discrete definition of the term "network", but also makes clear that they have been, and continue to be a more widespread element of world politics and international relations than is sometimes assumed. In this spirit, the geographical range of the course is global and both discussion and research projects can and will focus on Latin America, Africa, the Middle East, and beyond. Prerequisite: Students should have completed at least two quarters of course work, or instructor's permission.

DA4900 Advanced Directed Studies in Special Operations and Low-Intensity Conflict (4-0)
Fall/Winter/Spring/Summer

(Variable hours 1.0 - 4.0.) Supervised study in selected areas of special operations and low-intensity conflict to meet the needs of individual students. Format and content may vary. Normally involves individual research under the direction of the instructor and submission of a substantial paper of graduate seminar quality and scope. May be repeated for credit if course content changes. Prerequisite: Consent of the instructor.

Joint Information Operations - Curriculum 698

Academic Associate

Hy Rothstein, Ph.D.
Code DA/Ro, Root Hall, Room 212

(831) 656-2203, DSN 756-2203
FAX (831) 656-2649
hsrothst@nps.edu

Program Manager

Jennifer J. Duncan
Code DA, Root Hall, Room 219

(831) 656-3584, DSN 756-3584
FAX (831) 656-2649
jduncan@nps.edu

Brief Overview

The goal of this curriculum is to educate military personnel and civilian officials of the United States and its Allies in the strategic and operational dimensions of information relative to the use of force as an instrument of statecraft.

The curriculum is designed for both the specialist who will be assigned to an information operations position and the generalist who will be assigned to an operations directorate. The curriculum includes a core of military art and operations, the human dimension of warfare emphasizing psychological warfare and military deception, analytical methods, and a technical sequence customized for each student that may include concentrations in cyber systems and operations, electronic warfare, intelligence support to JIO and computer network operations. Additional areas of concentration are available to meet specific student and organizational requirements. Finally, each student will write a thesis relevant to the field of information operations. The JIO curriculum is designed to develop the following competencies in its graduates:

· Analyze the global information environment and assess its impact on national security strategy.

- Analyze the role of information operations in national military strategy and maximize it contributions to national military power.
- Analyze information operations' role in national information strategy and maximize its contributions to the non-military elements of national power.
- Evaluate the relationships, linkages and dependencies between intelligence and information operations.
- Analyze the contributions of the interagency community to information operations and vice versa.
- Analyze non-US approaches to, capabilities, and doctrines for information operations.
- Analyze the use of information operations to achieve desired effects across the spectrum of national security threats.
- Analyze how information operations are integrated to support the national military and security strategies and the interagency process.
- Analyze how information operations apply at the operational and strategic levels of war and how they support the operations of a networked force.
- Evaluate the national security technological environment as an enabler for current and future competitive advantage.
- Detect enemy cyber fires and plan defensive and offensive cyber operations.
- Analyze the principles, capabilities and limitations of information operations across the range of military operations, to include pre and post-conflict operations.

Requirements for Entry

The Joint Information Operations curriculum is open to all branches of the military, federal employees, international military officers and government sponsored civilians. U.S. officers must be eligible for a TOP SECRET clearance with access to Sensitive Compartmented Information based on a Special Background Investigation completed within the last five years. A baccalaureate degree earned with above average academic performance and a minimum APC of 265 is required.

Entry Date

The Joint Information Operations curriculum is a six-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate or the Program Officer for this curriculum.

Degree

Requirements for the degree of Master of Science in Information Operations are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

Master of Science in Information Operations

The Master of Science in Information Operations degree will be awarded in accordance with the following degree requirements:
- This degree requires 45 quarter-hours of graduate-level work, of which 15 hours must represent courses at the 4000 level.
- Completion of an acceptable thesis.
- The Chairman of the Defense Analysis Department and the Academic Associate of the Joint Information Operations curriculum approve each individual program.

Subspecialty

Completion of the 698 curriculum qualifies an officer as an Information Operations Subspecialist. The curriculum sponsor is the Office of the Undersecretary of Defense for Policy (OSD-P).

Typical Subspecialty Jobs

Command Positions at the LTC/CDR level and above
Staff Officer, Plans or Operations: Joint Headquarters
Information Operations Officer at the LTC/CDR level and above on service staffs, JTFS, and combatant commands

Typical Course of Study

Quarter 1
DA3882	(4-0)	Deterrence, Coercion, and Crisis Management
DA2010	(4-0)	Technical Writing and English Composition
MN3121	(4-0)	Organizational Design
DA2410	(4-0)	Modeling for Military Decision Making, I

Quarter 2
DA3101	(4-0)	Warfare in the Information Age
DA3250	(4-0)	Anatomy of Intelligence
DA4450	(4-0)	Analytical Methods
DA3410	(4-0)	Modeling for Military Decision Making, II

Quarter 3
DA4107	(4-0)	Public Diplomacy to Psychological Operations
DA4106	(4-0)	Trust, Influence, and Networks
DA3104	(4-0)	Computer Network Attack and Defense
DA3802	(4-0)	Seminar in Guerrilla Warfare

Quarter 4
DA3180	(3-2)	Electronic Warfare Principles and Applications
DA4108	(4-0)	Deception, Denial, Surprise Attacks and Counterdeception

DA3750	(4-0)	Anthropology of Conflict
DA3120	(4-0)	Jihadist Information Operations

Quarter 5

DA3801	(4-0)	International Terrorism
DA3720	(4-0)	The Rise of Religious Violence
DAXXXX		
DA4600	(0-8)	Tracking and Disrupting Dark Networks

Quarter 6

DA4105	(4-0)	Special Topics in IO
DA4104	(4-0)	Militaries and Technological Change
DA3105	(0-8)	Conflict in Cyberspace
DA4710	(0-8)	Critical Thinking an Ethical Decision-making

Educational Skill Requirements (ESR)
Joint Information Operations - Curriculum 698
Subspecialty Code: None

1. **Military Art and Operations**: Graduates will understand the organization, formulation, and execution of national security strategy and national military strategy; the effects of technical developments on warfare; the capabilities and roles of military forces throughout the entire spectrum of conflict; and current defense issues.

2. **Emerging Security Challenges**: Graduates will explore major security issues among states and between states and nonstate actors, with emphasis placed on examining the sources of instability and violence including ethnic conflict, insurgency, and terrorism.

3. **Information Operations (IO)**: Graduates will understand the role of information in winning wars. An important aspect of this requirement is to examine the principles of information operations, to include psychological operations, military deception, computer network operations, electronic warfare, public affairs and command and control warfare, and how the proper integration of IO can contribute to U.S. information dominance of the twenty-first century battlefield. Additionally, graduates will understand the role of physical (kinetic) attack and civil-military operations (CMO) in support of DoD informational objectives.

4. **Analytical Methods and Applications**: Graduates will have a foundation in analytical methods and their application to military modeling, simulations, and gaming. Close attention will be given to the ways in which such analytical techniques can be used in heuristic and decision-making tools for strategic and operational planning. Attention will be given to both historical and contemporary military applications with particular focus on the ways in which such techniques

can be used to address issues of interest to the joint information operations community.

5. **Information Systems**: Graduates will have a systems-level understanding of information systems and their vulnerabilities as well as capabilities.

6. **Intelligence Processes and Applications**: Graduates will know intelligence processes and their applications to joint warfare through the national level, with particular emphasis given to the role of intelligence in planning, executing, and terminating information operations.

7. **Thesis**: Graduates will demonstrate their ability to conduct independent research and analysis, and demonstrate proficiency in presenting the results in writing by means of a thesis appropriate to this curriculum.

Special Operations/Irregular Warfare - Curriculum 699

Academic Associate

Gordon H. McCormick, Ph.D.
Code DA/Mc, Root Hall, Room 214

(831) 656-2933, DSN 756-2933
FAX (831) 656-2649
GMcCormick@nps.edu

Program Manager

Jennifer J. Duncan
Code DA, Root Hall, Room 219

(831) 656-3584, DSN 756-3584
jduncan@nps.edu

Brief Overview

The Special Operations/Irregular Warfare curriculum is designed to provide a focused course of study of the conflict spectrum below general conventional war. Graduates of this curriculum will possess a thorough knowledge of the broad range of factors involved in the planning and conduct of these forms of conflict and a detailed understanding of the role of special operations and related forces in U.S. foreign and defense policy. The curriculum examines the sources and dynamics of inter-state and intra-state conflict; the challenge these forms of conflict have posed and are likely to increasingly pose for U.S. security planning; the doctrinal and institutional evolution of the U.S. special operations community; the recent history of political violence and "small wars"; the history of irregular warfare; and contemporary perspectives on low-intensity conflict resolution. The curriculum provides the graduate with a strong background in the areas of strategic analysis, decision making, organization

theory, the technological revolution in military affairs, and advanced analytical methods.

Requirements for Entry

The Special Operations/Irregular Warfare curriculum is open to all branches of the U.S. military, civilian employees of the U.S. Government, and international military and government officials. U.S. officers must be eligible for a TOP SECRET clearance with access to Sensitive Compartmented Information based on a Special Background Investigation completed within the last five years. A baccalaureate degree earned with above average academic performance and a minimum academic profile code (APC) of 265 is required.

Entry Date

The Special Operations/Irregular Warfare curriculum is a six-quarter course of study with entry dates in January and June. If further information is needed, contact the Academic Associate or the Program Manager/Officer for this curriculum.

Degree

Requirements for the Master of Science in Defense Analysis degree are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program. The program currently offers 10 specialty tracks. Other specialty tracks can be tailored to meet student interests. The current tracks include Irregular Warfare, Information Operations, Terrorist Operations and Financing, Strategic Forecasting and Decision Making, Operations Analysis, C4I Systems, Combat Systems, Financial Management, National Security Affairs (Regional Studies) and National Security Affairs (Stability/Reconstruction).

Master of Science in Defense Analysis

The Master of Science in Defense Analysis degree will be awarded in accordance with the following degree requirements:

· This degree requires 45 quarter-hours of graduate-level work, of which 15 hours must represent courses at the 4000 level in at least two disciplines. Within the course program there must be a specialization sequence consisting of at least six courses.
· In addition to the 45 hours of course credit, an acceptable thesis must be completed.
· The Department of Defense offers the Special Operations/Irregular Warfare curriculum 699 and the Information Operations curriculum 698.

The Chairman of the Defense Analysis Department approves each individual program.

Subspecialty

Completion of the 699 curriculum qualifies an officer as a Special Operations Subspecialist with a subspecialty code of 2500P. The curriculum sponsor is the Commanding General, Special Operations Command.

Typical Subspecialty Jobs

Command Positions at the LTC/CDR level
Assistant Operations Officer, U.S. Army Special Forces Group
Staff Officer, Plans or Operations: USSOCOM
Action Officer, Counterterrorism Directorate, ASD (SO/LIC)
Staff Officer, Plans or Operations: Theater Special Operations Commands
Special Warfare Plans: CINCLANT/CINCPAC/NAVEUR
Chief, Intelligence/Plans: COMNAVSPECWARCOM
Joint Plans/Doctrine: COMNAVSPECWARCOM
Joint Staff Action Officer: J-3, Special Operations Directorate (J-3, DDSO)

Typical Course of Study
(Irregular Warfare Track)

Quarter 1

DA3802	(4-0)	Seminar in Guerrilla Warfare
MN3121	(4-0)	Organizational Design for Special Operations
DA2410	(4-0)	Modeling for Military Decision Making, I
XXXXXX	(4-0)	Emphasis Elective

Quarter 2

DA3882	(4-0)	Deterrence, Coercion, and Crisis Management
DA3410	(4-0)	Modeling for Military Decision Making, II
DA3880	(4-0)	History of Special Operations
DA3101	(4-0)	Warfare in the Information Age

Quarter 3

DA4450	(4-0)	Analytical Methods
DA3750	(4-0)	Anthropology of Conflict
DA4410	(4-0)	Models of Conflict
DA48XX	(4-0)	Regional Seminar in Low-Intensity Conflict (1st)*

Quarter 4

DA3801	(4-0)	International Terrorism
DA3102	(4-0)	Psychological Operations and Deception
DA3883	(4-0)	The Rise, Transformation and Future of the Nation-State System
DA4835	(4-0)	Islamic Insurgencies

Quarter 5

DA4760	(4-0)	The Military Advisor
DA4500	(4-0)	Special Topics in Strategic Analysis
DA4106	(4-0)	Trust, Influence, and Networks
DA0810	(0-8)	Thesis Research

Quarter 6

DA4710	(4-0)	Critical Thinking and Ethical Decision Making
DA48XX	(4-0)	Regional Seminar in Low-Intensity Conflict (2nd)*
XXXXXX	(4-0)	Emphasis Elective
DA0810	(0-8)	Thesis Research

* Five courses in Low-Intensity Conflict covering different regions of the world will be offered; students will select two of the three.

Educational Skill Requirements (ESR)
Special Operations/Irregular Warfare - Curriculum 699
Subspecialty Code: 2500P

1. **Strategy and Policy**: Graduates will develop an ability to think strategically, analyze past operations, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's political interests and goals and the ways military power may be used to achieve them. This requirement is fulfilled by completing the first of three Naval War College courses leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit. (Required only for USN and USMC students.)

2. **The Dynamics of Inter-State and Intra-State Conflict**: Students will have an understanding of the political, ethnic, and cultural dynamics that explain the outbreak of war between and within modern states. Particular attention should be given to the issues of intra-state conflict; unconventional forms of inter-state military rivalry; the integrated role of force and diplomacy in crisis management operations short of war; problems of escalation in a crisis environment; military alliance behavior; the dynamic differences between zero-sum and nonzero-sum conflicts; the special problems associated with suppressing and resolving zero-sum engagements; and military and nonmilitary approaches to conflict resolution. Students must have a close understanding of the prevailing analytical literature on these and related subjects and be able to apply this literature to a broad range of contemporary and historical cases.

3. **Terrorism, Social Revolution, and Unconventional Warfare**: Graduates will have a detailed understanding of the problems of domestic and international terrorism, social revolution, and other forms of irregular conflict. Close attention must be given to problems of both threat and response. The student must have a close knowledge of the prominent contending theoretical perspectives on the problems of terrorism and social revolution; a detailed knowledge of the operational and organizational dynamics underlying each of these forms of conflict; and a strong working understanding of the ways in which these and similar forms of irregular conflict have been countered historically. Where appropriate, the courses designed to satisfy this requirement should survey the U.S. experience in irregular warfare as well as that of other states that have been prominently engaged in such actions in the past, such as Great Britain, France, Israel, and the former Soviet Union.

4. **Historical and Comparative Perspectives on Special Operations**: Students will have a close understanding of the historical use of special operations forces, to include how these and similar forces have been organized, trained, equipped, directed, and employed. Attention should be given not only to the U.S. experience, but to other national experiences as well, such as those of Great Britain, Germany, Italy, and the former Soviet Union. Similarly, this examination should not be restricted to contemporary history alone, but should extend back into the historical record to examine the ways in which special operations and related forces have been employed creatively to support state objectives in the more distant past. Throughout this inquiry, attention should be given to the contemporary lessons that can be drawn from historic experience.

5. **Special Operations Doctrine, Concepts, and Institutions**: Graduates will have a detailed and conceptual understanding of the development of doctrine for special operations. Work in this area should focus, first, on the defining events and experiences that have stimulated doctrinal and institutional innovations in SO and, second, on the forms these innovations have taken. This examination should cover the period from the end of World War II through the post-Cold War era. These and related issues should be explored creatively in an effort to uncover the appropriate roles, missions, strengths, and limitations of military power in the emerging multipolar environment.

6. **Crisis Management and the Contingent Use of Military Power**: Students will have an understanding of the political role played by military power in operations short of war, the problem of military crisis management, and the contingent use of force in support of local U.S. policy objectives. Attention should be given to the "signaling" role that can be

played by military force, the special problems of deterrence and coercion in a crisis environment, and the military consequences of deterrence failure. The student should have a close knowledge of the historical record of "armed diplomacy" throughout the post-war period. This should include knowledge of the individual cases of U.S. military intervention in the Third World, from Lebanon (1958) to Somalia (1993). Attention should be given to both the theoretical and empirical literature on these subjects to provide the student with an understanding of the special political and operational issues associated with operating in a crisis environment.

7. **Comparative Cases of and Responses to Regional Conflict**: Graduates will have a close knowledge of historical and contemporary "small wars" and other forms of low-intensity conflict in Latin America, Asia, and the Middle East. The courses that satisfy this requirement should examine the pertinent theoretical literature on political violence in the region in question, review the recent history of regionally-based terrorism, insurgency, and communal conflict, the regional and international implications of these conflicts, and any functional issues that are of particular interest or concern in the particular area under investigation, such as the religious or communal sources of political violence or the relationship between narcotics and insurgency.

8. **Special Operations and the Revolution in Military Affairs**: Students will have an understanding of the ways in which the proliferation of new and emerging technologies is changing the shape of modern warfare. An important aspect of this requirement is to examine the likely impact of these developments on the dynamics and characteristics of twenty-first century warfare within both the inter-state and intra-state arena. The student must have a working knowledge of the major technological developments and trends in this area (both lethal and nonlethal) and their conflict implications.

9. **Special Operations and Information Warfare**: Graduates will have an understanding of the likely and potential implications of information warfare on future special operations. An important aspect of this requirement is to examine the principles of information warfare and examine the ways in which SOF can contribute to U.S. information dominance on the twenty-first century battlefield. This examination should address the problem of information dominance at the inter-state and intra-state level of war.

10. **Weapons of Mass Destruction (WMD) Proliferation and Counter-Proliferation**: Students will have an understanding of the developing problem of WMD proliferation and counter-proliferation. Students may have a technical or operational perspective on WMD. The student must have an understanding of the political dynamics of WMD proliferation and an understanding of recent and possible future trends in these areas. Close attention should also be given to the problem of counter-proliferation and the ways in which SOF might approach this task. Students having a technical focus should have a working knowledge of nuclear and non-nuclear WMD technologies.

11. **Analytical Methods and Applications**: Each student will receive grounding in analytical methods and their application to military modeling, simulations, and gaming. Close attention will be given to the ways in which such analytical techniques can be used as heuristic and decision-making tools for strategic and operational planning. Attention will be given to both historical and contemporary military applications, with particular focus on the ways in which such techniques can be used to address issues of interest to the special operations community.

12. **Strategic and Operational Complexity**: Special Operations (SO) is a style of warfare. No traditional single academic discipline can adequately address the educational requirements of the SO community, so an interdisciplinary approach is required. Each student will develop a course of study that permits him or her to pursue a disciplinary orientation that best suits their particular academic background and interests within the substantive limits of the other ESRs.

Department of Information Sciences

Chairman

Dan C. Boger, Ph.D.
Code IS, Glasgow West, Room 3005

(831) 656-3671/2214, DSN 756-3671/2214,
FAX (831) 656-3679
dboger@nps.edu

Associate Chairman, Research

Alexander Bordetsky, Ph.D.
Code IS, Root Hall, Room 225

(831) 656-2287, DSN 756-2287
FAX (831) 656-3679
abordets@nps.edu

Associate Chairman, Operations

Glenn R. Cook
Code IS, Glasgow West, Room 3012

(831) 656-2778, DSN 756-2778
FAX (831) 656-3679
grcook@nps.edu

Associate Chairman, Distance Instruction

Steven J. Iatrou
Glasgow West, Room 3011

(831) 656-3770, DSN 756-3770
FAX (831) 656-3679
sjiatrou@nps.edu

Associate Chairman, Resident Academics

Thomas J. Housel, Ph.D.
Code IS, Root Hall, Room 239

(831) 656-7657, DSN 756-7657
FAX (831) 656-3679
tjhousel@nps.edu

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

Tarek Abdel-Hamid, Professor (1986); Ph.D., Massachusetts Institute of Technology, 1986.

Albert Barreto, Lecturer (2006); M.S., Naval Postgraduate School, 2011.

Richard Bergin, Visiting Assistant Professor (2002); M.S., University of Southern California, 1998.

Dan C. Boger, Chairman, Department of Information Sciences and Professor (1979); Ph.D., University of California at Berkeley, 1979.

Alexander Bordetsky, Associate Professor (2000); Ph.D., Chelyabinsk State Technical University of Russia, 1982.

Eugene Bourakov, Research Associate (2002); MSEE, Chelyabinsk State Technical University of Russia, 1974.

Donald Brutzman, Associate Professor (1994); Ph.D., Naval Postgraduate School, 1994.

Raymond J. Buettner, Jr., Associate Professor (1999); Ph.D., Stanford University, 2003.

Glenn R. Cook, Senior Lecturer (2000); M.S., Naval Postgraduate School, 1994, 2003.

Dale M. Courtney, Lecturer (2000); M.S., Naval Postgraduate School, 1996.

James Ehlert, Research Associate (2004); M.S., Naval Postgraduate School, 1995.

Edward Fisher, Lecturer (2005); M.A., California State University, 1989.

Shelley P. Gallup, Research Associate Professor (1999); Ph.D., Old Dominion University, 1998.

Joshua D. Green, Lt Col, Lecturer (2011); M.S., Air Force Institute of Technology, 2004.

Susan Higgins, Lecturer (1999); M.S., Naval Postgraduate School, 1988.

Thomas J. Housel, Professor (2001); Ph.D., University of Utah, 1980.

Susan Hutchins, Research Associate Professor (1994); M.S., San Diego State University, 1983.

Steven J. Iatrou, Senior Lecturer (2000); M.S., Naval Postgraduate School, 1992.

Nelson J. Irvine, Research Assistant Professor (2003); Ph.D., Case Western Reserve University, 1973.

Erik Jansen, Senior Lecturer (1994); Ph.D., University of Southern California, 1987.

Magdi N. Kamel, Associate Professor (1988); Ph.D., University of Pennsylvania, 1988.

Anthony Kendall, Lecturer (1999); M.S., Naval Postgraduate School, 1980.

David Kleinman, Research Professor (1994); Ph.D., Massachusetts Institute of Technology, 1967.

Randall Maule, Visiting Associate Professor (2003); Ph.D., University of Florida, 1987.

Mark Nissen, Professor, (1996); Ph.D., University of Southern California, 1996.

John Osmundson, Research Associate Professor (1995); Ph.D., University of Maryland, 1968.

David Roberts, LCDR, USN, Lecturer (2010); MBA, Naval Postgraduate School, 2010.

Jim Robinette, CDR, USN, Lecturer (2011); M.A., Naval War College, 2007.

Brian J. Steckler, Lecturer (2002); M.S., Naval Postgraduate School, 1994.

William J. Welch, Lecturer (2000); M.S., Naval Postgraduate School, 1987.

Emeritus Professors

Daniel R. Dolk, Professor (1982); Ph.D., University of Arizona, 1982.

Carl R. Jones, Professor Emeritus (1965); Ph.D., Claremont Graduate School, 1965.

Michael G. Sovereign, Professor Emeritus (1970); Ph.D., Purdue University, 1965.

Brief Overview

The Department of Information Sciences provides in-residence graduate education, as well as a continuum of career-long learning opportunities, in support of defense requirements in the areas of information sciences, systems, and operations. The Department maintains an internationally respected research program in selected areas of information sciences, systems, and operations, and has the capability of developing research programs in additional areas of information sciences that are required to support graduate education.

Degrees

The Department provides the following degree programs:

Master of Science in Information Technology Management

The degree of Master of Science in Information Technology Management will be awarded at the completion of the appropriate interdisciplinary program in Curriculum 370. The Master of Science in Information Technology Management requires:
· Completion or validation of core courses in each of the following disciplines: Information Systems, Computer Science, Electrical and Computer Engineering, and Systems Management.
· Completion of a minimum of 52 hours of graduate-level courses, at least 20 hours of which are at the 4000 level.
· Completion of an acceptable thesis.
· Approval of the candidate's program by the Chairman, Information Sciences Department.

Master of Science in Information Warfare Systems Engineering/Master of Science in Electronic Warfare Systems Engineering

The degree of Master of Science in Information Warfare Systems Engineering/Master of Science in Electronic Warfare Systems Engineering will be awarded at the completion of a multidisciplinary program in Curricula 595 and 596, respectively. The Master of Science in Information Warfare Systems Engineering/Master of Science in Electronic Warfare Systems Engineering programs have not been reviewed by the Engineering Accreditation Commission of ABET. The Master of Science in Information Warfare Systems Engineering/Master of Science in Electronic Warfare Systems Engineering requires:
· Completion of a minimum of 45 quarter-hours of graduate-level work, of which at least 15 hours must represent courses at the 4000 level.
· Graduate courses in at least four different academic disciplines must be included and a course at the 4000 level must be included in two disciplines.
· An approved sequence of at least three courses, constituting advanced specialization in one area, must be included.
· In addition to the 45 graduate hours of course work, an acceptable thesis must be completed.
· The candidate's program must be approved by the Chairman, Information Sciences Department.

The Master of Science in Remote Sensing Intelligence

The degree of Master of Science in Remote Sensing Intelligence will be awarded at the completion of the appropriate interdisciplinary program in Curriculum 475. The Master of Science in Remote Sensing Intelligence requires:
· Completion or validation of core courses in each of the following disciplines: Space Systems, Physics, Information Systems, Computer Science, and National Security.
· Completion of a minimum of 43 graduate level credits, including the required course sequence with alternate courses approved by the Program Manager.
· Completion of an acceptable thesis.
· Approval of the candidate's program by the Chairman, Information Sciences Department.

Master of Science in Systems Technology

The degree of Master of Science in Systems Technology (Command, Control, and Communications) will be awarded at the completion of the Joint Command, Control, Communications, Computers, and Intelligence (C4I) interdisciplinary program, Curriculum 365, carried out in accordance with the following degree requirements:

- Completion of a minimum of 45 quarter-hours of graduate-level work in four different academic disciplines, of which at least 15 hours must represent courses at the 4000 level in at least two of the disciplines.
- Within the course program there must be a specialization sequence consisting of at least three courses.
- In addition to the 45 hours of course credit, an acceptable thesis must be completed.
- The program must be approved by the Chairman, Information Sciences Department.

Master of Science in Network Operations

The degree Master of Science in Network Operations will be awarded at the completion of the multidisciplinary program in Curriculum 386 requiring:
- Completion of a minimum of 36 quarter-hours of core graduate course work, of which 12 quarter hours must be at the 4000 level.
- In addition to these 36 hours of core work, students must complete an approved specialization sequence of courses in one of the following areas:
  - Decision Superiority
  - Network Operations
  - Information Systems Management
- Complete an acceptable thesis or research project approved by the Chairman, Information Sciences Department.

Doctor of Philosophy in Information Sciences

The Department offers the Ph.D. degree in Information Sciences. The program begins with advanced course work guided by the Departmental Ph.D. Committee, which leads to qualifying examinations. The primary emphasis then shifts to the student's research program, culminating in the Ph.D. dissertation. Three areas of primary concentration within the field of information sciences are available: information systems, command and control, and information operations/warfare. Interested potential students may obtain further details by contacting the Information Sciences Ph.D. Program Director, Code IS, 589 Dyer Road, Room 200A, Naval Postgraduate School, Monterey, CA 93943-5100. An applicant to the Ph.D. program will need to apply to the School Admissions Office formally (see www.nps.edu/Admissions/PhD/index.html), and will need to submit: an application letter describing general background, interests and experience in research, and career goals; official or certified copies of all academic transcripts; results of a GRE general examination taken within the past five years; and three letters of references relating to your suitability to pursue a doctoral degree. Send these materials to the Director of Admissions, 1

University Circle, He-022, Naval Postgraduate School, Monterey, CA 93943. Detailed admission procedures may vary depending on the individual's location and position. However, in all cases, the student must fulfill the general school requirements for the doctoral degree. Residency for this program is one year at the minimum, and the program generally requires three years beyond completion of a master's degree to complete.

Information Sciences Course Descriptions

CC Courses

CC0001 Seminar Series in C4I (0-2) As Required
Seminars (consisting of guest lectures, video teleconferences, and field trips) are scheduled to provide background information on specific Joint C4I systems and activities. Prerequisite: None.

CC0810 Thesis Research for C4I Students (0-8) As Required
Thesis research time for JC4I students. Prerequisite: None.

CC3000 Command and Control (4-0) As Required
No single activity in military operations is more important than C2! This course focuses on the fundamental theories of both command and control as they apply in current and emerging operational environments including but not limited to the nuances of cross domain C2 involving cyber, information, and kinetic operations. Emphasis is placed on understanding established theories associated with control of forces and systems and how application of these theories varies according to changing forces and systems and how application of these theories varies according to changing and evolving environments, technologies and organizations. Theoretical concepts may include but are not limited to decision making, organizational design, control, motivation, and information theories. Additionally, the course will explore the evolution of information systems to include current enterprise and cloud architectures and how they impact control processes and the ability to command. Cases involving US national security and military events are studied as a means of identifying successes and failures in the application of these theories. Prerequisites: none.

CC3102 Combat Modeling and Analysis for Command and Control (3-2) As Required
Emphasis is on the use of mathematical and computer models to help solve operational problems or improve the efficiency and effectiveness of control. Topics include but are not limited to the evolution of computer based experimentation and modeling, fundamental mathematical modeling techniques, examination and evaluation of current modeling software, and the interpretation and application of model outputs to real-world situations. The course is the basis for later courses on the use of modeling techniques to conduct detailed analysis and evaluation of command and control processes and systems. Prerequisites: CC3000 and OS3105 (may be concurrent). Classification: U.S. Only, SECRET.

CC3250 Command, Control and Communications (C3) (4-0) Winter, Summer
CC3250 is designed to introduce technical curriculum students to command and control theory and processes as well as the first principles associated with modern electronic communication systems of interest to military operations. Specific course topics include command and control (C2) elements and concepts, the technology influence on C2 as well as fundamental communications principles and concepts to include: signal

representations, noise considerations, link analysis, analog/digital modulations and Defense Department systems within the Global Information Grid concept. Prerequisites: SI1001, SI1002, or equivalent; SI2011 or equivalent.

CC3900 Special Topics in C4ISR (V-V) As Required

Supervised study in selected areas of command, control, and communications to meet the needs of individual students. May be repeated for credit if course content changes. Graded on Pass/Fail basis only. Prerequisite: Consent of the Academic Associate.

CC4101 Systems Engineering for Joint C4I (4-2) Summer

Provide an introduction to systems engineering by performing systems engineering activities, using the tools that a systems engineer uses, analyzing the procedures a systems engineer follows, and performing an actual systems design on a joint C4I system element. The course will use practical examples to explain the fundamental principles, while maximizing the hands-on practical systems design activities. A required course for the 365 curriculum. Prerequisites: CC3000 and OS3604. Classification: TOP SECRET.

CC4103 Joint C4I Systems Evaluation (2-4) As Required

Experiments in determining C4I system effectiveness using wargaming and simulation. Design of experiments. Survey of current C4I systems evaluation techniques. Prerequisites: CC4101 and U.S. citizenship. Classification TOP SECRET with Eligibility for SI/SAO.

CC4250 Enterprise Architecture (4-0) Winter, Summer

The focus of the course is the DoD enterprise and extended enterprise in terms of its information architecture. The course will look at Enterprise Architecture at the strategic, tactical and operational levels. The activities will include analysis of state of the art architectures, modeling enterprises, viewpoints and communications requirements. The student will analyze existing architectures, learn the relevance and limitations of enterprise architectures and to learn to appreciate the strengths and limitations of various approaches. The student will also become familiar with Service oriented architecture, the Information Technology Infrastructure Library and the role of components in the delivery of infrastructure products and standards. Prerequisites: CC3000, IS3502.

CC4900 Advanced Study in C4ISR (V-V) As Required

Supervised study in selected areas of command, control, and communications to meet the needs of individual students. May be repeated for credit if course content changes. Graded on a Pass/Fail basis only. Prerequisite: Consent of the Academic Associate.

CC4913 Policies and Problems in C2 (4-0) As Required

Study of the fundamental role C2 systems fulfill in operational military situations, including the full range of military operations. Analysis of the changing role of organizational structures and processes as well as technologies and impacts on C2 systems requirements and designs. Consideration of the complexities imposed on C2 systems as the force structure becomes more heterogeneous, as in the case of NATO and NGOs. Case study of selected incidents and systems with a focus on current problems. This course is specifically for students in the 365 curriculum. Prerequisite: CC4103.

CC4920 Multi-Criteria Analysis (4-0) Winter, Summer

The major goal of this course is to learn where and how to search for the best solutions for problems with contradictory criteria. This course will introduce methodology for correct statement and solution of engineering optimization problems, called the Parameter Space Investigation (PSI) method. This technique has been widely integrated into various fields of industry, science, and technology. The PSI method is implemented in the comprehensive software system MOVI (Multicriteria Optimization and Vector Identification) that will be used and distributed during the course. Prerequisites: None.

IO Courses

IO0001 Seminar Series in IO Topics (0-2) As Required

Seminar lectures in Information Operations. Prerequisite: None.

IO0810 Thesis Research for IO (0-8) As Required

Information Operations thesis research. Prerequisite: None.

IO3100 Information Operations (4-0) Fall/Winter/Summer

This course, available in the classroom or through asynchronous Internet-based education, provides a survey of Information Operations (IO) along the time line of peace, to conflict, and back to the cessation of hostilities. Students study the specific methods and elements of IO and how they integrate with other elements of national power to meet national security objectives. Prerequisite: None.

IO4300 Planning and Execution of Military Operations in the Information Environment (3-2) Spring/Summer

This course refines the students' ability to develop and analyze IO plans. Students learn to integrate seemingly disparate disciplines (national security affairs, information warfare/operations, computer science, physics (kinetic warfare), and operations analysis) into a cogent operations plan as an integral part of a theater campaign plan. Prerequisites: NW3230, IW3101 or IO3100, OS3105 or equivalent OS course. Classification: US only with SECRET clearance.

IS Courses

IS0001 Seminar Sessions (0-2) As Required

Seminar Sessions in Information Systems for IST Students. Prerequisite: None.

IS0810 Thesis Research (0-8) As Required

Thesis research time for IST Students. Prerequisite: None.

IS2000 Introduction to Information Technology (3-1) As Required

Provide an introduction to the field of Information Technology Management and the functions and responsibilities of the information technology manager. Offered as part of the E-FIST certificate for distance learning only. Prerequisite: None.

IS2010 Introduction to Information Technology (1-2) Fall/Winter/Spring/Summer

This course provides an overview of the technology used to implement modern information systems. Extensive use of hands-on laboratories and demonstrations provide students with a thorough introduction to microcomputer architecture and design, the Internet and Web page development, local area network (LAN) operation and administration, databases, management information systems, and computer security. The strong emphasis on hardware and software technical issues in this course establishes the foundation necessary for studying IT management issues during the follow-on course. Prerequisite: None.

IS2020 Introduction to Object-Oriented Programming Using Visual Basic (2-3) As Required
A first course in computer programming using VB, DoN's IT21 mandated standard, as a high-level, event-driven, object-oriented, programming language. Course emphasis will be on planning, program development, graphical user interfaces, rapid prototyping, program construction, data types, operations, control flow, arrays, records, file I/O, database access, random number generators, and event-driven OOP structures. Prerequisite: None.

IS2025 Fundamentals of Networks (3-2) Spring
Undergraduate level Network fundamentals class for the E-FIST program. Security Clearance: CONFIDENTIAL.

IS3001 Information Sciences for Defense (3-0) Fall/Spring
The purpose of this overview course is to introduce first quarter students from the Information Systems and Technology and the Joint C4I curricula to an overview of the information environment in the Department of Defense. During this quarter students will be exposed to the tactical and business systems, technologies, organization, culture, policies and issues regarding the acquisition, operations and management of technology. Specific topics include the DoD information environment, enterprise architecture and systems, systems development polices and processes as well as critical issues of security, privacy and issues of identity. Prerequisite: None.

IS3181 Integrating and Leveraging Information Technologies (3-0) As Required
The attributes of information technology are studied in conjunction with the management aspects of developing and maintaining systems in support of DoN and the joint services. This course is heavily project- and case-study oriented. Minicases force the student to apply theory from reading to realistic DoN settings. These case studies will force trade-offs, resource allocation decisions, development of strategy for specific problems, etc. Prerequisite: Lead program students only.

IS3200 Enterprise Systems Analysis and Design (3-2) Fall/Spring
This course covers the concepts, models, and processes used by enterprise systems analysts to determine: 1) The current situation of an organization that desires to improve itself; 2) The problems and opportunities in this situation; and 3) The plans and specifications that can be formed to feasibly address these problems or opportunities. The course covers how enterprise -level system analysis is performed to successfully define and develop systems requirements how to apply these to system design. Additionally, the fundamentals of information system design are discussed and applied. The overall goal for the course is for the students to understand the system development life cycle, system analysis and design methodologies, and have applied them in a team project within the class. Prerequisite: None.

IS3201 Enterprise Database Management Systems (4-2) Fall/Spring
Enterprise database management systems are the core of all information systems capabilities. The course provides the foundational knowledge, language, and capabilities to create, operate and manage enterprise-level data management systems. Students will learn the essential activities of how to store, retrieve, manage, and control data using a relational database management system. They not only will learn how to build a database application using modern database tools, and but also how to deploy database technology in a larger, organizational context to support problem

solving. Further, by the time students have completed the course, they will understand the major steps required to manage complex database projects. Prerequisite: None.

IS3202 Thin-Client Database Systems Development (4-2) Winter/Summer
At the core of modem information systems is the ability for remote users to gain access to centralized data management services. This course is designed to familiarize students with the various approaches for developing database-driven, interactive, dynamic capabilities for accessing data through thin-client systems. These approaches include client-side scripting using Java scripts; server-side scripting using Active Server Pages; and Extensible Markup Language (XML) technologies. An integrated development environment is used throughout the course to demonstrate the application of these approaches. Students are expected to develop a fully functional, dynamic capability using the approaches/technologies learned in class. Prerequisites: IS3200 and IS3201, or consent of the instructor.

IS3210 Information and Knowledge Management Issues in Defense (4-0) Spring
This elective course on defense knowledge and information management integrates theory with practice to help prepare current and future leaders to leverage knowledge and knowing for competitive advantage in learning organizations. Knowing refers to knowledge in action and is concerned with activities (e.g., decisions, behaviors, work) in the organization. Using emerging knowledge-flow theory as its intellectual base, the theoretical part of the course helps professionals understand: how knowledge is both critical and unique; how it builds and depends on information; and how to design effective work processes, organizations, and technologies around dynamic knowledge and information. Using application cases for group critique, the problem-based learning part of the course examines a diverse set of knowledge-based processes and organizations in operation today, and it offers both principles for and experience in identifying strengths and weaknesses. Students also select new or operational knowledge-based processes for evaluation, and work individually as consultants to assess and redesign them around knowledge flows. This course may be offered as an online course. You can view more details at the NPS online website. Prerequisite: None.

IS3301 Computer-Based Tools for Decision Support (3-2) Fall/Spring
This course introduces the principles for designing, implementing and using computer-based tools to support a variety of decision-making situations. A key objective of the course is to introduce managerial decision-making technology in a format that is not too abstract or too mathematical. We cover a variety of analytical techniques for decision making in complex environments, involving single or multiple criteria made under certainty and uncertainty. Students learn the difference between building "private" models and "public" models and are introduced to software engineering practices for engineering quality models. Exemplary computer-based applications that support or involve the use of formal decision making methods and tools are discussed. Group projects will supplement and reinforce the course's learning objectives. Prerequisites: IS3200, IS3201.

IS3302 Database Management for Decision Support (3-2) Summer/Winter
Database management systems that support decision making constitute essential components of information-driven organizations. These systems are employed in a wide array of

activities, ranging from combat support to logistics and administration. This course covers the essential aspects of database management systems and their role in supporting decision making. The course is a hands-on, technically oriented course that provides students with an understanding of conceptual database management techniques as well as the application using decision support tools. This course is intended for students in the ISO (356) and IC4I (365) curricula . Prerequisite: None.

IS3330 Research Methods for Information Sciences (3-0) Summer/Winter

The purpose of this course is to provide an overview of research design for research in the Information Sciences (IS) field. This overview consists of understanding the preliminary considerations that go into selecting a qualitative, quantitative, or mixed methods research design. These include knowing the definition for these different approaches, considering philosophical worldviews, reviewing the literature, understanding the use of theory, anticipating ethical issues, and developing writing strategies. We will discuss the process of research as it relates to each approach in IS research. This process includes writing an introduction, specifying a purpose statement, and developing research questions and/or hypotheses. This course will focus on the methods and procedures for quantitative, qualitative, and mixed methods studies. Prerequisites: None.

IS3333 Thesis Research for Information Sciences (2-0) Fall/Spring

Introduction to the thesis research process and requirements for IS Department students. Prerequisite: None.

IS3450 RF and EW Concepts in Networked Systems (2-0) Fall

This course giving a broad, non-technical overview of concepts in Radio Frequency (RF) Communications used in networked communications systems. The course covers RF signaling terminology and the basics of RF communications via examining the basic concepts such as RF waveforms, data rates and bandwidth, and RF atmospheric limitations. Additionally, the course discusses how RF is used in several modern communications systems such as Wireless LANs (WiFi), Cell Phone Systems (GSM and LTE), and Land Mobile Radios (LMRs).

IS3460 Networked Autonomous and Unmanned Systems (4-0) Summer

This unclassified course examines autonomous and unmanned systems and platforms from a systems and operational perspective. Historical and modern systems are discussed to include Industrial Control Systems, botnets, UxVs, etc. The nature of autonomy versus unmanned systems is examined. Opportunities and security issues presented by the growing dependence upon these systems and platforms are studied. The ethics of using unmanned and autonomous platforms and systems for warfare is examined, along with the ethics of attacking such systems when integrated into society. Operational applications within the private and public sectors, as well as the military, are discussed. Current and future research into autonomy is examined. Prerequisites: None.

IS3502 Network Operations I (4-2) Winter/Summer

This course introduces the basics of network operations. Topics covered include but are not limited to configuring and managing networks, routers, and servers (file, e-mail, web, DNS, printer, etc.); network monitoring and traffic analysis; storage and bandwidth allocation; quality of service, performance monitoring and analysis; deploying and managing firewalls and malware/intrusion detection/prevention systems; configuring access controls; managing and retaining logs; setting up VPNs and secure connections; business continuity and disaster recovery planning; managing software patches; and network policy and compliance. Prerequisites: None.

IS3504 Modern Network Operating Systems: Windows 2003 Server (3-2) As Required

This course focuses on the planning, design, installation, configuration, and management of network operating systems used throughout DoD and private industry. Network operating systems are compared with single-user operating systems to understand differences and similarities. Popular client/server and peer-to-peer systems are examined to provide a thorough understanding of the correct applications of each. Network labs provide in-depth analysis of such topics as file server configuration and administration, multilevel network security procedures, and global file server synchronization processes. Prerequisite: IS3502.

IS3710 Identity Management Operations (3-0) As Required

This course will integrate theory with practice to help prepare students with ways of thinking about how to leverage Identity for competitive advantage in operational environments. The focus of this course is on the design architecture for integrated systems which will allow for the collection, analysis, storage, and dissemination of information related to the identity of a person. This course is one of several that will collectively comprise the requirements for Identity Management specialization tracks in both the Information Science and Computer Science degree programs. Completion of four courses: CS3686, CS3699, IS3710, and IS3720, will meet the requirements for earning the Federal/DoD Identity Management Certificate offered by NPS. Prerequisites: None.

IS3720 Identity Management Policy (3-0)

The goals for the Identity Management Policy Course are to provide the student with the necessary ways to think about the creation or implementation of Identity Management policies. The focus is to provide students with a background on the approaches to the verification of personal identity and the implications in a digital environment. As individuals become more conscious of the collection of data regarding their actions, the student must understand the implications of privacy in this changing environment. There will be a strong, case-based focus on the laws, ethics, and moral implications of the collection, analysis, storage, and dissemination of personal data so that the student can prudently apply the appropriate policy. Additionally, the policies and procedures for the provisioning, propagating, maintaining, and removal of personally identifiable information will be discussed. The student will be required to develop a case study for a scenario that will address the policy implications and create a solution to meet the operational requirements. Prerequisite: None.

IS4010 Technology in Homeland Security (4-0) Fall/Winter/Spring

Government agencies in today's Information Age are more dependent than ever on technology and information sharing. This course provides students involved in homeland security with a broad overview of homeland security technology, information systems, sensors, networks, knowledge management, and information security. The course focuses on technology as a tool to support homeland security personnel regardless of functional specialty. The study of principles and theory is combined with

homeland security examples and cases. The student will gain a perspective on the important role of senior management in enterprise-level computing and their personal role as change agents. The knowledge and skills acquired will make the students more effective technology users and help them recognize opportunities where the application of technology solutions can provide a strategic advantage and therefore make a contribution to homeland security. The ultimate objectives are to show students how homeland security professionals can exploit technology and not be exploited by it, and to wisely use technology in the most efficient and productive manner. This course is open to students in the Homeland Security Program only. Prerequisite: None.

IS4031 Economic Evaluation for Enterprise Technology Investments (4-0) Fall/Spring

The objectives of this course are to provide the student with the tools and methodologies that will allow for the objective economic evaluation of enterprise information systems from a business perspective. The course will focus on the alignment of IT investment to strategic goals and productivity, the methods of obtaining IT services through outsourcing, and the importance of managing to the needs of the enterprise. Included in this course are the components for creating a Defense Business Case, options theory/real options and market comparables. The goal is for the students to be able to include critical economic factors into IT investment decision-making. Prerequisite: None.

IS4052 Imaging Spectrometry Theory, Analysis, and Applications (3-2) Winter

This course is designed to enable scientists to analyze and exploit data from hypersectral sensors. The course utilizes a blend of lectures, demonstrations, case histories, and hands-on imaging spectrometer data analysis. The physical properties of Earth surface materials are defined as the basis for imaging spectrometry utilizing visible/near-infrared (VNIR), short wave infrared(SWIR), and long wave infrared (LWIR) data. Students will learn the theory behind imaging spectrometry measurements and systems, how to analyze the data, and apply lessons learned to analysis of a variety of imaging spectrometer datasets. Prerequisites: PH3052. Corequisites: IS4053.

IS4053 Spectral and Polarimetric Tools and Analysis Techniques (3-2) Winter

Analysis of multi-dimensional data sets, from multipsectral and optical polarimetric imaging systems. Nature of spectral data, analysis methods with application to military and civil problems. Primary focus is on the use of statistical techniques (spectral imaging). Basic theory of optical polarimetric imaging and analysis. Prerequisite: PH3052.

IS4054 Remote Sensing III: Analysis Techniques for Passive Imaging Systems (3-2) Spring

Analysis techniques for thermal imagery from ground, airborne, and satellite systems. Applications in imaging systems, and to Overhead Persistent Infrared Systems (OPIR). Tools and applications for systems, applications to military an intelligence problems. TS/SCI ; Prerequisites: SS3001, PH3052.

IS4055 Analysis Techniques for RADAR Imaging Systems (3-2) Summer

Active imaging systems (RADAR), tools for analysis, application to civil and military problems. Theory of non-literal analysis techniques for polarimetric RADAR(interferometric synthetic aperture RADAR). Application of RADAR to development of digital elevation models (DEMs) and terrain classification. Prerequisites: PH3052.

IS4056 Geographic Information Systems (3-2) Summer

Theory and application of geographic information systems. Topics include spatial data models, map projections, data fusion, satellite surveying, spatial query and analysis, and cartographic principles. Application of GIS to decision making processes and the solution of current real-world problems. Prerequisites: None.

IS4060 Analysis Techniques for Laser Imaging Systems (LiDAR) (3-2) Spring

Exploitation of terrestrial and airborne laser scanning systems for military and intelligence purposes. Technology basics are defined, operational systems described, and analysis techniques developed. Applications developed include the production of Digital Elevation Models and terrain classification, and are addressed by examples and in laboratory applications of commercial software. Current state of the art single return and waveform system exploitation is developed. Prerequisites: PH3052.

IS4182 Enterprise Information Systems Strategy and Policy (4-0) Fall/Spring

Enterprise Information Systems Strategy and Policy: How to Be an Effective CIO or IT Strategist. This course aims to make students fluent in architecture-based decision making for enterprise systems strategy and policy. Students should become capable of significantly enhancing the prospects of an enterprise through effective, strategic use of IT architecture. The student should be capable of suggesting significant improvements in existing or proposed architectures, demonstrating both analysis and synthesis skills. Topics include: the enterprise and extended enterprise; information processing for competitive superiority; technology evolution and adaptive stresses; the role of the era; information systems architecture and enterprise architecture; architecting; U.S. Government architecture efforts; 000 imperatives; information superiority; network-centric warfare; and architecture synthesis and evaluation. Prerequisite: None.

IS4188 Collaborative Technologies (3-2) As Required

Collaborative technologies and multiple-agent, decision-support architectures become the central application elements of emerging GIG, FORCEnet, DARPA NICCI, and other sensor/decision maker networking initiatives. The first part of the course is based on the analysis of collaboration in different human organizations and the requirements of agent-based, decision-support architecture. The second part of the course is focused on studies of intelligent agents and multiple-agent architecture. From the beginning of the course, students are involved in hands-on practice with wireless collaborative environments including GPS units, pocket PCs, laptops, and other devices. We start with using the peer-to-peer Groove collaborative tool and NPS agents-facilitators. We later move on to several demonstrations, including the client-server GENOA system implementation for Homeland Security and PACOM POST virtual meetings via the Lotus Same Place System. Prerequisite: None.

IS4201 Enterprise Data Management (4-2) As Required

An elective course that will focus on the technological infrastructure, as well as the management processes, related to the operations and maintenance of enterprise data management systems. Prerequisite: IS3201.

IS4210 Knowledge Superiority (3-0) As Required

This elective course on knowledge superiority integrates theory with practice to help prepare current and future leaders to leverage knowledge and knowing for competitive advantage in learning

organizations. Knowing refers to knowledge in action, and is concerned with activities (e.g., decision, behaviors, work) in the organization. Using emerging knowledge-flow theory as its intellectual base, the theoretical part of the course helps professionals understand how knowledge is both critical and unique, and equips them to design effective work processes, organizations, and technologies around knowledge flows. Using real-time cases for group critique, the problem-based learning part of the course examines a diverse set of knowledge-based processes and organizations in operation today, and offers both principles for and experience in identifying strengths and weaknesses. Students also select new or operational knowledge-based processes for evaluation, and work individually as consultants to assess and redesign them around knowledge flows. This course may be offered as an online course. You can view more details at the NPS website. Prerequisites: IS3201 and IS3301, or IS3302, or equivalent with consent of the instructor.

IS4220 Technology Enabled Process Improvement (3-2) Winter/Summer

The focus of this class is on practical application of Business Process Reengineering (BPR), lean six sigma (L6S) and TQL principles to enable innovative redesigns of core defense processes. These tools are principles that define a set of heuristics or "rules-of-thumb" that help the analyst accomplish the transformational goals required in dramatically changing core processes to create greater value. The course makes use of process analysis and measurement methodologies to ensure productivity increases as a result of the process redesigns. The students will define an existing process, model it in simulation software and analyze the current state. Then through the application of learned principles, demonstrate the application of IT to the process and compare the before and after to determine impact. Prerequisites: IS3200 and IS4031, or consent of the instructor.

IS4300 Project Management for Enterprise Systems (3-2) Fall/Spring

The objective of this course is to educate the student in areas of great concern to the DoD in the field of IT project management to include software engineering and risk management. The course examines both the technological tools of software production as well as the software engineering techniques for software project management. Software testing, metrics, and reliability are also covered. DoD software standards and metrics programs are included. Prerequisites: CS3030 and IS3200 and IS3171 and OS3004.

IS4301 Data Warehousing, Data Mining, and Visualization (4-2) Winter

This elective course is designed to provide students with the basic concepts of data warehousing, data mining, and visualization. The course emphasizes both technical and managerial issues and the implications of these emerging technologies on those issues. The course has a distinctly "real-world" and DoD orientation that emphasizes application and implementation over design and development. A state-of-the-art system/tool will be used to help students understand and apply the concepts presented in the class. Prerequisites: IS3201 and IS3301 and IS3200, or consent of the instructor.

IS4505 Wireless Networking (3-2) Winter/Summer

This course provides students with wireless networking fundamentals essential to design, install, administer, and support IEEE 802.11-compliant wireless networks. The course content and format is aligned with the Planet3 Wireless Certified Wireless Network Administrator (CWNA) Official Study Guide. Students who successfully complete this course will be prepared to take the CWNA certification exam. Prerequisites: IS3502 or CS3502 and EO3502, or consent of the instructor.

IS4520 Systems Thinking and Modeling for a Complex World (4-0) Spring

This course introduces system dynamics modeling for the analysis of organizational policy and strategy. Students will learn to visualize an organization in terms of the structures and policies that create dynamics and regulate performance. The goal is to use the analysis and modeling techniques of system dynamics to improve their understanding of how complex organizational structures drive organizational performance, and then to use that understanding to design high-leverage interventions to achieve organizational goals. We use computer-based simulations to model long-term side effects of decisions, systematically explore new strategies, and develop our understanding of complex systems (analogous to the "flight simulators" that pilots use to learn about the dynamics of flying an aircraft). Prerequisite: None.

IS4550 Internet Appliances and Me-Centric Computing (3-2) Winter

In the next decade, computing as we know it will be radically transformed around highly personalized devices that know their users, know how to get work done, and can interact with billions of devices and services over the Internet. Computing empires built up on traditional OSI 7-level stacks will lose their preeminence. In the emerging new world of Internet appliances, the center of the universe will become the individual and products will be built around knowledge of how to serve that user. Billions more people will gain access to computing power this way, and our daily experience will shift from endless efforts to tame incomprehensible software products to being masters of a universe of appliances and services that aim to please. This transition is inevitable, because hyper-complex technology isn't welcomed or assimilated fast enough, and pressures exist to find better paths to market. The clear path for powerful technology is to reach many more customers through a radical simplification of what customers must do to employ it. This revolution is underway now, and it will fundamentally alter the landscape for IT, IT management, and strategic uses of technology. The course will look into various technologies including personalization, services, wireless communications, Internet (including IP v. 6), and identity services that are driving the changes. Student projects will create Me-Centric innovations pertinent to their domains of interest. Prerequisite: None.

IS4700 Introduction to the Philosophy of Science (3-2) Winter

This course is designed to help prepare the prospective Ph.D. in Information Sciences candidate to engage in original research. The focus will be on understanding the underpinnings of doing science by studying the work of modern philosophers of science. The course will review the epistemologies (economic, behavioral, physics-based, and general systems-based) serving as a scaffolding for the development of original theory development in the field of IS. The characteristic features of the received view, hypothetico-deductive formalism will be reviewed, along with the modern challenges to this framework. The distinction between the instrumental-realist positions will be examined in light of its implications for theory development in IS. Students should understand the requirements for theory generation in terms of the

underlying assumptions of given epistemic perspectives as a result of taking this course. Prerequisite: None.

IS4710 Qualitative Methods for Research (3-2) Winter

Qualitative Methods for research will be explored in this course. Quantitative research methods are powerful, but not all research questions and settings are amenable to such methods. In particular, early stage exploratory research (e.g., "how" and "why" questions), studies in which the phenomena of interest are intertwined with their contexts (e.g., where people, technology, and organizations interact), investigations of individual and small-group behaviors (e.g., leaders, project teams, user groups), understanding rare and idiosyncratic events (e.g., catastrophes, new technology introductions, organizational changes), and research in which potential sample sizes are small, or measures cannot be operationalized practically, are all candidates for qualitative research methods. Additionally, combining qualitative and quantitative methods represents a compelling tactic for triangulation through data analysis. In this course, students learn to appreciate when qualitative research methods are appropriate, and they gain both theoretical and experiential knowledge about how to employ such methods. Prerequisite: None.

IS4720 Quantitative Methods for Research (3-2) Summer

This course equips IS doctoral students with the quantitative methods necessary to support dissertation research, using real-world project data and case studies. Topics include: defining research objectives, formulating and testing hypotheses, designing experiments, developing analytic and simulation models, collecting data, analyzing data, validating models, using quantitative software tools, and presenting results in written and oral reports. Prerequisite: None.

IS4730 Design of Experiments for Research (3-2) Fall

Design of experiments for Ph.D. students. Prerequisites: IS4700 and IS4710 and IS4720.

IS4790 Research Seminar for Ph.D. Students (0-3) Fall/Winter/Spring/Summer

Research seminar for students in the IS Ph.D. program. Prerequisite: None.

IS4800 Directed Study in Information Sciences (V-V) Fall/Winter/Spring/Summer

Directed study of selected areas of information science to meet the needs of the individual student. Intended primarily to permit students to pursue in-depth subjects not fully covered in formal class work or thesis research. Prerequisites: Consent of instructor and department chairman. Grading on Pass/Fail basis or standard grading criteria are both available.

IS4925 Special Topics in Information Systems (V-V) Summer

Special topics courses are first-run courses that are intended to gauge student response and interest. After a course has run once, if successful, it will be submitted to the academic council for final approval. Prerequisite: None.

IS4926 Network Operating Centers (4-0) Winter

The course provides analytical background for implementing telecommunications management systems and integrating management infrastructure into the information grid design. It targets operations support for GIG, terrestrial, satellite, and mobile wireless network operation centers. The course combines classroom activities with research and design experience in telecommunication networks configuration, fault, and performance management. In the center of analytical work is the project-based study of management functions and information models for SNMP MIBs, TMN, and architectures. The advanced study issues include an introduction to knowledge-based management and intelligent agent technology. The applications target the needs of GIG operations, C4ISR networks management, Joint Experimentation, Fusion Centers, and Network Operation Centers environment. They employ features of LAN/WAN networks, ATM networks, PCS networks, satellite/wireless networks, UAV, HALO, and other platforms. During the course work, students will gain basic knowledge of several commercial telecommunications management systems used by the NOCs: Spectrum, HP Open View, Tivoli, Unicenter TNG, Micro Muse, etc. The classroom, studies, and projects teamwork are facilitated by the on-line distance learning and shared electronic workspace environment. Prerequisite: None.

IS4927 Special Topics in Information Systems II (V-V) Fall/Winter/Spring/Summer

Special topics courses are first run courses that are intended to gauge student response and interest. After a course has run once, if successful, it will be submitted to the academic council for final approval. Prerequisite: None.

IS5810 Dissertation Research (0-8) As Required

Dissertation research for doctoral studies. Required in the quarter following advancement to candidacy and then continuously each quarter until dissertation is approved by the Academic Council.

IW Courses

IW0001 Seminar Series for IW Students (0-2) As Required

Seminar series for IW students. Prerequisite: None.

IW0810 Thesis Research for IW Students (0-8) As Required

Thesis research work for IW students. Prerequisite: None.

IW3101 Military Operations in the Information Environment (4-0) As Required

This course provides a survey of military operations in the information environment along the time line of peace, to conflict, and back to cessation of hostilities. This is accomplished by studying the theoretical underpinnings and implementation of military actions in the information environment to influence decisions in both the biological domain (human) and non-biological/cyber domain (hardware, software and spectra). Topics include but are not limited to military-civilian relationships, human cognition and decision-making, social influence, cyberspace operations, C2 structures, legal issues and considerations in IO, the joint planning process, and intelligence support to IO. Prerequisite: None. Classification: SECRET; U.S. Citizenship.

IW3301 Influence Modeling (3-2) As Required

This course explores influence models and analysis in support of military requirements. Students will learn the strengths and weaknesses of modeling techniques as applied to operations in the information environment whether through cyberspace or other media, how to determine whether or not an influence model is appropriate for use and how to evaluate the utility of various models and modeling techniques. The student will become familiar with the process of designing, constructing and applying influence models within the context of military operations. Prerequisites: IW3101 or IO3100.

IW3502 Information Warfare Networks (4-2) Summer

This course provides students with an understanding of data and computer communications. The course coverage includes the essential topics of data transmission and networking of

data/voice/multimedia along with network protocols. Students are provided with a first principle understanding of the current status, and future technology directions of Internet-Protocol (IP) based data and communication systems through discussions of related standards and accepted practices. Course coverage includes: Guided-wave transmission lines (cable, twisted-pair and fiber), signaling aspects of multiplexing, flow and error control at the various layers of the network topology. High-speed local area networking devices (hubs, switches, and routers) and methods (including virtual local area networks (LANs)) are also discussed. Some network security methods and procedures are briefly presented at the end of the course. Prerequisite: EO2652, CS3030, and EO2512 or equivalents.

IW3921 Non-Kinetic Targeting I (2-0) As Required

This course describes the joint targeting process as it applies to the employment of non-kinetic munitions associated with military operations in the information environment including cyber and information operations. Targeting will be discussed in reference to information, cyber and kinetic weapons that can be used to garner effects in the physical domain. Specific areas of discussions will include but are not limited to: The joint planning process, network centric warfare, links and nodes analysis for target selection, effects-based targeting, time-critical targeting, information operations systems characteristics, cyber operations, intelligence requirements for analysis and damage/effects assessment, and lethal versus non-lethal options. This course is conducted at the unclassified level utilizing open-source information. Prerequisite: IW3101 or IO3100 or consent of instructor.

IW3922 Non-Kinetic Targeting II (2-0) As Required

This course is taught in conjunction with IW3921 and explores the practical application of non-kinetic targeting concepts as described for IW3921 through lecture and laboratory work. Prerequisite: IW3101 or IO3100 or by consent of the instructor; Corequisite: IW3921. Classification: This course is conducted at the SECRET level.

IW4301 Advanced Topics in Influence Modeling (4-0) Summer

This course provides students with the opportunity to develop an Influence Model and to use this model to conduct analysis in support of actual military requirements. Students will design, construct, and analyze Influence Models in collaboration with fellow students. Work completed as part of this course may be included in one or more Naval Postgraduate School Technical Reports. Each project may be briefed to appropriate senior DoD leadership as well, if deemed suitable for such briefings by the instructor. Students must have access to a United States Government computer network and have access to "For Official Use Only" (FOUO) data. SECRET-level work may be conducted as well by special arrangement with the instructor. Prerequisite: IW3301.

IW4500 Information Warfare Systems Engineering (3-2) Spring

This course applies Systems Engineering Principles to design an Information Warfare System. Project teams will develop an Information Warfare System from requirements determination through and including preliminary design. The five pillars of Information Warfare will be used in the design process, including information security considerations. Lectures will discuss both Systems Engineering principles and Information Warfare concepts. Prerequisite: IW3101.

IW4800 Directed Study for IW Students (V-V) As Required

Directed Study for IW/EW students. Credit hours are variable and must be chosen on a case-by-case basis. Prerequisite: None.

IW4925 Special Topics in Information Warfare (V-V) Summer

Special topics courses are first-run courses that are intended to gauge student response and interest. After a course has run once, if successful, it will be submitted to the academic council for final approval. Prerequisite: None.

IW4950 Advanced Information Warfare Systems (3-2) Fall

This course examines the use of modern EW systems in support of information warfare operations. Modern EW systems studied include IDECM, Towed FO decoys, AIEWS, MAWS, ASPJ, Advanced Standoff Jammers, Stand-in Jamming, DECM, and Situational Awareness. Advanced topics, including stealth, directed energy weapons, modern threats, GPS jamming, Hard kill/Soft kill interactions, MASINT, and DRFM systems, are discussed. The laboratory includes visits to EW manufacturers and invited lecturers on advanced topics. Prerequisite: None. Classification: SECRET.

IW4960 Advanced Information Warfare Systems (3-2) Winter

The characteristics and performance of modern EW systems are discussed. Course topics include: the Advanced Radar Threat, Architecture and Technology of EA systems, EA against modern radar systems, Noise and DECM EA systems, DDS and DRFMs, characteristics of modern ES systems, Expendables and Towed Decoys, directed energy systems, and stealth principles. Prerequisite: EO4612 or consent of the instructor.

Network Operations and Technology-Operations (NWOT-OPS) - Academic Certificate in Network Operations and Technology-Operations - Curriculum 271

Program Officer

Steven J. Iatrou
Code IW/Is, Glasgow West, Room 3011

(831) 656-3770, DSN 756-3770
FAX (831) 656-3679
isoaa@nps.edu

Brief Overview

The Network Operations and Technology-Operations (NWOT-OPS) academic certificate program is designed to provide Navy personnel with an opportunity to obtain advanced education in the operational arts supporting information domain via asynchronous web-based media. The four courses in the NWOT-OPS program represent the foundation on which modern warfare is built: Command and Control, Space Operations, Network Operations, and Information Operations. This four-course sequence is also the bedrock of the N2/N6-sponsored Network Operations and Technology (NWOT) curricula at the Naval Postgraduate School.

The ISO academic certificate provides the fundamental education needed to achieve information superiority, thus

enabling full spectrum dominance in the information and cognitive domains. The actions associated with information operations are wide-ranging—from physical destruction to psychological operations to cyber operations. The NWOT-OPS academic certificate provides the fundamental education needed to achieve information superiority through information dominance and decision superiority, thus enabling full spectrum dominance in the information and cognitive domains.

The courses are provided through asynchronous web-based media (i.e., the Internet) because the Navy recognizes that this education should be available to their personnel regardless of geographic limitations. So, if students have access to the Internet, they have access to tools necessary to help meet U.S. national security objectives in the information domain.

All courses in this academic certificate are graduate-level courses carrying full NPS academic credit. They provide the baseline for advanced education in operationally essential disciplines.

Requirements for Entry

Applicants must have earned a baccalaureate degree to be considered for admission.

Entry Date

At the beginning of any quarter in the NPS academic year. These courses may be taken in any sequence and they need not be taken all in the same academic year.

Program Length

Four quarters.

NWOT-OPS Academic Certificate Requirements

To earn the NWOT-OPS academic certificate you must pass all four courses with a C+ (2.3 Quality Point Rating (QPR)) or better in each course and an overall QPR of 3.0 or better. Students earning grades below these standards will need to retake the courses to bring their grades within standards or they will be withdrawn from the program.

Program Sponsors/Advisors

OPNAV N2/6

Required Courses

CC3000 Command and Control
IO3100 Information Operations
IS3502 Network Operations I
SS3011 Space Technology and Applications

Network Operations and Technology-Technology (NWOT-TECH) - Academic Certificate in Network Operations and Technology-Technology - Curriculum 272

Program Officer

Steven J. Iatrou
Code IW/Is, Glasgow West, Room 3011

(831) 656-3770, DSN 756-3770
FAX (831) 656-3679
isoaa@nps.edu

Brief Overview

The NWOT-TECH academic certificate provides education in the fundamentals of network systems technology. This education is essential to helping the Navy reach information superiority in the operational environment. It also offers advanced education in areas essential to enabling global networked communications, including: databases, systems analysis and design, decision support systems, and network security.

The NWOT-TECH academic certificate is provided through asynchronous Web-based media (i.e., the Internet) because the Navy recognizes that this education should be available to their personnel regardless of geographic limitations. If you have access to the Internet, you have access to tools necessary to help meet U.S. national security objectives in the information domain.

All courses in the NWOT-TECH academic certificate are graduate-level courses carrying full NPS academic credit. They provide the baseline for advanced education in essential disciplines in networking and information technology.

Requirements for Entry

Applicants must have earned a baccalaureate degree to be considered for admission.

Entry Date

Program entry dates are at the beginning of any quarter in the NPS academic year. These courses may be taken in any sequence and need not be taken in the same academic year.

Program Length

Four quarters.

NWOT-TECH Academic Certificate Requirements

To earn the NWOT-TECH academic certificate students must pass all four courses with a C+ (2.3 Quality Point Rating (QPR)) or better in each course and an overall QPR of 3.0 or better. Students earning grades below these standards will need to retake the courses to bring their grades within standards or they will be withdrawn from the program.

Program Sponsors/Advisors

OPNAV N2/6

Required Courses

CS3606 An Introduction to Information Systems Security
IS3200 Enterprise Systems Analysis and Design
IS3201 Enterprise Database Management Systems
IS3301 Fundamentals of Decision Support Systems

Fundamentals in Information Systems Technology (Electronically Delivered) (EFIST) - Curriculum 276

Program Officer

Steven J. Iatrou
Glasgow West, Room 3011

(831) 656-3770, DSN 756-3770
FAX (831) 656-3679
isoaa@nps.edu

Brief Overview

This program has been designed to enhance students' knowledge of and productivity in the Navy's information technology fields. The courses are Web-based and will be delivered entirely online. They provide an introduction to the field of Information Technology Management and the functions and responsibilities of the information technology manager.

The programming course meets DoN's IT21 mandated standard, as a high-level, event-driven, object-oriented, programming language. Course emphasis is on planning, program development, graphical user interfaces, rapid prototyping, program construction, data types, operations, control flow, arrays, records, file I/O, database access, and event-driven OOP structures.

A fundamentals course focuses on the basics of computer networking. Since networking is an underpinning to our technology-driven forces, understanding the basics of computer networking is important to any technology professional interested in building a solid technology understanding, and is an essential precursor to other courses in the Information Systems and Information Technology arenas.

All courses in the eFIST academic certificate are undergraduate-level courses carrying full NPS academic credit. They provide the baseline for advanced education in essential disciplines in information technology.

Requirements for Entry

A bachelor's degree is not required. There are no prerequisites.

Entry Date

Contact the Program Manager.

Program Sponsors/Advisors

Naval Network Warfare Command (NETWARCOM), Navy Information Professional Center of Excellence (IPCOE), Naval Education and Training Command (NETC)

Required Courses

IS2000	Introduction to Information Technology
IS2020	Introduction to Object-Oriented Programming using Microsoft Visual Basic
IS2502	Network Fundamentals

Knowledge Superiority (KS) Academic Certificate in Information Systems and Operations - Curriculum 277

Program Officer

Mark E. Nissen, Ph.D.
Code 06/IS, Glasgow West
Room 2006

(831) 656-3570, DSN 756-3570
FAX (831) 656-3679
mnissen@nps.edu

Brief Overview

Knowledge is hailed widely as one of the very few, sustainable sources of competitive advantage for organizations in the Information Age. But knowledge is distributed unevenly through the enterprise, clumping noticeably in particular people, organizations, locations, and times of application. Getting knowledge to flow— from where and when it is located to where and when it is needed for action—represents an essential aspect of knowledge-based competition.

However, knowledge is distinct from information and data, and competing on a knowledge basis requires more than just setting up high-bandwidth computer networks, shunting great volumes of data bits around the world, and making large online information repositories broadly accessible. Although such network, data, and information steps are important for knowledge flows, they are clearly insufficient. Rather, flows of knowledge build upon flows of network signals, data, and information, as knowledge— particularly tacit, experiential knowledge—resides principally in the minds of people and the routines of organizations. Hence, competing on a knowledge basis involves more than technology: it requires deft integration

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of people, processes, organizations, and technologies alike. This pushes knowledge-based competition beyond the limited, technical realm of many information sciences, and makes it a relatively challenging, but quintessentially effective basis for sustainable competitive advantage. The study of Knowledge Superiority focuses precisely on such sustainable, knowledge-based, competitive advantage.

The Knowledge Superiority Track develops and builds upon technical systems understanding in networks, databases, systems analysis, decision support systems, and like subjects, to develop a higher level design capability in students. To wit, students learn more than designing only technical systems: they learn to integrate such technical system designs into socio-technical system designs, the latter of which include people, processes, and organizations, in addition to technology. This higher level design capability enables graduates to escape the relatively narrow confines of purely technological jobs, and to support direct knowledge flows, attention focusing, and decision making at the highest levels of the military and government.

The Knowledge Superiority academic certificate is provided through asynchronous, Web-based media (i.e., the Internet) because DoD recognizes that this education should be available to their personnel regardless of geographic limitations. So, if students have access to the Internet, they have access to the tools necessary to help meet U.S. national security objectives in the information domain. All courses in the Knowledge Superiority academic certificate program are graduate-level courses carrying full NPS academic credit.

Requirements for Entry

Applicants must have earned a baccalaureate degree to be considered for admission and have completed fundamental college-level courses in databases and computer networks.

Program Length

Four Quarters

KS Academic Certificate Requirements

To earn the KS academic certificate you must pass all four courses with a C+ (2.3 Quality Point Rating (QPR)) or better in each course and an overall QPR of 3.0 or better. Students earning grades below these standards will need to retake the courses to bring their grades within standards or they will be withdrawn from the program.

Program Sponsors/Advisors

Naval Network Warfare Command (NETWARCOM), Navy Information Operations Command (NIOC), Naval Education and Training Command (NETC)

Required Courses

The curriculum consists of two core courses and two electives.

Core Courses:

IS3210	Issues in Defense Knowledge & Information Management
IS4210	Knowledge Superiority*

Elective Courses:

CC3000	Command Control Communication Computer and Intelligence Systems in DoD
CS3606	An Introduction to Information System Security
IO3100	Information Operations
IS3200	Enterprise Systems Analysis and Design
IS3201	Enterprise Database Management Systems
IS3301	Computer-Based Tools for Decision Support
IS3302	Database Management for Decision Support
IS3502	Network Operations I
IS4201	Enterprise Database Management
IS4301	Data Warehousing, Mining & Visualization
SS3011	Space Technology and Applications

Information Systems and Operations - Curriculum 356

This curriculum is closed to new admissions. Previous catalog descriptions of this curriculum are found in the Past Edition Archives at this link:

http://www.nps.edu/Academics/Admissions/Registrar/AcademicCatalog

Program Officer

David Roberts, LCDR, USN
Glasgow West, Room 3009

(831) 656-3670, DSN 756-3670
FAX (831) 656-3675
derobert@nps.edu

Joint Command, Control, Communications, Computers, and Intelligence (C4I) Systems - Curriculum 365

Program Officer

Jim Robinette, CDR, USN
Glasgow West, Room 2012

(831) 656-2433, DSN 756-2433
wjrobine@nps.edu

Academic Associate

Steven J. Iatrou
Glasgow West, Room 3011

(831) 656-3770, DSN 756-3770
FAX (831) 656-3679
sjiatrou@nps.edu

Brief Overview

The Joint C4I curriculum is designed to meet broad educational objectives endorsed by the Joint Chiefs of Staff. The overall objective is to provide officers and DoD civilian equivalents, through graduate education, with a comprehensive operational and technical understanding of the field of C4I systems as applied to joint and combined military operations at the national and unified command levels. The program is designed with the following goals: enable individuals to develop an understanding of the role C4I systems play in the use of military power and the ability to interpret the impact of C4I on operating philosophy; provide adequate background knowledge in basic technology, human capabilities, and joint military operations and how these factors are exploited in current C4I systems; and provide the framework whereby students can perform requirement and planning studies of new C4I systems and contribute to crisis management. This curriculum is sponsored by the Headquarters USMC, Director of Command, Control, Communications, and Computers (C4).

These officers should be able to undertake a wide range of assignments in C4I (both joint and intra-service) over the full span of their careers.

Requirements for Entry

The Joint C4I curriculum is open to all U.S. military services and selected civilian employees of the U.S. Government. Admission requires a baccalaureate degree with above-average grades and mathematics through differential and integral calculus. Eligibility for a TOP SECRET security clearance with access to SPECIAL COMPARTMENTED INFORMATION (SCI) is required. An academic profile code (APC) of 334 is required for direct entry. Officers not meeting the APC may be admitted based on transcript reviews by the Director of Admissions and the Program Officer.

Entry Date

Joint C4I Systems is a seven-quarter course of study with a single entry date in October. If further information is needed, contact the Academic Associate or the Program Officer.

Degree

Requirements for the Master of Science in Systems Technology (Joint Command, Control, and Communications (C3)) degree are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

Master of Science in Systems Technology (Command, Control, and Communications)

The Master of Science in Systems Technology (Joint C3) degree will be awarded at the completion of the appropriate interdisciplinary program carried out in accordance with the following degree requirements:

· Completion of a minimum of 45 quarter-hours of graduate-level work in four different academic disciplines, of which at least 15 hours must represent courses at the 4000 level in at least two of the disciplines.
· Within the course program there must be a specialization sequence consisting of at least three courses.
· In addition to the 45 hours of course credit, an acceptable thesis must be completed.
· The program must be approved by the Chairman, Information Sciences Department.

Subspecialty

None.

Typical Course of Study

Quarter 1

CC3000	(4-0)	Introduction to Command and Control
IS3001	(4-1)	Computer and Software Technology
NW3230	(4-2)	Strategy and Policy
MO1901	(3-0)	Mathematics

Quarter 2

CC3101	(4-0)	Combat Analysis for C4I
IS3502	(3-2)	Network Operations I
OS3105	(4-0)	Statistics for Technical Management
CS3600	(4-2)	Introduction to Computer Security
EO2513	(4-2)	Introduction to Communication Systems Engineering

Quarter 3

IW3101	(4-1)	Introduction to Information Warfare
OS3008	(4-0)	Analytical Planning Methodology
PH3052	(3-0)	Sensors
EO3513	(4-2)	Communication Systems Engineering

Quarter 4

CC4101	(4-2)	Systems Engineering for Joint C4I
SS3011	(3-2)	Space Systems
IS3302	(3-0)	Database Management for Decision Support
EO4513	(4-2)	Communication Systems Analysis

Quarter 5

SS3613	(3-0)	Military Satellite Communications
CC0810	(0-4)	Thesis Research for C4I Students
	(4-0)	Emphasis Elective

Quarter 6

CC4103	(2-4)	Joint C4I Systems
MN3331	(5-0)	Acquisition and Program Management
CC0810	(0-4)	Thesis Research for C4I Students
	(4-0)	Emphasis Elective

Quarter 7

CC4913	(4-0)	Policies and Problems in Joint C4I
CC0810	(0-8)	Thesis Research for C4I Students
	(4-0)	Emphasis Elective

Educational Skill Requirements (ESR) Joint Command, Control, Communications, Computers, and Intelligence (C4I) Systems Curriculum - 365

The graduate shall be able to:

1. **Technologies**: Develop adequate background knowledge to evaluate and apply current and emerging technologies to include digital and analog communications systems; application, database and network architecture and topology; maritime, ground, aerial and space-based platforms and sensors; and human and system interfaces; to conduct operational assessments.

2. **Systems Engineering and Analysis**: Perform systems engineering studies; develop operational, technical, and systems architectures to support a C4I enterprise; integrate systems including mission requirements determination; conduct experimental design including modeling, simulation and quantitative analysis of the results; evaluate human-in-the-loop C4I systems; analyze current and emerging C4I technologies and architectures with respect to assured information delivery, availability and protection, with an awareness of attack and exploitation capabilities; understand and apply standard and alternative acquisition process.

3. **Joint C4I**: Understand the joint, coalition and interagency C4I enterprise, including concepts, policies, doctrine, processes, and organizational design; apply current and emerging joint C4I technologies and architectures; understand the employment and effects of combined operations to include operations within the cyber domain.

4. **Strategy and Policy**: Develop a graduate-level ability to think strategically, critically analyze past military campaigns, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's policies and goals and the ways military power may be used to achieve them.

5. **Practice**: Demonstrate the ability to conduct independent analysis of a joint, coalition or interagency C4I enterprise, and the proficiency to present the results in writing and orally by means of a thesis and a command-oriented briefing.

Curriculum Sponsor and ESR Approval Authority

Director, C4 Systems (J6); Director, Space and Electronic Warfare (N6); June 1997.

Information Systems and Technology - Curriculum 370

Program Officer

Jim Robinette, CDR, USN
Glasgow West, Room 2012

(831) 656-2433, DSN 756-2433
wjrobine@nps.edu

Academic Associate

Glenn R. Cook
Glasgow West, Room 3012

(831) 656-2778, DSN 756-2778
FAX (831) 656-3679
grcook@nps.edu

Brief Overview

The Information Systems Technology curriculum is part of the larger Information Sciences, Systems, and Operations (ISSO) discipline. The ISSO curricula consist of the Professional Practice Core and seven degree tracks: Computer Sciences; Joint C4I Systems; Information Systems and Technology; Information Warfare; Intelligence Information Management; Modeling, Virtual Environments, and Simulation; and Space Systems Operations. The Professional Practice Core consists of material in Information Sciences and Technology;

Command and Control; C4ISR Systems; Acquisition; C4ISR System Evaluation; Information Operations/Warfare; and Enterprise Policy, Strategy, and Change. This specialization satisfies the ISSO Educational Skill Requirements as established by CNO-N61.

This curriculum provides officers with knowledge of information systems technology to include computer and telecommunications systems, software engineering, networked and distributed applications, database management systems, and decision support systems in the military services. Students will also gain proficiency in information systems, economics, and management necessary for the critical management decisions needed in the development and utilization of complex and evolving computer-based military systems.

Information Systems Technology is an interdisciplinary, graduate-level, master's program integrating mathematics, accounting, economics, statistics, computer science, information systems, communications engineering, networks, and management disciplines. This curriculum is sponsored by the Headquarters USMC, Director of Command, Control, Communications, and Computers (C4).

Requirements for Entry

A baccalaureate degree, or the equivalent, with above-average grades in mathematics (including differential and integral calculus) resulting in an academic profile code (APC) of at least 325 is required for direct entry. Students lacking these quantitative prerequisites may be acceptable for the program, through a twelve-week refresher, providing their undergraduate records and/or other indicators of success, such as the Graduate Record Examination (GRE) or Graduate Management Admission Test (GMAT), indicate a capability for graduate-level work. While previous computer, communications, or information systems experience is certainly helpful, it is not essential. International students should refer to the Admissions section for current TOEFL and entrance requirements.

Entry Date

Information Systems Technology is an eight-quarter course of study with entry dates in March and September (Spring and Fall Quarters). Those requiring the twelve-week refresher will begin study prior to those entry dates. If further information is needed, contact the Academic Associate or Program Officer for this curriculum.

Degree

Requirements for the Master of Science in Information Technology Management degree are met as a milestone en route to satisfying the Educational Skill Requirements established by the curricular program's sponsor.

Master of Science in Information Technology Management

The Master of Science in Information Technology Management degree will be awarded at the completion of the appropriate interdisciplinary program in Curriculum 370. The Master of Science in Information Technology Management requires:
· Completion or validation of core courses in each of the following disciplines:
  · Information Systems
  · Computer Science
  · Electrical and Computer Engineering
  · Systems Management
· Completion of a minimum of 52 hours of graduate-level courses, at least 20 hours of which are at the 4000 level.
· Completion of an acceptable thesis.
· Approval of the candidate's program by the Chairman, Information Sciences Department.

Subspecialty

Completion of this curriculum qualifies a Navy officer as an Information Technology Management Subspecialist with a subspecialty code of 6201P. Other services have analogous coding. The curriculum sponsor is the Commander, Naval Network Warfare Command.

Typical Subspecialty Jobs

CO/XO, Naval Computer and Telecommunication Station/Master Station
Staff Comm/Fleet Communications Officer, Numbered Fleets
Information Systems Officer, USS George Washington
ADP Plans Readiness Assessment Officer, COMNAVSURFLANT
ADP Systems Officer, Director Strategic Systems Procedure
SNAP System Officer, SPAWARSYSCOM
OIC, NAVMEDINFORMGMTCENDET
Data Base Management Officer, Naval Security Group
Plans and Programs, COMNAVCOMTELCOM

Typical Course of Study

Quarter 1

Course	Hours	Title
IS3201	(4-2)	Enterprise Database Management Systems
CS3600	(4-2)	Introduction to Computer Security
IS3200	(3-2)	Enterprise Systems Analysis and Design
OS3105	(4-1)	Statistical Analysis for Management I

Quarter 2

CC3000	(4-0)	Introduction to Command and Control
IS4925	(V - V)	Special Topics in Information Systems
IS3502	(3-2)	Network Operations I
NW3230	(4-2)	Strategy & Policy: The American Experience

Quarter 3

MO1901	(3-0)	Mathematics for ISSO
IS3301	(3-2)	Computer-Based Tools for Decision Support
MN4125	(4-0)	Managing Planned Change in Complex Organizations
NW3275	(4-0)	Joint Maritime Operations (Part 1)

Quarter 4

IS3202	(3-2)	Thin-Client Database Systems Development
IS3333	(0-2)	Introduction to Thesis Research
EO3502	(4-0)	Telecommunications Systems Technology
NW3276	(4-0)	Joint Maritime Operations (Part 2)
Track	Course	Track Specialization #2

Track Specialization Course 1

Quarter 5

IW3101	(4-1)	Introduction to Information Warfare
IS4031	(4-0)	Economic Evaluation for Enterprise Technology Investments
NW3285	(4-0)	National Security Decision Making
Track	Course	Track Specialization #2

Track Specialization Course 2

Quarter 6

IS0810	(0-8)	Thesis Research
CC4250	(4-0)	Enterprise Architecture
IS4220	(3-2)	Technology Enabled Process Improvement
Track	Course	Track Specialization #3

Track Specialization Course 3

Quarter 7

IS4300	(3-2)	Project Management for Enterprise Systems
IS0810	(0-8)	Thesis Research
IS4182	(4-0)	Enterprise Information Systems Strategy and Policy
MN3331	(5-1)	Principles of Acquisition and Program Management

Quarter 8

SS3011	(3-0)	Space Technology and Applications
IS0810	(0-8)	Thesis Research
IS0810	(0-8)	Thesis Research
MN3154	(3-0)	Financial Management in the Armed Forces

Each student in the Information Systems and Technology Curriculum will choose a specialization track no later than the start of the third quarter of study. Current track specializations offered by the Information Sciences Department are:

Network Management Track

Prerequisites

IS3502	Network Operations I
CS3502	Computer Communications and Networks

Network Track Courses (Choose 3)

CS3690	Network Security
IS4926	Network Operating Centers
IS4188	Collaborative Technologies
IS4925	Special Topics in Information Systems

Other Supporting Courses

CC4250	Enterprise Architecture

Information Assurance Track

Prerequisite

CS3600	Introduction to Computer Security

Information Assurance Track Courses

CS3670	Information Assurance: Secure Management of Systems
CS3695	Internet Security Resources and Policy
CS3690	Network Security

Communications Systems Engineering Track

Prerequisite

MO1901	Mathematics for ISSO

Communications Systems Engineering Track Courses

EO2513	Introduction to Communications Systems Engineering
EO3513	Communications Systems Engineering II
EO4513	Communications Systems Analysis

Other Requirements

Remove from Matrix:

EO3502	Telecommunications Systems Engineering

Add to Matrix:

PH3052	Physics of Space and Airborne Sensor Systems (USN) or
SS3613	Military Satellite Communications (USMC)

Software Engineering Track

Prerequisites

IS4300	Software Engineering/ Project Management

**Software Engineering Track Courses
(Choose 3)**

SW3460   Software Methodology
SW4500   Introduction to Software Engineering
SW4530   Software Engineering R&D in DoD
SW4591   Requirements Engineering

Students with a strong educational or experience background in information systems or computer science may be eligible to validate certain requirements. Students who have validated certain courses will be required to substitute additional courses into their educational plan. These courses may include additional courses of study within their specialization track or other courses offered within the Information Sciences Department or other related fields of study. The Academic Associate and the Program Officer must approve all changes to the matrix.

Educational Skill Requirements (ESR) Information Systems Technology - Curriculum 370 Subspecialty Code: 6201P

The Information Systems Technology graduate shall have the knowledge, skills, and competencies to engineer information systems afloat and ashore; manage information systems, centers, and commands afloat and ashore; and solve information systems engineering and management problems individually and in teams. These general Educational Skill Requirements are supported by the following topical Educational Skill Requirements.

1. **Strategy and Policy**: Graduates will develop an ability to think strategically, analyze past operations, and apply historical lessons to future joint and combined operations, in order to discern the relationship between a nation's political interests and goals and the ways military power may be used to achieve them. This requirement is fulfilled by completing the first of three Naval War College courses leading to Service Intermediate-level Professional Military Education (PME) and Phase I Joint PME credit. (Required only for USN and USMC students.)

2. *Space, Information Warfare and Command and Control Professional Practices*: The officer shall possess skills in the ISSO core subject areas of Science and Technology (Information Technology, Communications, Space, and Sensors), Analysis and Evaluation (Statistics, Operations Analysis, and System Evaluation), Operations Information Management and Systems (C2, C4ISR, Information Operations, and Acquisition Management).

3. **Software Development**: The officer must have a thorough knowledge of modern software development to include: an understanding of the software development process; the ability to plan and implement a major programming project and develop the appropriate documentation; the ability to utilize object-oriented techniques in system design; and the ability to use modern software development tools in the construction of modeling, virtual environment, and simulation systems.

4. **Information Systems Technology**: The officer must have a thorough knowledge of information systems technology to include: computer system components, computer networks, communication systems and networks, software engineering, database management systems, decision support and expert systems.

5. **Information Systems Analysis and Management**: The officer must master the following concepts to effectively manage information system assets: managerial concepts, evaluation of information systems, systems analysis and design, management of information systems, adapting to technological, organizational, and economic changes, and military use of commercial telecommunications systems.

6. **Military Applications**: The officer must be able to combine analytical methods and technical expertise with operational experience for effective military applications to include: DoD decision-making process on information systems, information technology acquisition management, DoD computer and telecommunications, C4ISR, and C2W.

7. **Independent Research**: The graduate will demonstrate the ability to conduct independent research analysis, and proficiency in communicating the results in writing and orally by means of a thesis and a command-oriented briefing. The research in information technology and its management will include problem formulation, decision criteria specification, decision modeling, data collection and experimentation, analysis, and evaluation.

Curriculum Sponsor and ESR Approval Authority

Director, Space, Information Warfare, Command and Control Directorate, OPNAV (N6), March 2000.

Doctor of Philosophy in Information Sciences - Curriculum 474

Program Manager

Dan C. Boger, Ph.D.
Glasgow West, Room 3005

(831) 656-3671, DSN 756-3671
FAX (831) 656-3679
dboger@nps.edu

Academic Associates

Thomas Housel, Ph.D.

Root Hall, Room 239

(831) 656-7657, DSN 756-7657
FAX (831) 656-3679
tjhousel@nps.edu

Alex Bordetsky, Ph.D.
Root Hall, Room 225

(831) 656-2287, DSN 756-2287
FAX (831) 656-3679
abordets@nps.edu

Brief Overview

The Department of Information Sciences at the Naval Postgraduate School will award the Doctor of Philosophy in Information Sciences degree as a result of meritorious and scholarly achievement in a particular field of information sciences (IS). This program includes course work, scholarly socialization, written and oral examinations, research, and a written dissertation. A candidate must exhibit scholarly application to the entire course of study, achieve a high level of scientific advancement, and establish ability for original investigation leading to the advancement of fundamental knowledge.

IS broadly encompasses the design, implementation, use, promotion and evaluation of organizations, processes and systems associated with knowledge, information, data and communication. It includes areas of concentration in information systems, information technology, information warfare, information operations, and command and control.

The study of IS is multidisciplinary, and no single theory or perspective dominates the field. In general, the field can be divided into technical and behavioral approaches. The technical approach to IS emphasizes mathematically based, normative models to study capabilities of systems and processes, in addition to emphasis on the technological artifacts that enable and support organizations, processes and systems associated with knowledge, information, data and communication. The behavioral approach to IS emphasizes behavioral problems associated with design, implementation, use, promotion and evaluation of organizations, processes and systems associated with knowledge, information, data and communication. A great part of IS research involves integrating these two, complementary approaches.

The Ph.D. in Information Sciences prepares scholars to conduct original research that contributes new knowledge in the domain of information systems, information technology, information warfare, information operations, or command and control. With such ability to conduct original research and contribute new knowledge, the IS Ph.D. helps to prepare scholars also to teach effectively.

Requirements for Entry

U.S. military officers, foreign military officers, U.S. Government civilians, and employees of foreign governments may apply. Applications should begin with the Office of Admissions (see www.nps.edu/admissions/index.html). In addition to a completed application form, the complete application should include: an application letter describing your general background, your interests and experience in research, and your career goals; Official or Certified copies of all academic transcripts; results of a GRE general examination taken within the past five years; and letters from three references relating to your suitability to pursue a doctoral degree. These materials should be sent directly to the Admissions Office. Foreign students who are not native speakers of English must provide scores from the Test of English as a Foreign Language (TOEFL) examination.

An applicant should have a master's degree in any Information Sciences Department program or in a closely related field from another NPS school or civilian institution. Generally, an acceptable Ph.D. applicant must have above-average grades (GPA > 3.5) in a typical master's degree program. The Ph.D. Committee will also take other evidence of research or academic ability into account in making a recommendation as to whether to admit an applicant. Final acceptance will be based on the professional discretion of the Chairman, Ph.D. Committee.

Entry Date

The Ph.D. Program Committee will evaluate each applicant to gauge the minimum amount of time the applicant will need to complete the program (normal time is three years of full-time study). The Information Sciences Department may impose the condition that the applicant obtain authorization for at least four years to complete the Ph.D. Admitted Ph.D. students may begin in any quarter.

Program of Study

Each student's Doctoral Committee will guide the student in designing a program suitable for his/her special interests and background, alert them to opportunities both within the Department of Information Sciences and other departments at NPS, and monitor the student's progress.

The doctoral program is based on a core of courses designed to provide the student with the broad knowledge, analytic skills, and proficiency in research methods necessary for advanced course work and dissertation research. Additional course work in application areas may be required and is based on the discretion of the student's primary advisor.

Core Courses

IS4700	(4-0)	Introduction to the Philosophy of Sciences

IS4710	(3-2)	Qualitative Methods for Research
IS4720	(3-2)	Quantitative Methods for Research
IS4730	(3-2)	Design of Experiments for Research
IS4790	(0-3)	Topical I

Students who have taken the equivalent of these courses may waive one or more of these core requirements by the Departmental Ph.D. Committee.

Sample Ph.D. Program in Information Sciences

First Year: Complete the core program course and residency requirements for the Ph.D. program. Complete additional course work in accordance with the student's specific program requirements. Have a faculty advisor for course work appointed.

A diagnostic review will be conducted following the first year of study. The review will consider indicators of scholastic achievement, including performance in master's- and Ph.D.-level courses, as well as other indicators deemed appropriate by the examining faculty. The review culminates in a formal report to the Chairman of the Departmental Ph.D. Committee; includes a recommendation as to whether or not the student should continue in the program; and, if so, makes recommendations regarding how the student can improve his or her performance. A professor from the student's chosen academic unit then discusses the report with the individual, making a careful assessment of demonstrated strengths and weaknesses in order to help the student to progress more effectively.

Second Year: Finish course requirements, and prepare for the Written and Oral Qualifying Examinations. Take Qualifying Examinations, in residence, near the middle of the second year. Upon successful completion of both examinations, the student will establish a Dissertation Committee, defend a dissertation proposal, and then advance to candidacy. Students who fail either of the qualifying examinations can petition the Departmental Ph.D. Committee Chair for one additional attempt at passing it.

Third Year: Concentrate primarily on dissertation research, with perhaps a course or two related to the dissertation.

The dissertation culminates the student's academic endeavors. Working closely with faculty members from his or her committee during all phases of research, the student is expected to complete a dissertation of substantial magnitude, and to make a significant contribution to the advancement of knowledge in the Information Sciences field. It should be of sufficient originality and quality to merit publication, either in whole or in part, in a scholarly journal.

The dissertation is defended, in residence, at a final oral examination. It must be completed and accepted within five years of advancement to candidacy. The dissertation defense is held before an examination committee, and is open to the public. The defense will normally consist of a one-hour public segment and a one-hour private segment, but should, in no case, exceed two hours in length.

The pursuit of the Ph.D. is both challenging and rewarding. A Ph.D. is not a more in-depth version of the Master's Degree. It requires high-level, integrative, critical thinking; extended, independent research; self-motivated effort; and a commitment to expand one's perspective of the world. It is difficult to assess one's likelihood of success based on previous academic or professional performance. Applicants should be aware that admission to the program does not guarantee completion. It is anticipated that a number of candidates will not be allowed to continue after the diagnostic review (approximately one year), and that a number of candidates will self-select out of the program throughout its various stages. Applicants should seriously consider the effort that will be required for successful completion prior to applying.

Network Operations and Technology - Curriculum 386

Program Officer

Jim Robinette, CDR, USN
Glasgow West, Room 2012

(831) 656-2433, DSN 756-2433
wjrobine@nps.edu

Academic Associates

Glen R. Cook
Glasgow West, Room 3012

(831) 656-2778, DSN 756-2778
FAX (831) 656-3679
grcook@nps.edu

Alex Bordetsky, Ph.D.
Root Hall, Room 225

abordets@nps.edu

Brief Overview

The Network Operations and Technology (NWOT) is an interdisciplinary, graduate-level, master's program integrating the study of military operations, decision making, information networks and systems, and computer science.

The NWOT program is designed to provide the broad base of knowledge needed to assist in fighting and winning America's wars in today's networked environment. The curriculum consists of a professional practice core of courses and specialization tracks of study in decision superiority, network operations, and information systems management. The academic core consists of study in

military operations in the information environment, command and control, web services, network operations, enterprise strategies and policy, and managing process change. The specialization tracks are designed to provide students and opportunity to explore specific areas of interest to the Navy.

Requirements for Entry

A baccalaureate degree or the equivalent resulting in an academic profile code (APC) of at least 344 is required for direct acceptance into the program. Students not meeting the minimum APC may be considered for admission following review of their past academic performance.

Entry Date

Network Operations and Technology is a six-quarter course of study with an entry date in September of each year.

Degree

The Master of Science in Network Operations degree will be awarded after successful completion of an approved matrix of courses and research under the following guidelines:
- Completion of a minimum of 36 quarter-hours of core graduate course work, of which 12 quarter hours must be at the 4000 level.
- In addition to these 36 hours of core work, students must complete an approved specialization sequence of courses in one of the following areas:
  - Decision Superiority
  - Network Operations
  - Information Systems Management
- Complete an acceptable thesis or research project approved by the Chairman, Information Sciences Department.

Subspecialty

Completion of this curriculum qualifies a Navy officer for the 6209P (proposed) subspecialty.

Core Course of Study

The following courses are core to the NWOT degree and are required for all tracks:

CS3600	4-2	Introduction to Computer Security
IS3001	3-0	Information Sciences for Defense
IS3201	4-2	Enterprise Database Management Systems
IS3301	3-2	Computer Based Tools for Decision Support
IS3330	3-0	Research Methods for Information Sciences
IS3502	4-2	Network Operations I
IS4220	3-2	Technology Enabled Process Improvement
IS44410	4-0	Policies and Problems in Information Dominance
IS4926	4-0	Network Operating Centers
NW3230	4-2	Strategy and War (naval personnel only)
IS0810	0-8	Thesis Research (taken three times)

In addition to the core courses students must complete one of three approved curriculum tracks consisting of the following courses (or their equivalent) as appropriate for each track:

Decision Superiority (DS):

IW3101 or	4-0	Military Operations in the Information Environment
CC3000	4-0	Command and Control
SS3011	3-0	Space Technology and Applications
MR2416	2-0	Meteorology for EW
IS3450	2-0	RF and EW Theory and Applications
IS3460	3-0	Autonomous Vehicles and Industrial Control Systems
IS3210	4-0	Information and Knowledge Management Issues for Defense
IS3410	4-0	Communications Architectures; Strategic-Tactical-Cyber
IS4210	3-0	Knowledge Superiority
OA3411	3-0	Introduction to Human Systems Integration

Completion of JPME (in addition to NW3230 listed in the core):

NW3275	Joint Military Operations I
NW3276	Joint Military Operations II
NW3285	Theater Security Decision Making

Network Operations (NETOPS):

IW3101 or	4-0	Military Operations in the Information Environment
CC3000	4-0	Command and Control
SS3011	4-0	Space Technology and Applications
MR2416	2-0	Meteorology for EW
IS3450	2-0	RF and EW Theory and Applications
IS3460	3-0	Autonomous Vehicles and Industrial Control Systems
CC4250	4-0	Enterprise Architecture
IS4182	4-0	Enterprise Information Systems Security Strategy and Policy
IS4300	3-2	Project Management for Enterprise Systems
IS4505	3-2	Wireless Network Operations

Completion of JPME (in addition to NW3230 listed in the core):

NW3275	Joint Military Operations I
NW3276	Joint Military Operations II
NW3285	Theater Security Decision Making

Information Systems Management (ISM):

IW3101 or	4-0	Military Operations in the Information Environment
CC3000 or	4-0	Command and Control
SS3011	4-0	Space Technology and Applications

CC4250	4-0	Enterprise Architecture
CS3030	4-0	Computer Architecture and Operating Systems
IS3200	3-2	Enterprise Systems Analysis and Design
IS3202	4-2	Thin Client Database Systems Development
IS4031	4-0	Economic Evaluation for Enterprise Technology Investments
IS4182	4-0	Enterprise Information Systems Security Strategy and Policy
IS4300	3-2	Project Management of Enterprise Systems
IS4505	3-2	Wireless Network Operations
MN3331	5-1	Principles of Acquisition and Program Management
MN3154	3-0	Financial Management in the Armed Forces

Educational Skill Requirements (ESR)
Network Operations and Technology - Curriculum 386
Subspecialty Code: 6209P - (Proposed)

Core Curriculum Requirements:

Graduates will be able to identify and describe theories and concepts associated with data, information, information systems and networks (human and technological). Students will demonstrate the ability to apply theories and technology associated with the physical, information and cognitive domains to enhance and improve military operations. Graduates will possess domain specific knowledge in Network Operations and the theories and technologies that enabled networked military operations. This includes but is not limited to the ability to:
· Optimize C2 systems configurations to align with changes in the operational environment
· Understand the critical nature of information in military planning and operations
· Develop alternate configuration plans to cope with:
    · Anti-access/area denial and limited bandwidth, emission control, satellite loss and other C2-challenging situations
    · An intruded, degraded or compromised network environment
    · Varied terrestrial, celestial and meteorological environments
    · Prioritize information needs across the continuum of operations
    · Develop and apply operational and contingency plans for usage and defense of information and information systems, and information assurance

· Develop communications plans that exploit the full Radio Frequency (RF) and Electro Magnetic Spectrum (EMS) including communications activities operating in and through space.

Graduates will be able to compare and evaluate existing, emerging and innovative technological and theoretical approaches to military operations in terms of how information is acquired, encoded, stored, transmitted, managed, protected, displayed, and ultimately used.

Graduates will be able to evaluate and critique existing information policies, procedures and doctrine affecting military operations, and propose alternatives to seize and maintain information advantage. Graduates will support these proposals by identifying their impact across the spectrum of military operations.

Students will demonstrate their ability to incorporate concepts learned in each of the aforementioned skill requirements by choosing either a group research project or individual thesis to complete prior to graduation. In addition to completing a written project report or individual thesis, each student will demonstrate knowledge and skills through an oral presentation of their research.

Graduates will be able to relate information theories and information systems technologies to current and emerging human interfaces, operations, systems and underlying technologies of military C2 systems.

All students will receive a common core of instruction, and complete one of three tracks of specialization in Network Operations, Decision Superiority, or Information Systems Management. Specific common core areas of study include but are not limited to:
· Networking (cloud computing concepts, large data management, RF-based and mobile) theory and applications
· Assured C2
· Cybersecurity and Information Assurance (IA) theory and applications
· Network, Enterprise, System and related user security
· Satellite and space communications systems
· Ship, Shore, Expeditionary, and National (e.g., GIG) RF theory and applications
· Analytical Decision Making Process Change Management

Specialization Tracks Requirements:
· Decision Superiority: This track will focus on the mastery of data, information, knowledge and insights as fundamental to decisions. Students will examine tools, concepts of operation and practices that enable better informed and faster decisions throughout the range of military operations. Graduates will have a grasp of military C2, networks, knowledge

management, human machine interface, technology change management, operations centers and use of information in warfare and information as warfare, to be able to apply problem solving skills to achieve mission objectives in GIG operational scenarios, to include a denied or compromised environment. This will include knowledge of RF spectrum utilization in all military environments and phases of operation; unmanned, autonomous and unattended sensors and platforms; and industrial control systems.

· Network Operations: This track will focus on technology employment and integration in operations. It emphasizes instruction on systems and technology architectures: design, protection, management and operation of cyber systems and the DoD GIG as they apply to military operations. Students will have knowledge of networks and their components, applied to all operational areas, in all environments (land, undersea, sea, air, space and cyberspace), at unclassified and classified levels, and understand and be able to employ the network as an agile warfighting system. This will include knowledge of RF spectrum utilization in all military environments and phases of operation; unmanned, autonomous and unattended sensors and platforms; and industrial control systems.

· Information Systems Management: This track will focus on the acquisitions and program management of information technology in support of sustainment to global and collaborative military operations.   Students will examine acquisition methods/policies, enterprise investment strategies, change management considerations, system analysis, analytics, and intelligent design.   Graduates will understand how to develop appropriate technical and acquisition documentation based on policy and best practices, perform financial, cost-benefit and trade-off analysis, and perform required lifecycle planning, programming, and budgeting actions for an Information Technology enterprise that keeps pace with our National Security Strategy.

Curriculum Sponsor and ESR Approval Authority

Deputy Chief of Naval Operations for Information Dominance/Director of Naval Intelligence OPNAV (N2/N6). July 2012.

Master of Science in Remote Sensing Intelligence - Curriculum 475

Program Manager

Richard Christopher Olsen, Ph.D.

Code PH, Spanagel Hall, Room 103

(831) 656-2019, DSN 756-2019
FAX (831) 656-2834
olsen@nps.edu

Brief Overview

The Master of Science in Remote Sensing Intelligence curriculum focuses on improving the technical skills of the intelligence image analyst, allowing them to address more sophisticated problems and make use of the newest available technology. The student will develop a deeper understanding of how imagery is acquired, processed, and exploited as part of the intelligence cycle. The degree program requires a research thesis which explores, evaluates or develops new or significant contributions to the Remote Sensing field. Curriculum focus is on foundation technical skills, different Remote Sensing technologies currently available for imagery, processing techniques, and intelligence applications.

Requirements for Entry

A baccalaureate degree or the equivalent resulting in an academic profile code (APC) of at least 234 is required for acceptance into the program. TOP SECRET security clearance with access to SPECIAL COMPARTMENTED INFORMATION (SCI) is also required (eligibility only required to apply and be accepted to the program. However, it must be cleared and granted prior to beginning coursework). Additional specific pre-requisite classes are college level Linear Algebra (equivalent to MA2043) and a college level Basic Physics sequence (calculus level not required); and a basic course in computer programming.

Entry Dates

The MS-RSI is a four quarter course of study with a start date at the beginning of the academic year, October session.

Degree

Master of Science in Remote Sensing Intelligence

The degree of Master of Science in Remote Sensing Intelligence will be awarded at the completion of the appropriate interdisciplinary program in Curriculum 475. The Master of Science in Remote Sensing Intelligence requires:

· Completion or validation of core courses in each of the following disciplines: Information Systems, Computer Science, Physics, Space Systems and National Security;

· Completion of the approved and required course sequence, with alternate courses approved by the Program Manager, a total of 43 graduate level credits;

· Completion of an acceptable thesis; and

· Approval of the candidate's program by the Chairman, Information Sciences Department.

The MS-RSI students will satisfy these degree requirements using the following approved courses or approved alternates:

SS3011	(3-0)	Space Technology and Applications
SS3001	(3-2)	Military Applications of National Space Systems (TS/SCI)
NS3159	(4-0)	Principles of Joint Operational Intelligence (TS/SCI)
CS4330	(3-2)	Video Imaging and Surveillance (Photogrammetry possible substitution)
OS3180	(4-1)	Probability and Statistics
PH3052	(4-0)	Physics of Space and Airborne Sensor Systems
IS4052	(3-2)	Imaging Spectrometry Theory, Analysis and Applications
IS4053	(3-2)	Spectral and Polarimetric Tools and Analysis Techniques TS/SCI
IS4054	(3-1)	Analysis Techniques for Passive Imaging Systems TS/SCI
IS4055	(3-1)	Analysis Techniques for RADAR Imaging Systems
IS4060	(3-2)	Analysis Techniques for Laser Imaging Systems (LiDAR) Confidential

Curriculum Sponsor and ESR Approval Authority

National Geospatial-Intelligence Agency

Information Warfare - Curriculum 595

Program Officer

Jim Robinette, CDR, USN
Glasgow West, Room 2012

(831) 656-2433, DSN 756-2433
wjrobine@nps.edu

Academic Associate

Steven J. Iatrou
Glasgow West, Room 3011

(831) 656-3770, DSN 756-3770
FAX (831) 656-3679
sjiatrou@nps.edu

Brief Overview

Graduates of this curriculum are thoroughly knowledgeable in Information Operations (IO) and Information Warfare (IW). They receive a Master of Science in Information Warfare Systems Engineering (MSIWSE) degree that provides the services with officers who are well versed in the technical, theoretical, and operational aspects of interdisciplinary IO/IW as they relate to joint mission objectives in modern warfare. This curriculum is sponsored by the Headquarters USMC, Director of Strategy and Plans.

Requirements for Entry

A baccalaureate degree with above-average grades with courses in science and mathematics (through integral calculus) is required for entry. Additionally, applicants must have a minimum academic profile code (APC) of 324. Eligibility for TOP SECRET security clearance with access to SPECIAL COMPARTMENTED INFORMATION (SCI) is required for U.S. students. Applicants not meeting the mathematics requirements may be considered for entry via a refresher quarter.

Entry Date

The Information Warfare curriculum is an eight-quarter course of study with a single entry date in June. For further information, contact the Program Officer or Academic Associate for this curriculum.

Degree

Requirements for the MSIWSE degree are met en route to satisfying the Educational Skill Requirements of the curricular program.

Master of Science in Information Warfare Systems Engineering

The MSIWSE degree will be awarded at the completion of a multidisciplinary program in Curricula 595. The MSIWSE degree program has not been reviewed by the Engineering Accreditation Commission ABET. The MSIWSE requires:
· Completion of a minimum of 45 quarter-hours of graduate-level work, of which at least 15 hours must represent courses at the 4000 level, and in two (or more) discrete disciplines.
· Graduate courses in at least four discrete academic specialization sequences, minimum, and in two disciplines, a course at the 4000 level must be included.
· One Systems Engineering class.
· In addition to the 45 graduate hours of course work, an acceptable thesis must be completed.
· The candidate's program must be approved by the Chairman, Information Sciences Department.

Course of Study

Quarter 1

MA2121	(4-0)	Differential Equations
CS3030	(4-0)	Architecture and Operating Systems
IW3101	(4-1)	Introduction to Information Warfare
NW3230	(4-2)	Strategy & Policy: The American Experience

Quarter 2

MA3139	(4-0)	Fourier Analysis and Partial Differential Equations
OS3104	(4-0)	Statistics for Science and Engineering
CS3600	(4-2)	Introduction to Computer Security
EO2652	(4-1)	Field, Waves, and Electromagnetic Engineering

Quarter 3

DA3101	(4-0)	Warfare in the Information Age
EO2512	(4-2)	Introduction to Communications & Countermeasures
EO3602	(4-2)	Electromagnetic Radiation, Scattering and Propagation
IW3921	(2-0)	IO Targeting I
IW3922	(1-2)	IO Targeting II

Quarter 4

EO4612	(4-2)	Microwave Devices and Radar
IW4925	(4-2)	Advanced Targeting
EO3512	(4-1)	Telecommunications Engineering
IW3502	(4-2)	Information Warfare Networks

Quarter 5

IW4505	(3-2)	Wireless Networking
EO4512	(3-2)	Communications and Countermeasures
CS3675	(3 -2)	Network Vulnerability
IW4950	(3 -2)	Advanced Information Warfare Systems

Quarter 6

CS3690	(4-2)	Network Security
EC3760	(3-2)	Information Operations Systems
IW4500	(3-2)	Information Warfare Systems Engineering
IW0810	(0-8)	Thesis Research for IW Students

Quarter 7

	(4-0)	Approved Elective
IW3301	(3-2)	IW Influence Models
DA4106	(4-0)	Trust, Influence and Networks
IW0810	(0-8)	Thesis Research for IW Students

Quarter 8

IW4301	(3-2)	Advanced Topics in Influence Modeling
IO4300	(3-2)	Information Operations Planning and Execution
	(4-0)	Approved Elective
IW0810	(0-8)	Thesis Research for IW Students
IW0810	(0-8)	Thesis Research for IW Students

Educational Skill Requirements (ESR)
Information Warfare - Curriculum 595

Sciences, Technology and Business Processes (Knowledge, Comprehension and Application)

A. Identify, describe and apply concepts, theories and practices in mathematics; physics; statistics; engineering; systems engineering; systems analysis, design and testing; and operations research that apply to information operations systems and processes.

B. Describe, explain and apply DoD acquisition regulations and processes as they apply to information operations related systems.

Information Operations (Knowledge, Comprehension and Application)

A. Identify, describe, explain and apply concepts, theories and practices associated with the employment of information operations assets and methods across the range of military operations.

Information Operations (Analysis, Synthesis and Evaluation)

A. Compare existing strategies, objectives and technologies with emerging concepts in these areas. They will be able to identify and compare the advantages, disadvantages and risks associated with each area. The graduate will be able to defend their assessment in terms of operational advantage, financial risk and technological feasibility. This skill area shall provide for subject-area track options in:
  1. Public Policy
  2. SIGINT/EW
  3. CNO/Cyberspace Operations and
  4. Operations and Planning.

Planning and Execution (Application and Analysis)

A. Relate existing information operations technologies and theories to current and emerging military problem sets across the range of military operations (ROMO). These theories and technologies include, but are not limited to, those associated with electronic warfare, computer network operations, networks and cyberspace operations, decision making/command and control (C2), psychological operations/military information support operations, deception and influence operations.

Strategy and Policy (Synthesize and Evaluate)

A. Evaluate and critique existing policies, procedures and doctrine affecting information operations and propose alternatives to overcome identified shortcomings.

B. Graduates will support these proposals by identifying their impact across the range of military operations (ROMO).

Problem Solving and Real World Applicability (Application, Analysis, Synthesis and Evaluation)

A. Incorporate concepts learned in each of the aforementioned skill requirements by designing, developing and executing a research project resulting in the writing of a comprehensive master's thesis.

Electronic Warfare Curriculum - 596

Program Officer

Joshua D. Green, Lt Col, USAF
Glasgow Hall, Room 3010

(831) 656-3565, DSN 756-3565
jdgreen@nps.edu

Academic Associate

David C. Jenn, Ph.D.
Code EC/Jn, Spanagel Hall, Room 414

(831) 656-2254, DSN 756-2254
FAX (831) 656-2760
jenn@nps.edu

Brief Overview

This curriculum provides officers that are thoroughly knowledgeable in the technical and operational aspects of the role of electronic warfare as an integral part of modern warfare. The breadth of coverage includes Electronic Attack (EA), Electronic Protection (EP), and Electronic Warfare Support (ES). It is designed to provide an understanding of the principles underlying the broad field of using electronic warfare to control and manipulate the electromagnetic spectrum during military operations.

Requirements for Entry

Candidate students have a minimum academic profile code (APC) of 324 and receive approval by the Director of Admissions at the Naval Postgraduate School. The procedures for application are contained under the Admissions heading in this catalog. International students should refer to the Admissions section for current TOEFL and entrance requirements.

Entry Date

The Electronic Warfare curriculum is an eight-quarter course of study with an entry date in October. If further information is needed, contact the Program Officer or Academic Associate.

Degree

Requirements for the Master of Science in Electronic Warfare Systems Engineering (MSEWSE) degree are met en route to satisfying the specified curricular program and complying with the following requirements:

Master of Science in Electronic Warfare Systems Engineering

The MSEWSE degree will be awarded at the completion of a multidisciplinary program in Curricula 596. The MSEWSE degree program has not been reviewed by the Engineering Accreditation Commission of ABET. The Master of Science in Electronic Warfare Systems Engineering degree requires:

·   Completion of a minimum of 45 quarter-hours of graduate-level work, of which at least 15 hours must represent courses at the 4000 level, and in two (or more) discrete disciplines.
·   Graduate courses in at least four discrete academic specialization sequences, minimum, and in two disciplines, a course at the 4000 level must be included.
·   One Systems Engineering class.
·   In addition to the 45 graduate hours of course work, an acceptable thesis must be completed.
·   The candidate's program must be approved by the Chairman, Information Sciences Department.

Typical Course of Study

Quarter 1

MA2121	(4-0)	Differential Equations
PH1322	(4-2)	Electromagnetism
IT1500	(4-0)	Informational Program Seminar for International Officers
MA1115	(4-0)	Multi Variable Calculus

Quarter 2

OS3104	(4-0)	Statistics for Science and Engineering
MA3139	(4-0)	Fourier Analysis and Partial Differential Equations
EO2652	(4-1)	Fields, Waves, and Electromagnetic Engineering
EO2102	(4-2)	Basic Electronics and Electrical Machines

Quarter 3

OS3003	(4-0)	Operations Research for Information Operations
EO3602	(4-2)	Electromagnetic Radiation, Scattering, and Propagation
CS2971	(4-2)	Fundamental Object-Oriented Programming in C++
EO2512	(4-2)	Telecommunications Engineering

Quarter 4

EO4612	(4-2)	Microwave Devices and Radar
CS3030	(4-0)	Computer Architecture and Operating Systems
IW3502	(4-2)	Information Warfare Networks
EO3512	(4-1)	Communications and Countermeasures

Quarter 5

CS3600	(4-2)	Introduction to Computer Security
PH3204	(4-2)	Electro-Optic Principles and Devices
EC3700	(3-2)	Joint Network-Enabled Electronic Warfare
EO4911	(2-0)	Advanced Interdisciplinary Studies in Electrical and Computer Engineering

Quarter 6

PH4209	(3-2)	EO/IR Systems and Countermeasures
MR3419	(2-1)	Assessment of Atmospheric Factors in EM/EO Propagation
IW0810	(0-8)	Thesis Research for IW Students
OA4603	(4-0)	Test and Evaluation

Quarter 7

	(4-0)	Approved Elective
EC4010	(3-2)	Principles of System Engineering
EC4690	(3-2)	Joint Network-Enabled Electronic Warfare II
IW0810	(0-8)	Thesis Research for IW Students

Quarter 8

	(4-0)	Approved Elective
	(4-0)	Approved Elective
IW0810	(0-8)	Thesis Research for IW Students
IW0810	(0-8)	Thesis Research for IW Students

Department of Operations Research

Chairman

Robert F. Dell, Ph.D.
Code OR/DE, Glasgow Hall, Room 239

(831) 656-2853, DSN 756-2853
FAX (831) 656-2595
dell@nps.edu

Associate Chairman, Research

Ronald D. Fricker, Jr., Ph.D.
Code OR/Fr, Glasgow Hall, Room 275

(831) 656-3048, DSN 756-3048
FAX (831) 656-2595
rdfricke@nps.edu

Associate Chairman, Operations

Kevin J. Maher
Code OR/Mk, Glasgow Hall, Room 227

(831) 656-2691, DSN 756-2691
FAX (831) 656-2595
KJMaher@nps.edu

Associate Chairman, Instruction

Samuel E. Buttrey, Ph.D.
Code OR/Sb, Glasgow Hall, Room 290

(831) 656-3035, DSN 756-3035
FAX (831) 656-2595
buttrey@nps.edu

Associate Chairman, Curricula Coordination

James N. Eagle, Ph.D.
Code OR/Er, Glasgow Hall, Room 277

(831) 656-2654, DSN 756-2654
FAX (831) 656-2595
jeagle@nps.edu

Associate Chairman, Distributed Programs

Steven E. Pilnick, Ph.D.
Code OR/Ps, Glasgow Hall, Room 291

(831) 656-2283, DSN 756-2283
FAX (831) 656-2595
spilnick@nps.edu

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

David L. Alderson, Associate Professor (2006); Ph.D., Stanford University, 2003.

Jon Alt, LTC, USA, Military Assistant Professor (2013); Ph.D., Naval Postgraduate School, 2012.

Jeffrey Appleget, Senior Lecturer (2009); Ph.D., Naval Postgraduate School, 1999.

Michael Atkinson, Assistant Professor (2009); Ph.D., Stanford University, 2009.

Andrew H. Bellenkes, Senior Lecturer (2010); Ph.D., University of Illinois, 1999.

Gerald G. Brown, Distinguished Professor (1973); Ph.D., University of California at Los Angeles, 1974.

Samuel E. Buttrey, Associate Professor (1996); Ph.D., University of California at Berkeley, 1996.

W. Matthew Carlyle, Professor (2002); Ph.D., Stanford University, 1997.

Emily Craparo, Research Assistant Professor (2010); Ph.D., Massachusetts Institute of Technology, 2008.

Walter C. DeGrange, CDR, USN, Military Assistant Professor (2011); M.S. Naval Postgraduate School, (2005).

Robert F. Dell, Chairman, Department of Operations Research and Professor (1990); Ph.D., State University of New York at Buffalo, 1990.

Ned Dimitrov, Assistant Professor (2010); Ph.D., University of Texas at Austin, 2008.

James N. Eagle, Professor (1982); Ph.D., Stanford University, 1975.

Nelson Emmons, COL, USA, Associate Dean of the Graduate School of Operational and Information Sciences and Military Associate Professor (2013); M.S., Naval Postgraduate School, 1997.

Paul Lee Ewing, Research Associate Professor (2005); Ph.D., Colorado School of Mines, 2002.

Ronald D. Fricker, Jr., Professor (2005); Ph.D., Yale University, 1997.

Thomas E. Halwachs, Senior Lecturer (1988); M.S., Naval Postgraduate School, 1976.

Thomas A. Hamrick, Lecturer (2006); M.S., Naval Postgraduate School, 1997.

Thomas H. Hoivik, Senior Lecturer (1983); M.S., Naval Postgraduate School, 1973.

Jeff Hyink, CDR, USN, Military Assistant Professor (2012); M.S., Naval Postgraduate School, 2007.

Patricia A. Jacobs, Distinguished Professor (1978); Ph.D., Northwestern University, 1973.

Rachel Silvestrini, Assistant Professor (2009); Ph.D., Arizona State University, 2008.

Quinn Kennedy, Senior Lecturer (2007); Ph.D., Stanford, 2002.

Jeffrey E. Kline, Professor of Practice (2005); M.S., Naval Postgraduate School, 1991.

Robert A. Koyak, Associate Professor (1998); Ph.D., University of California at Berkeley, 1985.

Moshe Kress, Professor (2003); Ph.D., University of Texas at Austin, 1981.

Kyle Y. Lin, Associate Professor (2004); University of California at Berkeley, 2000.

Keith Littrell, LCDR, USN, Military Assistant Professor (2013); M.S., Naval Postgraduate School, 2010.

Thomas W. Lucas, Professor (1998); Ph.D., University of California at Riverside, 1991.

Kevin J. Maher, Lecturer (1997); M.S., Naval Postgraduate School, 1993.

Michael E. McCauley, Research Professor (2002); Ph.D., University of California at Santa Barbara, 1979.

Deidre McClay, CAPT, USN, Chair of Warfare Innovation and Military Associate Professor, 2012.

Gregory K. Mislick, Lecturer (2005); M.S., Naval Postgraduate School, 1988.

Christopher J. Nannini, LTC, USA, Military Instructor (2009); M.S., Naval Postgraduate School, 2006.

Scott Nestler, COL, USA, Assistant Professor (2010); Ph.D., University of Maryland, 2007.

Daniel A. Nussbaum, Visiting Professor (2004); Ph.D., Michigan State University, 1971.

Douglas E. Otte, Senior Lecturer (2007); M.S., Naval Postgraduate School, 1989.

Steven E. Pilnick, Senior Lecturer (1999); Ph.D., Naval Postgraduate School, 1989.

Johannes O. Royset, Associate Professor (2003); Ph.D., University of California at Berkeley 2002.

Anton Rowe, Research Associate (1999); M.S., Stanford University, 1997.

Javier Salmeron, Associate Professor (2000); Ph.D., Universidad Politecnica de Madrid, 1998.

Paul J. Sanchez, Senior Lecturer (1999); Ph.D., Cornell University, 1986.

Susan M. Sanchez, Professor (2000); Ph.D., Cornell University, 1986.

Lee Sciarini, LT, USN, Assistant Professor (2013); Ph.D., University of Central Florida, 2009.

Chad Seagren, MAJ, USMC, Assistant Professor (2010); Ph.D., George Mason University, 2010.

Lawrence G. Shattuck, Senior Lecturer (2005); Ph.D., The Ohio State University, 1995.

Nita Lewis Shattuck, Associate Professor (2000); Ph.D., University of Texas, 1982.

Dashi Singham, Research Assistant Professor (2010); Ph.D., University of California at Berkeley, 2010.

Christian Smith, Senior Lecturer (2009); Ph.D., University of Minnesota, 1996.

Roberto Szechtman, Associate Professor (2003); Ph.D., Stanford University, 2001.

Lyn R. Whitaker, Associate Professor (1988); Ph.D., University of California at Davis, 1985.

R. Kevin Wood, Distinguished Professor (1982); Ph.D., University of California at Berkeley, 1982.

Emeritus Professors

Gordon H. Bradley, Professor Emeritus (1973); Ph.D., Northwestern University, 1967.

Donald P. Gaver, Jr., Distinguished Professor Emeritus (1970); Ph.D., Princeton University, 1956.

Wayne P. Hughes, Jr., Professor of Practice (1979); M.S., Naval Postgraduate School, 1964.

Peter Purdue, Professor Emeritus (1986); Ph.D., Purdue University, 1972.

Robert R. Read, Professor Emeritus (1971); Ph.D., University of California at Berkeley, 1958.

David A. Schrady, Distinguished Professor Emeritus (1965); Ph.D., Case Institute of Technology, 1965.

Michael G. Sovereign, Professor Emeritus (1970); Ph.D., Purdue University, 1965.

Alan R. Washburn, Distinguished Professor Emeritus (1970); Ph.D., Carnegie Institute of Technology, 1965.

Brief Overview

Operations Research (OR) originated during World War II as a response to tactical problems relating to the effective and efficient operation of weapon systems, and to operational problems relating to the deployment and employment of military forces. Since then, OR has evolved into a full-scale, scientific discipline that is practiced widely by analysts in industry, government, and the military.

OR is the science of helping people and organizations make better decisions. More formally, it is the development and application of mathematical models, statistical analyses, simulations, analytical reasoning, and common sense to the understanding and improvement of real-world operations. Improvement can be measured by the minimization of cost, maximization of efficiency, or optimization of other relevant measures of effectiveness.

The military uses OR at the strategic, operational, and tactical levels. OR improves decision making and facilitates insights into the phenomena of combat. OR applications cover the gamut of military activities including: national policy analysis, resource allocation, force composition and modernization, logistics, human resources (recruiting, retention, promotion, training, and personnel assignment), battle planning, flight operations scheduling, intelligence, command and control, weapon selection (weapon system effectiveness, cost, compatibility, and operability), engagement tactics (fire control, maneuver, target selection, and battle damage assessment), maintenance and replenishment, and search and rescue.

The Naval Postgraduate School's Operations Research Department offers M.S. and Ph.D. degrees. In 2001, it celebrated the 50th anniversary of its curriculum, which

was the first educational program in OR in the United States. It is one of the oldest, largest, and highest-ranking OR departments in the country. It is without peer in terms of the extent to which graduate education is integrated with a commitment to solving real military problems. Our students and faculty use the latest mathematical modeling ideas and computing technology to penetrate deeply into the analysis of important real-world problems. Analysis is a key word; NPS operations researchers frequently influence decisions and serve as agents for change.

For further information, see the OR Department Website: www.nps.edu/Academics/GSOIS.

Degree

Master of Science in Applied Science

Master of Science in Operations Research

Doctor of Philosophy in Operations Research

Master of Science in Human Systems Integration

Master of Systems Analysis

Master of Cost Estimation and Analysis

Certificates

Human Systems Integration Certificate

Systems Analysis Certificate

Operations Research Course Descriptions

OA Refresher Courses

OAR100 Introduction to Computational Methods for Operations Research (2-2) As Required
(No credit) (Meets first 6 weeks of quarter.) Introduction to the Naval Postgraduate School computer laboratories and software. Windows operating system, files, Internet, editing, word processing, spreadsheets, data analysis, and presentation graphics. Review of selected topics in differential and integral calculus. Integration of functions of a single variable. Constrained and unconstrained optimization of functions of a single variable.

OAR160 Introduction of Operations Analysis II (2-2) As Required
(No credit) This course is the second half of OA1600.

OAR200 Introduction to Visual Basic for Operations Research (2-2) As Required
(No credit) (Meets last 6 weeks of quarter.) A first course in computer programming using Visual Basic as a high-level programming language. Primary emphasis will be on the planning, structuring, and debugging of computer programs for solving Operations Research problems. Prerequisite: None.

OAR100 Introduction to Computational Methods for Operations Research (2-2) As Required

(No Credit) (Meets first six weeks of quarter.) Introduction to the Naval Postgraduate School computer laboratories and software. Windows operating system, files, Internet, editing, word processing, spreadsheets, data analysis, and presentation graphics. Review of selected topics in differential and integral calculus. Integration of functions of a single variable. Constrained and unconstrained optimization of functions of a single variable.

OAR160 Introduction of Operations Analysis II (2-2) As Required

(No Credit) This course is the second half of OA1600.

OAR200 Introduction to Visual Basic for Operations Research (2-2) As Required

(No Credit) (Meets last six weeks of quarter.) A first course in computer programming using Visual Basic as a high-level programming language. Primary emphasis will be on the planning, structuring, and debugging of computer programs for solving operations research problems. Prerequisite: None.

OA Courses

OA0001 Seminar for Operations Analysis Students (0-2) As Required

(No credit) Guest lecturers. Review of experience tours. Thesis and research presentations. Prerequisite: None.

OA0810 Thesis Research for Operations Analysis Students (0-8) Fall/Winter/Summer/Spring

Every student conducting thesis research will enroll in this course. Prerequisite: None.

OA0820 Integrated Project (0-12) As Required

The Naval Postgraduate School provides many opportunities for students to participate in campus-wide interdisciplinary projects. These projects encourage students to conceptualize systems which respond to current and future operational requirements. An integral part of the project involves working with other groups to understand and resolve issues involved with system integration and to lend OR-specific expertise to these projects. This course is available to Operations Research students who are participating in a campus-wide integrated project. Course is graded on a Pass/Fail basis. Prerequisite: None. Classification: Security Clearance Required.

OA1600 Introduction to Operations Analysis I (2-2) As Required

(No credit) A first course in Operations Analysis, covering its origins in World War II to current practices. Introduces concepts, tools, and methods of analysis, with tactical examples. Emphasis on measuring combat effectiveness and developing better tactics. Prerequisite: None.

OA2801 Computational Methods for Operations Research (4-1) Fall/Spring

An introductory course in computation and procedural programming with an emphasis on the analysis and implementation of algorithms relevant to Operations Research. The course is taught using a general purpose programming language. The laboratory has weekly programming assignments. Prerequisite: None.

OA2900 Workshop in Operations Research/Systems Analysis (V-0) Fall/Winter/Spring/Summer

This course may be repeated for credit if course content changes. Graded on Pass/Fail basis only. Prerequisites: Department approval and a background in Operations Research.

OA2910 Selected Topics in Operations Analysis (V-4) Winter

(Variable hours 2-0 to 5-0.) Presentation of a wide selection of topics from the current literature. This course may be repeated for credit if course content changes. Prerequisite: A background in Operations Research.

OA3101 Probability (4-1) Fall/Spring

Introduction to data entry, manipulation, and graphing using spreadsheets and statistical packages. Graphical and tabular methods in descriptive statistics, measures of location and variability. Probability axioms, counting techniques, conditional probability. Discrete and continuous probability distributions: binomial, hypergeometric, negative binomial, Poisson, normal, exponential, gamma, and others. Joint probability distributions, conditional distributions and conditional expectation, linear functions. Random samples, probability plots. Prerequisites: Knowledge of single-variable calculus and MA1115 (may be taken concurrently).

OA3102 Statistics (4-2) Winter/Summer

Point estimation, method of moments, maximum likelihood, least squares. Confidence intervals, tests of hypotheses for one- and two-sample problems. Analysis of variance, multiple comparisons, interaction, simple design cases. Goodness of fit and contingency tables, sign tests, Wilcoxon-Mann-Whitney test. Prerequisites: OA3101 and MA1115 and MA3110 (taken concurrently).

OA3103 Data Analysis (4-1) Fall/Spring

Techniques for analyzing, summarizing, and comparing sets of real data with several variables. Computations are done in a statistical package and a common spreadsheet program. Model building and verification, graphical methods of exploration. Least squares regression, logistic and Poisson regression, introduction to categorical data analysis, principal components and/or classification. Prerequisite: None.

OA3105 Nonparametric Statistics (4-0) Winter

Tests based on the binomial distribution; confidence intervals for percentiles, tolerance intervals and goodness-of-fit tests; contingency tables; one-sample tests, two-sample tests, and tests for independence based on ranks and scores; nonparametric analysis of variance and regression. Applications will illustrate the techniques. Prerequisite: A course in statistical inference.

OA3201 Linear Programming (4-0) Spring

(Same as MA3301) Theory of optimization of linear functions subject to linear constraints. The simplex algorithm, duality, sensitivity analyses, parametric linear programming. Applications to resource allocation, manpower planning, transportation and communications, network models, ship scheduling, etc. Introduction to computer-based linear programming systems. Prerequisite: None.

OA3301 Stochastic Models I (4-0) Fall/Spring

Course objectives are to provide an introduction to stochastic modeling. Topics include the homogeneous Poisson process and its generalizations and discrete and continuous time Markov chains and their applications in modeling random phenomena in civilian and military problems. Prerequisite: OA3101 or consent of the instructor.

OA3302 Simulation Modeling (4-0) Winter/Summer
Discrete event digital simulation methodology. Monte Carlo techniques and use of simulation languages. Variance reduction techniques, design of simulation experiments, and analysis of results. Prerequisite: OA3103, OA3200, OA3301.

OA3304 Decision Theory (4-0) Winter/Summer
This course provides an introduction to modern theory and methods for decision making in both single and multiple person decision-making situations. Bayesian methods are emphasized in the single-person case, including decision trees, Bayesian networks, influence diagrams, and multicriterion decision making. Multiperson situations covered include two-person zero-sum games, voting, Nash bargaining, and the Shapley value. Applications are mainly to military problems. Prerequisite: None.

OA3401 Human Factors in Systems Design (3-1) Fall/Spring
This course will provide an introduction to the field of human factors with an emphasis on military systems. Humans are the most important element of any military system. Consequently, the design of effective systems must take into account human strengths and limitations as well as considerations of human variability. The course surveys human factors and human-centered design and system effectiveness and safety. Topics include human cognition and performance as they are influenced by physiological, anthropometric, and environmental considerations. Prerequisite: None.

OA3402 Research Methods for Performance Assessment (3-1) Winter/Summer
Well-constructed research is invaluable; informing and enabling decision makers to make better choices. This course covers the research process from beginning to end and explores the types of research conducted in a variety of laboratory and field settings. Topics include institutional approval and ethical use of human subjects; research reliability and validity; formulation of the research question; research designs ranging from experimentation to systematic observational techniques and subjective surveys; database management considerations; analytical approaches; and writing and presenting the research paper. Prerequisite: None.

OA3411 Introduction to Human Systems Integration (3-0) Fall/Spring
This course serves as the framework for examining Human Systems Integration in the context of Department of Defense Systems Acquisition as mandated by DoD Instruction 5000.2, Enclosure 7. This course provides an overview of the HSI domains: human factors engineering, personnel, habitability, manpower, training, environment safety and occupational health, and survivability. Principles of individual physiological and psychological capabilities and limitations and team attributes are also introduced. Prerequisites: None.

OA3412 Human Systems Integration in the DoD Acquisition Lifecycle (3-0) Fall
This course further expands on the role of Human Systems Integration within the context of the Department of Defense Systems Engineering Process in the DoD Acquisition Lifecycle. Students examine select acquisition activities (e.g., Joint Capabilities Integration Development System, or JCIDS) and the manner in which HSI practitioners influence these activities. This course also focuses on leveraging the unique activities of HSI practitioners to assist/support program managers and lead systems engineers in developing human-centered systems that optimize

total system performance while minimizing cost and risk. Prerequisite: OA3411.

OA3413 Human Systems Integration Tools, Tradeoffs, and Processes (3-1) Winter
This course provides a description and evaluation of tools and techniques available to facilitate the acquisition of human--centered military systems. It also provides an overview of techniques employed by practitioners within the sub-disciplines of HSI. The focus of this course is on tool inputs and outputs and their utility. This course also examines the manner in which HSI trade space analysis is performed — one of the most important roles of the HSI practitioner in the acquisition process. Prerequisite: OA3412.

OA3501 Inventory I (4-0) As Required
A study of deterministic and approximate stochastic inventory models. Deterministic economic lot size models with infinite production rate, constraints, quantity discounts. An approximate lot size-reorder point model with stochastic demand. An approximate stochastic periodic review model. Single period stochastic models. Applications to Navy supply systems. Prerequisite: OA3101 or consent of the instructor.

OA3601 Combat Models and Games (4-0) Fall/Spring
This course provides a discussion of measures of effectiveness and a quantitative introduction to dynamic programming, target coverage models, Kalman filters, Lanchester Systems, and two-person zero-sum games. Prerequisite: MA3110, OA3102.

OA3602 Search Theory and Detection (4-1) Winter/Summer
Search and detection as stochastic processes. Characterization of detection devices, use and interpretation of sweep widths and lateral range curves, true range curves. Measures of effectiveness of search-detection systems. Allocation of search efforts, sequential search. Introduction to the statistical theory of signal detection. Models of surveillance fields, barriers, tracking, and trailing. Prerequisite: OS2103 or OA3101.

OA3610 Introduction to Naval Logistics (4-0) As Required
Presentation of the fundamental purposes, history, and components of the naval logistics system. Logistics is introduced as a command function necessary for sustaining combat operations. This concept is developed by looking at logistics resources and processes, unit and battle group logistics, in-theater support, strategic lift, and CONUS/system support. Prerequisite: None.

OA3650 Improvised Explosive Devices (IED) Seminar (4-0) As Required
This seminar studies the improvised explosive device (IED) problem, with special emphasis on its use by insurgents in Iraq and Afghanistan. The seminar will discuss IEDs as one tactic in an insurgency and the goals and strategies with respect to the use of IEDs. The focus of the seminar will be the use of models, analysis, and systems technology to defeat the IED system. Topics include: short history of Iraq including demographics, religion, politics, and economics; access to SIPRNET data on IED incidents and analysis of attacks; geographic information systems (GIS) for display of incidents; a short overview of counterinsurgency methods that have been used in Iraq and elsewhere; systems engineering approaches to countering the use of IEDs; and operations research models of IED issues. There will be guest speakers with current knowledge of the IED threat. The seminar is open to all NPS students. Prerequisite: OS2103 or equivalent and U.S. citizenship. Classification: SECRET.

OA3801 Computational Methods for Operations Research II (3-1) As Required
An advanced course in computation, with emphasis on data structures and algorithms particularly appropriate for military Operations Research. The course is taught using a general purpose programming language. The laboratory has weekly programming assignments. Prerequisite: OA2200.

OA3900 Workshop in Operations Research/Systems Analysis (V-0) As Required
(Variable hours 2-0 to 5-0.) This course may be repeated for credit if course content changes. Graded on Pass/Fail basis only. Prerequisite: Departmental approval.

OA3910 Selected Topics in Operations Research/Systems Analysis (V-0) As Required
(Variable hours 2-0 to 5-0.) Presentation of a wide selection of topics from the current literature. This course may be repeated for credit if course content changes. Prerequisite: A background of advanced work in operations research and consent of the instructor.

OA4101 Design of Experiments (3-1) Fall/Spring
(Same as MA4302.) Theory and application of the general linear hypothesis model. Analysis of variance and analysis of covariance. Planning experiments; traditional and hybrid experimental designs. Use of standard computer packages for analysis of experimental data. Prerequisite: OA3103 or equivalent.

OA4102 Regressions Analysis (4-0) Winter
(Same as MA4303.) Construction, analysis, and testing of regression models. An in-depth study of regression and its application in operations research, economics, and the social sciences. Prerequisites: OA3102 and OA3103.

OA4103 Advanced Probability (3-0) As Required
Probability spaces, random variables as measurable functions, expectation using the Lebesque-Stieltjes integral, and abstract integration. Modes of convergence, characteristic functions, the continuity theorem, central limit theorems, the zero-one law. Conditional expectation. Prerequisite: MA3605 or departmental approval.

OA4104 Advanced Statistics (3-0) As Required
Foundations of statistics from a decision-theoretic viewpoint. Robust estimation techniques, biased estimation. Fisher and Kullback information, asymptotic methods, sufficiency, completeness, the Cramer-Rao inequality. Sequential tests, empirical Bayes tests. Statistical computation methods. Prerequisites: OA3103 and consent of the instructor.

OA4105 Nonparametric Statistics (4-0) Fall/Summer
Inference based on the binomial distribution, including hypothesis tests, confidence intervals for percentiles, and tolerance intervals. Kaplan-Meier estimation with censored failure data. Analysis of contingency tables, including tests for goodness-of-fit and independence. Permutation tests and tests based on ranks and scores in a variety of applications. Goodness-of-fit testing for continuous distributions and families. Application of techniques to data using computing software will be emphasized. Prerequisites: OA3103 and consent of the instructor.

OA4106 Advanced Data Analysis (3-1) As Required
The course features the blending of sophisticated statistical software and data from recent DoD applications. The manipulation of multivariate data and statistical graphics are emphasized. Methodologies presented can include survival analysis, classification and discrimination, categorical data analysis, and sample survey methods. Prerequisite: OA3103.

OA4107 Categorical Data Analysis (3-1) As Required
Contingency tables in two, three, and higher dimensions. Exact procedures for small tables. The course will feature case studies and treat log-linear models, expanded logistic analysis, ordinal variables multinominal response methods. Poisson regression and the problems of sparse data sets. Applications and DoD case studies appear in the laboratory exercises. Prerequisite: OA3103.

OA4108 Data Mining (2-2) Spring
The art and science of finding real patterns in (usually very large) data sets as seen from a statistical perspective. Introduction to some of the techniques used in data mining and discussion of their implementation, their strengths and weaknesses, and some common and specific pitfalls. Algorithms for classification and regression include trees and neural networks as well as the a priori algorithm for rule generation. Techniques for clustering and visualization include hierarchical and k-means clustering and XGobi and lattice-type graphics. The Clementine and S-Plus software packages are used. Real datasets used in the past have included fraud detection data from the Defense Finance and Accounting Service. Prerequisite: OA3103.

OA4109 Survey Research Methods (4-2) Winter/Summer
The course will cover the basic principles of survey research methods. It will provide students with a practical grounding in all aspects of survey methodology, from survey instrument design, to sample design, to modes of data collection, to methods for survey data analysis. Students will be able to immediately apply course work to their theses and other real-world applications, including a class capstone project in which students will design, field, and analyze a survey on behalf of a DoD organization. Prerequisite: OA3103 and OS3101 or equivalent, or consent of the instructor.

OA4201 Nonlinear Programming (4-0) Winter/Summer
(Same as MA4301.) Convex sets, convex functions, and conditions for local and global optimality. Elements and convergence of algorithms for solving constrained and unconstrained optimization problems. Introduction to algebraic modeling languages. Many applications of integer and nonlinear programming to military and civilian problems, such as weapons assignments, force structuring, parameter estimation for nonlinear or constrained regression, personnel assignment, and resource allocation. Prerequisite: OA3201.

OA4202 Network Flows and Graphs (4-0) Fall/Spring
Introduction to formulation and solution of problems involving networks, such as maximum flow, shortest route, minimum cost flows, and PERT/CPM. Elements of graph theory, data structure, algorithms, and computational complexity. Applications to production and inventory, routing, scheduling, network interdiction, and personnel management. Prerequisite: OA3201.

OA4203 Mathematical Programming (4-0) Spring
Advanced topics in linear programming, large-scale systems, the decomposition principle, additional algorithms, bounded variable techniques, linear fractional programming, formulation and solution procedures for problems in integer variables. Applications to capital budgeting, large-scale distribution systems, weapon systems allocation, and others. Prerequisite: OA3201.

OA4204 Games of Strategy (4-0) Summer
Mathematical models of conflict situations, emphasizing the theory of decision making against a completely opposed enemy. Topics include matrix games, Blotto games, stochastic games, and the Shapley value. Applications to combat, resource allocation, cost sharing, etc. Prerequisites: OA3103, OA3201.

OA4205 Advanced Nonlinear Programming (4-0) As Required
Continuation of OA4201. Advanced topics in nonlinear programming, including duality theory, further consideration of necessary and sufficient conditions for optimality, additional computational methods examination of recent literature in nonlinear programming. Prerequisite: OA4201.

OA4301 Stochastic Models II (4-0) Winter/Summer
Course objectives are to discuss methods of stochastic modeling beyond those presented in OA3301 and give students the opportunity to apply the methods. Topics include conditioning; renewal processes; renewal reward processes; length-biased sampling, semi-Markov models, and novel queuing, reliability and maintenance models. The topics are illustrated by DoD applications. This course also is offered as MA4305. Prerequisite: None.

OA4302 Reliability and Weapons System Effectiveness Measurement (4-0) Winter/Summer
Component and system reliability functions and other reliability descriptors of system effectiveness. Relationships between system and component reliability. Point and interval estimates of reliability parameters under various life testing plans. Prerequisite: OA3301.

OA4303 Sample Inspection and Quality Assurance (4-0) Winter/Summer
Attribute and variables sampling plans. Military Standard sampling plans with modifications. Multilevel continuous sampling plans and sequential sampling plans. Structure and implementation of quality assurance programs and analysis of selected quality assurance problems. Prerequisite: OA3101 or consent of the instructor.

OA4305 Stochastic Models III (4-0) As Required
Lecture topics include nonstationary behavior of Markov processes, point process models, regenerative processes, Markovian queuing network models, and non-Markovian systems. Applications include reliability, computer system modeling, combat modeling, and manpower systems. Students are given exercises entailing data analysis, formulation of probability models, and application of models to answer specific questions concerning particular phenomena. Prerequisites: OA3103, OA3301, and OA4301.

OA4308 Time Series Analysis (4-0) As Required
(Same as MA4304.) Second order stationary processes. Harmonic analysis of correlation functions. Filters and spectral windows. Ergodic properties. Problems of inference in time series analysis. Box-Jenkins techniques. Introduction to the analysis of multivariate processes. Prerequisites: OA3103 and OA3301.

OA4321 Decision Support Systems (3-1) Winter
An introduction to the topic; includes an overview of organizational decision making, discussion of Operations Research techniques integral to Decision Support Systems, relationships to artificial intelligence and expert systems, specialized computer languages, and nontraditional techniques for handling uncertainty. Current operational systems, both military and civilian, will be used as examples. Prerequisites: OA3101 and OA3200.

OA4333 Simulation Analysis (4-0) As Required
Advanced techniques of model development and simulation experimentation. Discussion of current research. Actual topics selected will depend on the interests of the students and instructor. Prerequisite: OA3302.

OA4401 Individual Performance & Personnel Considerations (3-1) Winter/Summer
This course provides students with a working knowledge of current theories regarding individual human performance and the methods used to measure individual states and traits that affect that performance. In addition, the course includes familiarization with tests and procedures used by the DoD and industry for personnel selection and job/task assessment procedures. The course builds on information covered in OA-3401, Human Factors in Systems Design. Prerequisite: OA3401, specifically, knowledge and basic understanding of human information processing, sensation, perception, attention, vigilance, and memory OR permission of instructor.

OA4402 Training and Simulation (3-1) As Required
This course will provide an overview of learning principles, training system development and evaluation, the Instructional System Development approach, Navy training practices, and simulation training systems. Tradeoffs among personnel selection, training. and other domains of HSI will be addressed. Prerequisite: None.

OA4406 Survivability, Habitability, Environmental Safety, and Occupational Health (4-0) Summer
This course will provide an overview of personnel survivability methodology in safety, health hazards, and occupational health concepts. The evaluation of new and modified military systems and equipment for safety and potential health hazards will be addressed through reviewing models, methods, and processes available to help identify and mitigate the potential harm from accidents and hostile environments. Occupational health concerns will be addressed and methods of alleviating or minimizing workplace hazards will be analyzed. Risk analysis and mitigation models also will be examined for their contribution to increased safety and operational effectiveness. Prerequisite: None.

OA4407 Human Anthropometry and Biomechanics (3-1) Spring
This course will cover current techniques for combining anthropometric and biomechanical data to model the relationships among people, tasks, equipment, and the workplace. The historical development of anthropometric databases and human engineering models will be reviewed and current techniques and multivariate models will be introduced. Both military and commercial guidelines for ergonomic design will be covered and emphasis will be given to software tools for 3-D modeling, visualization, and workstation design. Prerequisite: None.

OA4408 Macroergonomics and Organizational Behavior in Human Systems Integration (3-1) Winter/Summer
This course systematically examines the application of macroergonomic concepts and organizational processes in orchestrating human systems integration (HSI) efforts in acquisition programs. The key concepts, principles, and theories of macroergonomics are defined and then applied to analyze organizational structures, policies, and processes that impact effective HSI efforts. Specific attention will be paid to leadership, organizational, group, and team behaviors as they impact HSI strategy, planning, program execution, and risk assessment. The material covered will then be applied to manning, training, and

safety challenges in current acquisition programs. Prerequisite: None.

OA4414 Human Systems Integration Case Studies and Applications (4-0) Spring

This is the capstone course in the Human Systems Integration Certificate Program. This course provides students the opportunity to integrate and apply the materials from previous courses through the examination of actual military acquisition programs. One of the course objectives is to provide an historical analysis of both small and large military acquisition programs. The lessons learned from these historical case studies will reinforce best practices for HSI practitioners. Prerequisite: OA3413.

OA4415 HSI Case Studies and Applications (Capstone II) (4-0) Summer

This is the final course in the Naval Postgraduate School's distance learning Master of Human Systems Integration (MHSI) Program. Students will engage in a capstone project that builds on the activities in the OA44I4 HSI Case Studies and Applications (Capstone I) and all other previous courses. A typical capstone project would require a student to create a detailed HSI process document for his or her organization. This document would describe the HSI processes and activities that should be employed by that organization to design, develop, produce, deploy, operate, and support a system with an appropriate focus on the operators, maintainers, supporters, and trainers. Prerequisite: OA4414.

OA4501 Seminar in Supply Systems (3-0) Summer

A survey of the supply system for the U.S. Navy. Topics include inventory models at all levels for consumables and repairables, budget formulation and execution, provisioning and allowance lists, planned program requirements, transaction item reporting, and current topics of research such as stock migration and material distribution studies. Prerequisite: OA3501.

OA4600 Information in Warfare (4-0) As Required

Quantitative approaches to measuring and assessing the value of information in warfare, with emphasis on tradeoffs between information and firepower. Major components are on information as precision (Bayesian filtering, data association, and fusion), and information as a guide to decision making (decision theory, Markow policies, optimization). Prerequisite: OA3102, OA3201, OA3301.

OA4601 Models for Decision Making (4-0) As Required

The objective is to be able to formulate and analyze operational and executive decision problems, where a lack of clear problem definition and data, sequential timing of decisions, uncertainty, and conflicting objectives, are all normal features of such problems. Understanding and applying influence diagrams and decision trees form the core part of the course. Emphasis is on building models and determining data requirements. Specific areas include the use of policy space analysis in sensitivity. Prerequisite: OA3304.

OA4602 Joint Campaign Analysis (4-0) Winter/Summer

This course studies the development, use, and recent applications of campaign analysis in actual procurement, force structure, and operations planning. Emphasis is on formulating the problem, choosing assumptions, structuring the analysis, and measuring effectiveness. Interpreting and communicating results in speech and writing is an important part of the course. In the last three weeks, students conduct a broad gauge, quick reaction campaign analysis as team members. Prerequisites: A course in basic probability and

statistics theory, and operational experience in military environments.

OA4603 Test Evaluation (4-0) Winter/Summer

This course is designed to cover Developmental and Operational Test and Evaluation and Military Experimentation, including statistical concepts and methods frequently used in weapon system testing and experimentation environments. The course is taught from the perspective of the Program Manager, Test Project Officer, Test Engineer, Test Analyst, and Statistician. A number of actual military cases are used for examples. Topics include the Role of Test and Evaluation in Systems Engineering and Acquisition Management, Test Planning and Design, Development of Measures of Effectiveness and Measures of Performance, Conduct of Tests, Data Analysis, and Reporting of Test Results. A detailed group test planning project and design exercise are included. Upon successful completion of this course, students receive DAWIA Level II and Level III Intermediate and Advanced Test and Evaluation certification. Prerequisite: A previous course in probability and statistics, or consent of the instructor.

OA4604 Wargaming Applications (3-2) Fall/Spring

Wargaming has been an essential tool for military planning and decision making for centuries. A properly designed wargame provides a structured environment that allows military professionals to gain insight into complex military problems. The first half of the Wargaming Applications course teaches the fundamentals of wargaming using a mix of lectures and practical exercises. The second half of the course focuses on applying wargaming fundamentals to answer a DoD sponsor's real-life requirement. Student groups will design, develop, conduct, and analyze a wargame to address sponsor's needs. Prerequisite: OA4655 or consent of instructor.

OA4605 Operations Research Problems in Naval Warfare (3-0) Winter

Analysis of fleet exercises. Changes in tactics and force disposition arising from the introduction of nuclear weapons and missiles. Relationship of air defense to strike capability and USW. Current radar, sonar, communications, and ECM problems. Prerequisite: OA4604, OA4655.

OA4607 Tactical Decision Making (4-0) Spring

This course deals with computer-aided decision making. Topics include the human-computer interface, the construction of effective graphics, verification/validation, and theoretical frameworks for competitive and noncompetitive decision making. Kalman filters are introduced as an important fusion and tracking tool. The primary classroom application areas are information fusion, search/track, and mine warfare. A project is required. Prerequisites: OA3602, OS2103, OS3604 or equivalent. OS3301 or equivalent, and a working knowledge of a programming language such as MATLAB, C++, Java, or Visual Basic.

OA4608 Foreign Military Operations Research (4-0) Spring

This course considers military operations research of foreign countries that are of current concern to DoD. Because many of these have been military clients of the former Soviet Union, the course will take Soviet military operations research as a point of departure for study. Asymmetries between Soviet and American military operations research are emphasized. Exploitation of such information is discussed. Prerequisite: None.

OA4610 Mobilization (4-0) As Required
Introduction to the military and civilian systems for mobilization, linear programming, and simulation formulations of strategic mobility and munitions scheduling. Planning and controls of the logistics systems, including planning factors and joint operations planning. Integration of mobilization with Navy operational logistics. Prerequisite: None.

OA4611 Joint and Combined Logistics (4-0) As Required
Presentation of the role of logistics and logisticians in war planning and strategy development, with emphasis on jointness. Introduction to JCS, unified, and Navy command and staff structures, and participation in deliberate and crisis action-planning process. Emphasis on the transition to war, mobilization, strategic lift, and the weapon system acquisition process as related to logistics planning. Prerequisite: OA3610.

OA4612 Logistics Models (4-0) As Required
Mathematical modeling of most of the processes in unit/battle group or battle force logistics. Computation of fuel consumption, underway replenishment scheduling, shuttle ship requirements, measures of effectiveness, formations and their supportability, sustainability, engagement models, and ordnance prediction, and implementation of such models in microprocessor-based logistics decision aids. Also ordnance programming models. Only for U.S. students enrolled in curricula 360 or 361. Prerequisite: Consent of the instructor.

OA4613 Energy Logistics in Warfare Operations (4-0) As Required
Case studies and quantitative analysis of energy sources, distribution, and consumption focused on the sustainment of warfare operations. Energy sources to include petroleum-based fuels, and synthetic liquid fuels and other alternative energy sources. Distribution analysis to include requirements and vulnerability of operational logistics lines of supply by ship, rail, pipeline, trucks and air. Consumption analysis to include modeling of energy consumption logistics planning factors for ship, aircraft, and ground force operations. Prerequisites: OA3201 or OA3610 or OS3007 or permission of instructor.

OA4655 Introduction to Joint Combat Modeling (4-0) Winter/Summer
(Same as MV4655.) This course covers the basic tools and concepts of joint combat modeling. Both the science and the art are emphasized. Topics include: the role of combat modeling in analyses, taxonomies of models, an introduction to some important models and organizations, measures of effectiveness, approaches to effectively using models to assist decision making, object-oriented approaches to designing entities to simulate, firing theory, one-on-one and few-on-few engagements, introduction to aggregated force-on-force modeling (including the basic Lanchester model and some of its derivatives), sensing algorithms, simulation entity decision making, simulating C4ISR processes, terrain and movement algorithms, verification, validation, and accreditation (VV&A), stochastic versus deterministic representations, hierarchies of models, and variable resolution modeling. The primary course objective is for you to understand the enduring fundamentals of how combat models are built and used to support decision making. This will be done, in part, through several small projects that will require students to design, implement, and analyze models. Prerequisites: Probability and Statistics (through third course in the sequence), familiarity with a programming language (Java recommended), Stochastic Models (OA3301), Calculus, and concurrent instruction in computer simulation (e.g., OA3302).

OA4656 Advanced Combat Modeling (4-1) As Required
The objective of this course is to educate and train model-builders (as opposed to model-users). The phenomena and situations that are modeled in this course range from fundamental shooting processes to force-on-force engagements, and from minefields to air-defense systems. Special attention is given to contemporary issues such as the effect of information in the presence of precision-guided weapons and UAVs, and the war against terror. The focus of the course is on analytic models that are based on probability and optimization techniques. Prerequisites: OA4655 and OA3301 (or OS3311).

OA4658 Survey of Joint Combat Models (1-0) Winter/Summer/Fall/Spring
The purpose of the course is to introduce the student to a wide variety of models that are being used throughout DoD. A broad cross section of models are envisioned to be taught—characteristics of the models will include both large and small models; analytical models as well as those for experimentation and/or training; theater-level as well as strategic- and tactical-level models; ground as well as air models. Prerequisite: None.

OA4701 Econometrics (4-0) Winter
Construction and testing of econometric models, analysis of economic time series, and the use of multivariate statistical analysis in the study of economic behavior. Prerequisite: OA3103.

OA4702 Cost Estimation (4-0) Winter/Summer
This course provides a broad-based understanding of the cost analysis activities involved in the acquisition and support of DoD weapon systems. In addition, it introduces operations research techniques fundamental to the field of cost estimation. The course covers the defense systems acquisition process, time value of money, and economic analysis; it develops, uses, and analyzes estimating techniques commonly encountered in both the DoD and industry, including statistical and nonstatistical cost estimating relationships, inflation indices, cost improvement curves, time phasing, and uncertainty analysis. Prerequisite: None.

OA4703 Defense Expenditure and Policy Analysis (4-0) As Required
A presentation of the major components of defense budgeting and policy formulation, from the standpoint of the three major institutions involved—the agency, executive, and congress. The use of quantitative models of institutional behavior is emphasized when examining both individual institutions and the interaction between them. Prerequisite: OA3103.

OA4704 Operations Research Techniques in Manpower Modeling (4-0) Fall/Spring
The objective of this course is to introduce the student to the major types of manpower and personnel models for estimating the effects of policy changes on the personnel system. Topics include longitudinal and cross-section models, optimization models, data requirements, and validation. Application in the form of current military models are included. Prerequisite: OA3103 or consent of the instructor.

OA4801 Spreadsheet Modeling for Military Operations Research (3-2) As Required
Implementation of a wide variety of military operations research topics on software accessible in any typical Department of Defense

(Fleet) environment. This course highlights military spreadsheet applications of operations research methods (e.g., discrete event simulation, optimization, queuing, Markov chains), discusses limitations, and demonstrates methods to supplement and customize spreadsheet analytical functions. Prerequisites: OA3103, OA3301 and OA3302.

OA4910 Selected Topics in Operations Analysis (V-0) As Required

(Variable hours 2-0 to 5-0.) Presentation of a wide selection of topics from the current literature. This course may be repeated for credit if course content changes. Prerequisites: A background of advanced work in operations research and departmental approval.

OA4930 Readings in Operations Analysis (V-0) As Required

(Variable hours 2-0 to 5-0.) This course may be repeated for credit if course content changes. Graded on Pass/Fail basis only. Prerequisite: Departmental approval.

OA5810 Dissertation Research (0-8) All Quarters

Dissertation research for doctoral students. Required in the quarter following advancement to candidacy and then continuously each quarter until dissertation is approved by the Academic Council. Prerequisite: Advancement to Candidacy.

OS Courses

OS2080 Probability and Statistics I (3-0) Fall/Spring

Fundamentals of probability and statistics useful in military modeling. Topics include probability laws and calculation methods, conditional probability, Bayes' Theorem, discrete and continuous random variables, the binomial, geometric, Poisson, exponential, and normal distributions, expectation, variance, and covariance, confidence intervals, hypothesis testing, and simple linear regression. Emphasis is on understanding uncertainty and developing computational skills for military systems analysis. Prerequisite: Single variable calculus.

OS2101 Analysis of Experimental Data (4-0) As Required

Introduction to statistical analysis of measurements and experimental data. Frequency distributions, graphical representation. Populations and sampling. Principle of least squares, estimation of mean and standard deviation. Curve fitting and regression, propagation of errors. Confidence intervals, tests and contingency tables. Elementary ANOVA. Relevant probabilistic concepts introduced as needed. Prerequisite: None.

OS2103 Applied Probability for Systems Technology (4-1) Fall/Winter/Summer

A first course in probability for students in operational curricula. Topics include probability laws and calculation methods, discrete and continuous random variables, common probability distributions, introduction to modeling, expectation, variance, covariance, and rudiments of discrete time processes. Emphasis is on understanding uncertainty and developing computational skills in probability. Prerequisites: Single variable differentiation and integration at the MA1113 level and multiple integration at the MA1115 level.

OS3000 Introduction to Management Science (3-0) As Required

A survey of techniques for making decisions quantitatively. Utility theory, linear programming, decision trees, networks and graphs, games, simulation, and waiting lines. Prerequisites: OS2103.

OS3002 Operations Research for Naval Intelligence (4-0) Fall

This course provides an introduction to the approach and methods of operations research, with special emphasis on military applications of interest to intelligence. It focuses on the mathematical modeling of combat operations and considers intelligence aspects. Students develop basic skills in such modeling. Topics include: operational definitions, measurement of combat effectiveness, model validation/verification, and models versus modeling. Also included are modeling of processes of target acquisition, fire assessment (kill probabilities and target coverage), tactical decision making, and games. Prerequisite: None.

OS3003 Operations Research for Information Operations (4-0) Summer

This course is a survey of operations research techniques. Spreadsheet analysis using Excel is applied to problem solving using methods in optimization, network flow, simulation, queuing, forecasting and decision analysis. Students will practice defining a problem, formulating a model, attaining a solution and evaluating the results using operations research techniques. The relationship between operations research and information operations is explored. Students will develop and understanding of operations research techniques and their application in the information operations domain. Prerequisite: OS2103.

OS3004 Operations Research for Computer Systems Managers (4-1) Fall/Spring

A one-quarter survey of operations research techniques of particular interest to students in computer systems management. Topics covered include: optimization, network flow models, simulation, queuing, forecasting techniques, Markov chains, decision analysis, reliability, and project management techniques. Spreadsheet models and analysis tools are an integral part of the course. Prerequisites: OS3101 and MA2300.

OS3006 Operations Research for Cost Analysts (3-0) Summer

This course is a survey of operations research techniques. Spreadsheet analysis using Excel is applied to problem solving using methods in decision theory, linear programming, network flow, simulation, queuing, forecasting, and project management techniques. Students will practice defining a problem, formulating a model, attaining a solution and evaluating the results using operations research techniques. Subject Matter Experts in cost estimation will provide an overview and background in cost estimation. Cost estimation examples are provided as part of homework exercises. Prerequisites: Single-variable calculus (MA1117).

OS3007 Operations Research for Energy Systems Analysts (4-0) Summer

A survey of operations research techniques with emphasis on techniques relevant to energy applications. Topics covered include optimization, stochastic modeling, simulation, and statistical methods including forecasting and system test and evaluation. Excel-based spreadsheet models are used to analyze energy systems and energy consumption logistics during wartime operations and during peacetime.

OS3008 Analytical Planning Methodology (4-0) Spring

A one-quarter survey of operations research techniques of particular interest to students in the C4I curriculum, with emphasis on model formation. Topics include linear and nonlinear programming,

integer programming, networks, shop flow and project scheduling, decision analysis, queuing, and simulation. Prerequisite: MA2300.

OS3080 Probability and Statistics II (3-0) Summer/Winter

Additional topics in probability and statistics for systems analysis, including conditional probability and conditional expectation, basic analytical process models, graphical data analysis, simple and multiple regression, and basic time-series analysis. This course is a follow-on to OS2080 for Master of Systems Analysis students. Prerequisite: OS2080.

OS3081 Systems Analysis Cases I (3-0) Summer/Winter

This is the first course in a three-course sequence in systems analysis practice. This course focuses on learning from real defense systems analysis case histories through readings, discussion, and writing point papers. Emphasis is on understanding the pitfalls of analysis, highlighting critical assumptions, and recognition of the strengths and weaknesses of applied analytical methodologies. Case histories include actual defense studies conducted with large-scale warfare simulations, seminar wargaming, and other methodologies common in DoD studies and analysis. Prerequisites: Graduate standing in Systems Analysis, Operations Research, or Systems Engineering; completion of courses in probability, statistics, simulation, uncertainty modeling, cost-benefit, decision analysis, and optimization.

OS3082 Systems Analysis Cases II (3-0) Spring/Fall

This is the second course in a three-course sequence in systems analysis practice. This course focuses on learning from participating in class discussion of decision and analysis problem cases and writing concise systems analysis proposals. Cases are drawn from scenarios in defense planning, programming, and budgeting of weapons systems and forces. Emphasis is on systems analysis problem formulation, identification of objectives, measures of effectiveness, articulation of critical assumptions, and outlining of appropriate analytical methodologies. Special emphasis is placed on cases that are typical of quick turn-around, limited-resources Pentagon programming analysis and budget drills. Prerequisite: OS3081.

OS3101 Statistical Analysis for Management (4-1) Winter/Summer

A specialized course covering the basic methods of probability and statistics with emphasis on managerial applications. The course includes applications of probability models, statistical inference, and regression analysis. Computation for these applications are carried out on a computer, using commercial software packages. Topics in probability include the binomial, geometric, Poisson, and normal distributions, risk, and expected value. Parametric statistical techniques include significance testing and confidence intervals, together with point estimation of model parameters. Regression analysis includes simple linear regression and multiple regression, with estimation of parameters and tests of hypothesis and confidence intervals for regression coefficients and the variance of the error term. Prerequisite: College algebra.

OS3104 Statistics for Science and Engineering (4-0) Winter/Summer

Acquaint the engineering student with the techniques of statistical data analysis with examples from quality control, life testing, reliability, and sampling inspection. Histograms and empirical distributions and random variables are introduced, along with their probability distributions and associated characteristics such as moments and percentiles. Following a brief introduction to decision making, standard tests of hypotheses and confidence intervals for both one- and two-parameter situations are treated. Regression analysis is related to least squares estimation and associated tests of hypotheses and confidence intervals are treated. Prerequisite: Calculus.

OS3105 Statistics for Technical Management (4-1) Fall/Spring

The course emphasizes management applications of probability models, statistical inference, and regression analysis. Those aspects of probability germane to distributions such as the binomial and normal are covered. Statistical inference for one and two variables is introduced in the settings of both hypothesis testing and confidence interval estimation. Students develop problem solving and numerical computation skills during laboratory periods using commercial software packages. Prerequisite: None.

OS3111 Probability and Statistics for HSI and MOVES (4-0) Fall/Spring

Noncalculus-based introduction in the context. Descriptive statistics and graphical techniques. Probability rules including Bayes Rule and independence. Discrete and continuous probability distributions, expected values, quantiles, variance, covariance, correlation, expected values, and variance of linear combinations of random variables, notably the sample mean. Fundamentals of statistics in one-sample setting including the ideas of estimation, confidence intervals, and hypothesis testing. Use and comparison of parametric and nonparametric approaches. Prerequisite: None.

OS3112 Statistics and Design of Experiments (4-2) Winter/Summer

This course reviews the basic concepts of data collection, data description, and graphical displays. It covers fundamentals of experimental design and analysis of categorical data. Students will learn how to set and analyze experiments using basic experimental design starting with two-sample methods and advancing to designs such as factorials, fractional factorials, and randomized block designs. Designs appropriate for human research (such as repeated measure designs) and/or large-scale simulation experiments (such as Latin hypercube designs) are included. Parametric and nonparametric approaches are compared and contrasted. Methods for analyzing categorical data are introduced: one- and two-sample inference for proportions, and contingency tables. Datasets and motivational examples are drawn from recent research relevant to HSI and/or MOVES. Prerequisites: College algebra and OS3111.

OS3113 Data Analysis for HSI and MOVES (4-1) Winter

Regression techniques using hands-on experience. Emphasis throughout is on real problems and real data. Topics covered include Simple Linear Regression, Multiple Regression, and Logistic and Loglinear Regression. Special topics include regression trees, principle components, and factor analysis. Prerequisite: None.

OS3180 Probability and Statistics for Systems Engineering (4-1) Winter/Summer

This course introduces the systems engineering and analysis student to probability, descriptive statistics, inferential statistics, and regression. The modeling and analysis of the stochastic behavior of systems provides the context for the course. Topical coverage includes the normal, binomial, Poisson, exponential, and lognormal distributions; probabilistic measures of system performance; graphical and numerical data summaries; confidence intervals and hypothesis tests based on one or two samples; regression with one or more predictors; and single factor analysis of variance. The lab portion of the class uses spreadsheets to support the modeling and

analyses. The course is delivered in block format. Prerequisite: SE1001 or equivalent.

OS3211 Systems Optimization (4-0) Fall

This course is an application-oriented introduction to optimization. It introduces models (linear, integer, and nonlinear programs), modeling tools (sensitivity and post-optimality analysis), and optimization software and solution techniques (including heuristics). It presents many military and private sector optimization applications in production planning and scheduling, inventory planning, personnel scheduling, project scheduling, distribution systems planning, facility sizing and capacity expansion, communication systems design, and product development. Prerequisite: None.

OS3301 Simulation Modeling and Analysis (3-1) Fall

OS3301 is a simulation and analytical course that provides students with a foundation in simulation theory and process modeling, random number generation concepts, basic queuing theory in process modeling, applied data analysis, an introduction into experimental design, hypothesis testing, and hands-on system simulation using a simulation modeling package. Students will use these concepts in class projects to simulate systems, evaluate system performance, and compare alternative systems. Prerequisites: OS2080, or OS2103 and OS3604, or equivalent.

OS3302 Quality Assurance and Reliability (4-0) Winter/Summer

This course is a technical treatment of a contractor's quality assurance program with attention to Sampling Inspection, Statistical Process Control, and Reliability. Topics include attribute and variables sampling plans, MILSTD/ANSI/ASQC and sequential sampling plans, quality control chart development and utilization, and manufacturing process capability estimation. Process management analytical tools are introduced using Minitab Quality Control software applications. Structure and implementation of quality assurance programs and quality improvement measures are discussed. Fundamentals of reliability modeling, life testing, reliability growth, estimation, and assessment are presented. Time and failure censored life-testing methods for Exponential and Weibull reliability models and Bayesian reliability estimation techniques are introduced. Best Management Practices and Program Managers Workstation are reviewed. Prerequisite: A previous course in probability and statistics.

OS3303 Computer Simulation (4-1) Fall/Spring

Design, implementation and use of digital simulation models will be covered with special emphasis on features common to USW problems. Wargaming will be discussed and a game using the digital computer will be played and critiqued by the class. Exercise planning and analysis will be treated. Basic topics are explained including computer generation of random variates, statistical design and monitoring of model progress, machine representation of dynamic data structures, model verification and validation on special purpose simulation and gaming languages. Prerequisites: OS2103 and OS3604, or equivalent.

OS3307 Modeling Practices for Computing (4-1) Fall/Spring

An applied course in modeling and understanding systems where randomness plays a significant role. Topics include basic probability and statistics, queuing models, Monte Carlo and discrete-event simulation, least squares curve fitting, and elements of statistical design of experiments. The focus will be on applications of these techniques in a computer science context. Prerequisites: Discrete Math and Introductory Programming.

OS3311 Probability Models for Military Applications (4-0) Fall/Spring

An intermediate course in probability modeling focused on military systems and combat situations. Following a review of random variables, probability distributions, expected values and variance, we will present a selection of probability models that range from elementary models that describe static and simple dynamic military (mostly combat) related situations, to Markov models that represent more complex combat situations (e.g., tactical battle) and processes (e.g., surveillance and employment of UAVs). Prerequisite: None.

OS3380 Combat Systems Simulation (3-1) Fall/Spring

This course provides an introduction to discrete and continuous time modeling of systems, especially combat systems. Students learn the fundamentals of simulation modeling and analysis, and construct increasingly sophisticated models of combat behavior. Students are introduced to Lanchester equations and other abstract models, as well as JANUS and other high-resolution, commercial combat simulation programs. Students reinforce and extend statistical skills by learning the principles for design and analysis of simulation experiments for estimation and comparison. The primary course objective is for the student to understand the enduring fundamentals of how combat models are built and used to support decision making. Prerequisites: SE1002 and OS3180.

OS3401 Human Factors in System Design (3-1) Summer

This course will provide an introduction to the field of Human Factors for Systems Engineering students with an emphasis on military systems. Humans are the most important element of any military system. Consequently, the design of effective systems must take into account human strengths and limitations as well as considerations of human variability. The course surveys human factors, human-centered design, and system effectiveness and safety. Topics include system design in light of human cognition and performance as they are influenced by physiological, anthropometric and environmental considerations. Emphasis is given to the responsibility of Systems Engineers to assure human performance and system effectiveness. Prerequisite: None.

OS3403 Human Factors in Information Warfare (3-1) Winter

This course will provide the student with the ability to evaluate and predict human performance in specified operational environments. The effects of stress factors such as noise, temperature, motion, work load, etc., on various aspects of human performance will be studied. Students will identify the control and display requirements or an EW system and design a work space to accommodate an EW data reduction/analysis system. Prerequisite: OS3604.

OS3404 Human-Machine Interaction (3-2) Fall/Winter/Spring

An introduction to the man-machine interface problems in C3. Information, display, and human communication requirements for effective C3. Applied orientation involving message handling systems, query languages, computer-to-computer communications, command and control applications programs, file transfer between host computers, etc. Prerequisite: Enrollment in the Joint C4I curriculum.

OS3603 Simulation and Wargaming (3-1) Fall/Summer

This course introduces students to systemic and interactive war-game simulation models. The students will understand and play two interactive war games and will run an existing systemic combat

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model to conduct output and sensitivity analysis on the results. Basic topics include measures of effectiveness, Monte Carlo processes for generating simulation events, decision and utility models, high resolution versus aggregated combat models, scenario development, and analysis objectives. Prerequisites: Basic Probability, Statistics, and Data Analysis at the level of OS2103 and OS3604 or equivalent, and a working knowledge of a computer programming language.

OS3604 Statistics and Data Analysis (4-1) Fall

An introduction to statistics and data analysis for students in the operational curricula. Topics include point and interval estimation, hypotheses testing, analysis of variance, multiple regression techniques, and categorical data analysis. Emphasis is placed on decision rules and in the analysis of data sets from operational environments. Computations are done in a statistical analysis package. Prerequisite: A course in probability (OS2103 or equivalent).

OS3640 Framework for Countering Improvised Explosive Devices (2-0) Spring/Fall

The course describes the use of improvised explosive devices in contemporary warfare with emphasis on how to organize to counter an IED campaign. The course begins with descriptions of IED devices, why and how they are used, methods and technology to counter IEDs, the IED organization, how to organize to counter an IED campaign, and how to target organizations that control IED violence. A framework is developed to understand and address the many interlocking aspects of countering an IED campaign including: insurgency and civil war; recruiting, training, and financing of IED makers; data collection; geospatial analysis; crime forensics; intelligence; detainee interrogations; reconstruction; political and economic development; society and culture; information operations; training local police, security forces, and military personnel; reconciliation; and negotiations. The class will be taught in the accelerated mode with four hours per week for the first six weeks of the quarter. There will be extensive reading, weekly homework, and a short paper. Graded on a Pass/Fail basis. Prerequisite: None.

OS3661 Introduction to Modeling and Simulation in Test and Evaluation (4-0) (DL)

This course introduces the use of modeling and simulation as a complement to physical testing in support of systems evaluation. The general relationships among modeling, simulation, test, and evaluation are introduced in context of systems acquisition lifecycle management. Forms of Live, Virtual and Constructive simulation in support of test planning, test execution, and systems analysis will be described, characterized, and illustrated with real-world examples. VV&A issues and opportunities relevant to the integrated use of simulation and testing in Systems Engineering and Acquisition will be identified. Strategies to optimize the use of scarce resources in executing test and evaluation programs will be provided. Methodologies for identifying and developing test MOEs, MOPs, and test scenarios will be introduced. Appropriate statistical concepts for evaluating Performance Guarantees and Specifications will be presented. Students in groups will develop a detailed T&E and Simulation Plan for a weapons system or future systems of systems concept. Prerequisite: None.

OS3680 Naval Tactical Analysis (4-0) Fall/Spring

This course surveys and applies various tools of operational and decision analysis to naval tactical problems. Topics include basic operational and tactical problem formulation, tactical decision analysis, and the application of uncertainty models for tactical problems in search and detection and weapons effectiveness. Prerequisite: A course in calculus-based probability and statistics (OS2080, OS3104, OS3180 or equivalent) or permission of the instructor.

OS3701 Cost Estimation I: Methods and Techniques (3-0) Fall/Spring (DL)

This course provides a broad-based understanding of the cost analysis activities involved in the acquisition and support of DoD systems. It introduces operations research techniques fundamental to the field of cost estimation. The course covers the defense systems acquisition process, time value of money, cost processes, data collection and sources, and economic analysis; it develops, uses, and analyzes cost estimating techniques commonly encountered in both the DoD and industry, including statistical and nonstatistical cost estimating relationships, inflation indices, cost improvement curves, time phasing, wrap rates, and uncertainty analysis. Prerequisite: OS3080 or equivalent.

OS3703 Systems Assessment (4-0) Winter/Summer

It introduces operations research techniques fundamental to the evaluation of concepts, processes and systems. Topics include cost estimation, effectiveness estimation through the T&E process, techniques for conducting design trades, and managing the risk involved. Development of communication skills is accomplished through oral presentations and written reports. Prerequisite: A graduate course in probability and statistics or consent of the instructor.

OS4001 Introduction to Probabilistic Modeling for HSI (4-0) Fall/Spring

This course will introduce the student to desktop modeling of humans, particularly emphasizing models that are relevant to military systems. The course will demonstrate current software tools designed around models of human stature, movement, and behavior. We will focus on the utilization of existing modeling techniques, which are useful for system design or evaluation, e.g., JACK, MicroSAINT, and SAFTE/FAST. Prerequisite: None.

OS4010 Engineering Risk Benefit Analysis (3-2) As Required

This course emphasizes three methodologies: Decision Analysis (DA), Reliability and Probabilistic Risk Assessment (RPRA), and Cost-Benefit Analysis (CBA). The course is designed to give students an understanding of how these diverse topics can be applied to the decision-making process of product design, which must take into consideration significant risk. The course will present and interpret a framework for balancing risks and benefits to applicable situations. Typically, these involve human safety, potential environmental effects, and large financial and technological uncertainties. Concepts from CBA and RPRA are applied to real-world problems, resulting in decision models that provide insight and understanding, and consequently lead to improved decisions. Prerequisite: None.

OS4011 Risk Benefit Analysis (3-2) Fall/Spring

This course emphasizes decision analysis, probabilistic risk assessment, and cost-benefit analysis in systems analysis and systems acquisition contexts. The course is designed to give students an understanding of how these diverse topics can be applied to a decision-making process that must take into consideration significant technological and financial risk. The course will present and interpret a framework for balancing risks

and benefits to applicable situations. Typically, these involve large financial and technological uncertainties. Concepts are applied to real-world problems resulting in decision models that provide insight, understanding, and improvement of acquisition decisions. Prerequisite: OS3080 or an equivalent graduate-level course in probability modeling.

OS4012 Cost Estimation III: Risk and Uncertainty Analysis (3-0) Winter/Summer

Risk and Uncertainty Analysis provides the foundation for an understanding of risk management as it relates to cost estimation. It addresses program risks that help ensure program costs, schedule, and performance objectives are met. Students are given an overview of how to model the cost/risk associated with a defense acquisition program. Topics covered include basic probability concepts, correlation, cost drivers, subjective probability assessment, goodness-of-fit testing, and simulation concepts using spreadsheet-based simulation packages. Monte Carlo simulation based cost risk case reinforce the techniques taught. Prerequisites: OS3080 and OS3701.

OS4013 Cost Estimation VI: Decision Analysis for Cost Estimators (3-0) Winter

This course presents an introduction to the techniques of Decision analysis. Decision analysis techniques can be used to help decision makers solve complex decision problems involving sequential decisions, major uncertainties, imperfect information, varying degrees of risk, and often multiple competing or conflicting objectives. The course includes structuring decision with influence diagrams and decision trees, modeling uncertainty with subjective probabilities, sensitivity analysis, the value of information, and modeling risk attitudes using utility theory. A fundamental understanding of probability and calculus is expected. Prerequisites: OS3080, OS3006, OS4702.

OS4080 Cost Estimation V: Cost Estimating and Analysis Cases (3-0) Summer/Winter (starting Summer 2012)

This course focuses on learning from real cost estimation case histories through readings, discussion, and writing point papers. Emphasis is on understanding the capabilities and limitations of cost estimation and analysis, highlighting critical assumptions, and recognition of the strengths and weaknesses of applied analytical methods. Case histories include actual department of defense cost studies conducted that have been considered successes and those that have been considered failures. These cases provide the lessons learned for future cost estimation and analysis studies. Prerequisite: OS4703.

OS4081 Cost Estimating and Analysis Capstone I (3-4) Fall/Spring (starting Fall 2013)

This course focuses on learning from participating in a cost estimation team project. Small-teams (4-6 students) will be given an actual cost estimating analysis project drawn from actual cost problems compiled by the major systems commands and Service Cost Agencies from the departments of the Army, Navy, and Air Force. Emphasis is on cost problem formulation, identification of objectives, measures of effectiveness, articulation of critical assumptions, and outlining of appropriate analytical methods. Class time during the quarter is used for team progress briefings and critical class discussion. Prerequisite: OS4080.

OS4082 Cost Estimating and Analysis Capstone II (3-4) Winter/Summer (starting Winter 2013)

This course continues the on hands-on experience of OS4081, completing the cost estimation project. Student teams will develop the cost model and analyze alternative cost estimations of the problems presented in the previous course; they will develop and test the estimate, and then document and defend their estimate. Students provide concise written reports, which include the analytical results, and a presentation to decision makers. Class time during the quarter is used for team progress briefings and critical class discussion. Prerequisite: OS4801.

OS4083 Systems Analysis Cases III (3-4) Summer/Winter

This is the third course in a three-course sequence in systems analysis practice. This course focuses on hands-on experience conducting rapid quantitative systems analysis. Emphasis is on small-team (2-3 students) systems analysis projects and presentations. Typical projects are based on analysis proposals developed in the preceding course. Class time during the quarter is used for team progress briefings and critical class discussion. The projects culminate with a concise written report, including analytical results, and a presentation to decision makers. Prerequisite: OS3082.

OS4580 Logistics Systems Analysis (4-0) Fall/Spring

This course is about military logistics systems. It includes processes employed during system acquisition, chiefly reliability and maintainability analyses, which contribute, along with other aspects of a military logistics system, to determining the operational support costs and operational availability of military systems. In-service support includes the supply system for repair parts for organizational-level maintenance and the provision of military or contractor support of depot-level maintenance. Operational logistics includes logistics planning and predicting the sustainability of deployed forces. Prerequisites: OS3180 and SE3100.

OS4621 Critical Infrastructure Analysis and Defense (4-0) Spring

The premise of this course is straightforward: our dependence on critical infrastructures makes us vulnerable to both deliberate and non-deliberate events that can disrupt our physical, economic, and social welfare. This course develops the literacy and competencies necessary to understand potential problems and realistic solutions for critical military and civilian infrastructure in the United States. Students gain experience in the use of "red teaming" analysis for evaluating infrastructure vulnerability through case studies on civilian and DoD/DoN systems, and through a course project. **This course is restricted to U.S. students only.** Prerequisites: NS3180 or OA4202 or consent of instructor.

OS4661 Advanced Modeling and Simulation in Test and Evaluation (4-0) (DL)

This course addresses advanced issues in the application of modeling and simulation as a compliment to physical testing in support of systems evaluation. It introduces pre-test simulation using experimental designs to identify the most important factors to be used in live testing scenarios. Detailed analysis methods of testing and simulation results including military and statistical significance are addressed. Additional topics include reliability modeling and life testing and various enabling architectures in distributed simulation. Applications to Analysis of Alternatives and rapid acquisitions are discussed. Various forms of simulation in support of test planning, test execution, and systems analysis are described including simulation facilities and test ranges. Students in groups will conduct a comparative analysis of competing systems using experimental design and simulation methods. Prerequisite: OS3661Introduction to Modeling and Simulation in Test and Evaluation.

OS4680 Naval Systems Analysis (4-0) Winter/Summer
This course covers the techniques for the analysis of proposed and existing systems. It includes analysis of alternatives and models in decision making, optimization in design and operations, queuing theory and analysis, Markov analysis, and selected topics to support project work. Students analyze case studies and complete a course project. Students also use spreadsheet software for modeling and analyzing design alternatives, and develop communication skills by writing reports of analyses. Prerequisites: OS2080 or OS3180, OS3380 and OS3680.

OS4701 Manpower and Personnel Models (4-0) Winter/Summer
The objective of this course is to introduce the student to the major types of manpower and personnel models for estimating the effects of policy changes on the personnel system. Topics include longitudinal and cross-section models, optimization models, data requirements, and validation. Application in the form of current military models is included. Prerequisites: GB3040 and GB4043, or OA3103, or consent of the instructor.

OS4702 Cost Estimation II: Advanced Concepts in Cost Estimating (3-0) Winter/Summer
This course is the second of three sequential cost estimation courses. It provides a broad-based understanding of the cost estimating principles applied to various fields of the acquisition and support of DoD systems. It introduces topics such as Cost Estimating Relationships, non-Ordinary Least Squares methods, Software Cost Estimating, Labor Pricing, Source Selection Process, Cost Management, EVMS, and higher level Regression Applications. Prerequisite: OS3701 or OA4702.

OS4703 Cost Estimation IV: Applied Cost Analysis (3-0) Spring/Fall
This course is the third of three sequential cost estimation courses. It provides a broad based understanding of the cost estimating principles applied to various fields of the acquisition and support of DoD systems. It focuses on the analysis of cost methods and topics such as Specialized Cost Estimating, Portfolio Analysis, Cost Benefit Analysis, Industrial Base Analysis, Supply Chain Management, and Labor Rates. Prerequisite: OS4702 or OA4702.

Human Systems Integration Certificate - Curriculum 262

Program Manager

Lawrence G. Shattuck, Ph.D.
Code OR, Glasgow Hall, Room 234

(831) 656-2473, DSN 756-2473
FAX: (831) 656-2595
lgshattu@nps.edu

Brief Overview

The Human Systems Integration Certificate program is a distance learning, graduate-level, non-degree program designed to enable acquisition professionals, program managers, engineers and scientists of the DoD to effectively implement Human Systems Integration (HSI) as required by the DoD.

Students will learn the fundamentals in applying usability assessments, modeling, optimization, and decision making to demonstrate cost-benefit trade-offs for technical, cost, and schedule modifications in systems acquisition.

The program consists of four online courses taken over a 12 month period. The course content and projects address problems of interest to the DoD.

Requirements for Entry

A baccalaureate degree with above average grades and an academic profile code of 345. Two or more pre-calculus courses with B or better average. Completion of DAU ACQ_101 and ACQ_201A.

Entry Dates

Summer quarter.

Program Length

Four quarters.

Graduate Certificate Requirements

Requirements for the certificate are met by successful completion of all four courses, in succession.

Required Courses

OA3411	Introduction to Human Systems Integration	(3-0)
OA3412	Human Systems Integration in the Department of Defense Acquisition Lifecycle	(3-0)
OA3413	Human Systems Integration Tools, Tradeoffs, and Processes	(3-1)
OA4414	Human Systems Integration Case Studies and Applications	(4-0)

Cost Estimating and Analysis Certificate (DL) - Curriculum 289

Program Manager

Daniel Nussbaum, Ph.D.
Code OR/Glasgow, Room 242
(831) 656-2387, DSN 756-2387
danussba@nps.edu

Greg Mislick, Lecturer
Code OR/Glasgow Hall, Room 202
(831) 656-3113, DSN 756-3113
gmislick@nps.edu

Brief Overview

The Cost Estimating and Analysis certificate program is a distance learning, graduate-level, non-degree program designed to provide cost estimating and analysis training to

Navy and other DoD personnel. The program consists of four courses delivered one per quarter via distance learning over a one-year period.

Requirements for Entry

A baccalaureate degree is required. Recent completion (within five years) of mathematics through single variable differential and integral calculus is considered minimal preparation. Prior course work in probability and statistics, including regression is essential for successful completion of the certificate. An academic profile code (APC) of 335 is required.

Program Length

Four quarters

Graduate Certificate Requirements

Requirements for the graduate-level certificate in Cost Estimating and Analysis are met by successful completion of all four required courses.

Required Courses

OS3006	(3-0)	Operations Research for Cost Analysts
OS3701	(3-0)	Cost Estimation I: Methods and Techniques
OS4702	(3-0)	Cost Estimation II: Advanced Concepts in Cost Estimating
OS4012	(3-0)	Cost Estimation III: Risk and Uncertainty Analysis

Certificate in Systems Analysis - Curriculum 281

Program Officer

Jeffrey F. Hyink, CAPT, USN
Code OR, Glasgow Hall, Room 226

(831) 656-3094, DSN 756-3094
FAX (831) 656-2595
jfhyink@nps.edu

Academic Associate

Steven E. Pilnick, Ph.D.
Code OR/Ps, Glasgow Hall, Room 291

(831) 656-2283, DSN 756-2283
FAX (831) 656-2595
spilnick@nps.edu

Brief Overview

The Systems Analysis Certificate program is a distance learning, graduate-level, nondegree program designed to meet the needs of the Navy and other services in the Department of Defense (DoD) for nondegree technical

education in systems analysis as a basis for aiding key decisions on force requirements, weapon systems, and other defense matters. Students learn and apply modeling, optimization, simulation, and decision making under risk and uncertainty.

The Certificate Program consists of four, fully-accredited courses delivered entirely online over a one-year period. The course content and projects will challenge the student academically and address problems of interest to the Department of Defense. The courses are paced week-to-week by the instructors, but the students have great flexibility to do their course work at times of their choosing during each week.

Requirements for Entry

A baccalaureate degree is required. Completion of mathematics through single variable differential and integral calculus is considered minimal preparation. An academic profile code (APC) of 335 is required.

Entry Dates

At the beginning of the spring and fall quarters, with start dates in late March/early April and late September/early October, respectively.

Program Length

Four Quarters.

Graduate Certificate Requirements

Requirements for the graduate certificate in Systems Analysis are met by successful completion of all four courses.

Required Courses

Quarter 1

OS2080	(3-0)	Probability and Statistics I

Quarter 2

OS3380	(3-1)	Combat Systems Simulation

Quarter 3

OS3680	(4-0)	Naval Tactical Analysis

Quarter 4

OS4680	(4-0)	Naval Systems Analysis

Systems Engineering Analysis Program - Curriculum 308

This curriculum is described under the Systems Engineering Analysis Curriculum and Program section of this Catalog. The Department of Operations Research supports this curriculum with courses, faculty and project advisors.

Operations Analysis (Energy) - Curriculum 358

Program Officer

Walter C. DeGrange, CDR, USN
Code OR, Glasgow Hall, Room 254

(831) 656-3026, DSN 756-3026
FAX (831) 656-2595
wcdegran@nps.edu

Academic Associate

Steven E. Pilnick, Ph.D.
Code OR/Ps, Glasgow Hall, Room 291

(831) 656-2283, DSN 756-2283
FAX (831) 656-2595
spilnick@nps.edu

Brief Overview

The Operations Analysis (OA) curriculum was founded by the Navy in 1951, in order to retain, develop, and promulgate the methods of Operations Research (OR) that were used so successfully in World War II. OR is the science of helping people and organizations make better decisions. More formally, it is the development and application of mathematical models, statistical analyses, simulations, analytical reasoning, and common sense to the understanding and improvement of real-world operations. Improvement can be measured by the minimization of cost, maximization of efficiency, or optimization of other relevant measures of effectiveness. Practitioners are called on to advise military and civilian decision makers on the allocation of scarce resources, the selection of new equipment and processes, and the optimal deployment of given resources to achieve required missions.

The Energy Option applies targeted education in Energy technology and policy with the discipline of OA to enable the graduate to focus on Energy-related analysis concerning such issues as:
· development and implementation of cost-effective energy technology programs throughout DON and DOD;
· strengths and weaknesses as well as cost and logistics implications of new energy technical proposals, and the analysis of alternatives which recognize the potential impact on DOD/DON programs and objectives;
· risk assessment and impact analysis for platforms, systems and equipment that produce or consume energy;
· Energy systems in operations and logistics problem solving, and cost analysis efforts specifically as they relate to existing and proposed DON/DOD Energy programs; and

· evaluating the utility of Energy systems, technology, and programs currently employed by DON/DOD.

Mathematics, probability, statistics, economics, human factors, and optimization supply the theoretical background for analyzing alternative choices in tactical and strategic warfare, and in planning, budgeting, and procurement of systems and forces. The student learns computational methods and develops skills to identify relevant information, formulate decision criteria, and select alternatives. This education enhances performance in all duties throughout a military career including operational billets, technical management assignments, and policy-making positions.

Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of mathematics through single variable differential and integral calculus with above-average grades is considered minimal preparation. Students without these quantitative prerequisites will be accepted in cases where their undergraduate records indicate that they are exceptional students and there are other indicators of potential. An academic profile code (APC) of 325 is required. Waivers may be obtained with a one-quarter refresher.

Entry Date

Operations Analysis (Energy) is a seven-quarter course of study (eight quarters including JPME) with an entry date in September. If required, students attend one-quarter mathematics "refresher" prior to entering the OA curriculum. This refresher sequence begins in July for the September start dates. If further information is needed, contact the Academic Associate or the Program Officer for this curriculum.

Degree

Requirements for the Master of Science degree are met en route to satisfying the Educational Skill Requirements of the curricular program as well as Service Intermediate-level PME and Phase I Joint PME credit.

Master of Science in Operations Research

The Master of Science in Operations Research degree requires:
· Completion of a minimum of 40 quarter-hours of graduate-level courses with:
  · At least 20 quarter-hours of 4000-level courses, of which at least 16 are OA.
  · An elective sequence approved by the Chairman, Department of Operations Research.
· Submission of an acceptable thesis on a subject previously approved by the Chairman, Department of Operations Research.

Subspecialty

Completion of this curriculum qualifies an officer as an Operations Analysis – Energy Subspecialist with a subspecialty code of 3213P and JPME Phase I education certification for students whose orders include the extra quarter for JPME. The community manager for the OA subspecialty and major area sponsor of the curriculum is the Director of the Chief of Naval Operations, Assessment Division (OPNAV N81). The subject matter expert for the Energy Option is OPNAV N45, the Director of the Chief of Naval Operations Energy and Environmental Readiness Division.

Typical Course of Study (OA Energy Option- with JPME)

Quarter 0 (Refresher, if needed)
MA1113	(4-0)	Single Variable Calculus
MA1114	(4-0)	Single Variable Calculus II
MA1025	(4-0)	Introduction to Mathematical Reasoning
OA1600	(2-2)	Introduction to Operations Analysis I
EN3000	(2-0)	Defense Energy Seminar

Quarter 1
MA3042	(4-0)	Linear Algebra
MA1118	(4-0)	Multivariable Calculus
OA3101	(4-1)	Probability
OA2801	(4-1)	Computational Methods for Operations Research
EN3000	(2-0)	Defense Energy Seminar

Quarter 2
OA3201	(4-0)	Linear Programming
OA3102	(4-2)	Statistics
OA3301	(4-0)	Stochastic Models I
PH3700	(4-0)	Fundamentals of Energy
EN3000	(2-0)	Defense Energy Seminar

Quarter 3
OA4202	(4-0)	Network Flows and Graphs
OA3103	(4-1)	Data Analysis
OA3302	(4-0)	Simulation Modeling
MN4970	(4-0)	Energy Economics
EN3000	(2-0)	Defense Energy Seminar

Quarter 4
OA4201	(4-0)	Nonlinear Programming
OA4106	(3-1)	Advanced Data Analysis
OA4333	(4-0)	Simulation Analysis
OS3007	(4-0)	OR for Energy Systems Analysts
EN3000	(2-0)	Defense Energy Seminar

Quarter 5
OA4655	(4-0)	Introduction to Joint Combat Modeling
OA4801	(3-2)	Spreadsheet Modeling for Operations Research
OA3900	(5-0)	OA (Energy) Experience Tour (3 weeks)
OA46xx	(4-0)	Energy Logistics in Warfare Operations
EN3000	(2-0)	Defense Energy Seminar

Quarter 6
OA3304	(4-0)	Decision Theory
OA4702	(4-0)	Cost Estimation
	(V-V)	JPME
OA0810	(0-8)	(Energy) Thesis Research
EN3000	(2-0)	Defense Energy Seminar

Quarter 7
	(V-V)	JPME
	(V-V)	JPME
OA4301	(4-0)	Stochastic Models II
OA0810	(0-8)	(Energy) Thesis Research
EN3000	(2-0)	Defense Energy Seminar

Quarter 8
OA4602	(4-0)	Joint Campaign Analysis
OA4656	(4-0)	Advanced Combat Modeling
	(V-V)	JPME
OA0810	(0-8)	(Energy) Thesis Research
EN3000	(2-0)	Defense Energy Seminar

Educational Skill Requirements (ESR)
Operations Analysis (Energy) - Curriculum 358
Subspecialty Code: 3213P

Operations Analysis Core ESRs

1. **Basics:** The graduate will possess the mathematical and computer programming skills required to support graduate study in operations research and have the ability to use computers as a tool to aid in analysis.

2. **Optimization:** The graduate will be able to formulate and solve a wide variety of optimization problems and also be conversant with the major uses of such models in DoD and the private sector.

3. **Stochastic Modeling:** The graduate will be able to formulate and solve problems involving stochastic processes (processes with uncertainty over time) and also be familiar with the major applications of such models.

4. **Simulation:** The graduate will be able to construct and utilize simulations of combat and other processes that evolve in time, and will be able to deal with statistical issues associated with the need for replication.

5. **Analysis of Military Operations:** The graduate will be familiar with U.S./allied and potential enemy capabilities, doctrine, tactical and logistical support concepts. The graduate will be able to model and analyze military operations using operations analysis techniques, and be able to develop new tactical concepts based on theory and exercise reconstruction and analysis.

6. **Systems Analysis:** The graduate will understand the basic principles of systems analysis as a basis for making key decisions on force requirements, weapon systems, and other defense problems.

7. **Practice:** The graduate will have gained experience working on all aspects of an analytical study, and will demonstrate the ability to conduct independent analytical studies and proficiency in presenting the results both orally and in writing.

Energy ESRs

1. The graduate will have the ability to apply Energy principles as well as knowledge from Operations Analysis to the development and implementation of cost-effective energy technology development and acquisition programs throughout DON and DOD.

2. The graduate will be able to analyze the strengths and weaknesses as well as cost and logistics implications of new energy technical proposals and suggest alternatives which recognize the potential impact on DOD/DON programs and objectives.

3. The graduate will understand and be able to apply a range of Operations Analysis techniques (e.g., risk assessment and impact analysis) to RDT&E programs for platforms, systems and equipment that produce or consume energy.

4. The graduate will have the ability to use and understand Energy systems in operations and logistics problem solving and cost analysis efforts specifically as they relate to existing and proposed DON/DOD Energy programs.

5. The officer will be capable of understanding and evaluating the utility of Energy systems, technology, and programs currently employed by DON/DOD. Probability, Statistics, and Data Analysis: The graduate will be well-versed in the fundamentals of probability, statistics and data analysis for application to modeling, simulation, and analysis of military decision problems.

Curriculum Sponsor and ESR Approval Authority

Energy Subject Matter Expert is Director, Energy and Environmental Readiness Division (N45), Office of the Chief of Naval Operations. Operations Analysis sponsor is Director, Assessment Division (N81), Office of the Chief of Naval Operations. ESR approval authority is Director, Total Force Training and Education (N15), Office of the Chief of Naval Operations. (OA-E Curriculum Review conducted 21 February 2013.)

Operations Analysis - Curriculum 360

Program Officer

Jeffrey F. Hyink, CAPT, USN
Code OR, Glasgow Hall, Room 226

(831) 656-3094, DSN 756-3094
FAX (831) 656-2595
jfhyink@nps.edu

Academic Associate

Robert Koyak
Glasgow Hall, Room 289

(831) 656-2688, DSN 756-2688
FAX (831) 656-2595
rakoyak@nps.edu

Brief Overview

The Operations Analysis (OA) curriculum was founded by the Navy in 1951, in order to retain, develop, and promulgate the methods of Operations Research (OR) that were used so successfully in World War II. OR is the science of helping people and organizations make better decisions. More formally, it is the development and application of mathematical models, statistical analyses, simulations, analytical reasoning, and common sense to the understanding and improvement of real-world operations. Improvement can be measured by the minimization of cost, maximization of efficiency, or optimization of other relevant measures of effectiveness. Practitioners are called on to advise military and civilian decision makers on the allocation of scarce resources, the selection of new equipment and processes, and the optimal deployment of given resources to achieve required missions.

Mathematics, probability, statistics, economics, human factors, and optimization supply the theoretical background for analyzing alternative choices in tactical and strategic warfare, and in planning, budgeting, and procurement of systems and forces. The student learns computational methods and develops skills to identify relevant information, formulate decision criteria, and select alternatives. This education enhances performance in all duties throughout a military career including operational billets, technical management assignments, and policy-making positions.

Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of mathematics through single variable differential and integral calculus with above-average grades is considered minimal preparation. Students without these quantitative prerequisites will be accepted in cases where their undergraduate records indicate that they are exceptional students and there are other indicators of potential. An academic profile code (APC) of 325 is

required. Waivers may be obtained with a one-quarter refresher.

Entry Date

The Operations Analysis course of study (eight quarters including JPME) begins with entry dates in March and September. In general, students attend a one-quarter mathematics "refresher" prior to entering the OA curriculum. This refresher sequence begins in January or July, for the March or September start dates, respectively. If further information is needed, contact the Academic Associate or the Program Officer for this curriculum.

Degree

Requirements for the Master of Science degree are met en route to satisfying the Educational Skill Requirements of the curricular program as well as Service Intermediate-level PME and Phase I Joint PME credit.

Master of Science in Applied Science

Students with acceptable academic backgrounds may enter a program leading to a degree in Applied Science with a major in Operations Research. The program of each student seeking this degree must contain a minimum of 20 quarter-hours in operations research at the graduate level, including work at the 4000 level. Additionally, the program must contain a minimum of 12 graduate quarter-hours in an approved sequence of courses outside the Department of Operations Research. A total minimum of 12 quarter-hours at the 4000 level, plus an acceptable thesis, is required. This program provides depth and diversity through specially arranged course sequences to meet the needs of the Navy and the interests of the individual. The Department Chairman's approval is required for all programs leading to this degree. Applications to include this degree in dual master's programs will not be approved.

Master of Science in Operations Research

The Master of Science in Operations Research degree requires:
· Completion of a minimum of 40 quarter-hours of graduate-level courses with:
  · At least 20 quarter-hours of 4000-level courses, of which at least 16 are OA.
  · An elective sequence approved by the Chairman, Department of Operations Research.
· Submission of an acceptable thesis on a subject previously approved by the Chairman, Department of Operations Research.

Doctor of Philosophy in Operations Research

The department offers the Doctor of Philosophy in Operations Research degree. The program begins with advanced course work guided by the student's doctoral committee and leading to qualifying examinations in optimization, statistics, and stochastic processes as well as completion of a minor field of study outside of operations research. The primary emphasis then shifts to the student's research program, culminating in the Ph.D. dissertation.

An applicant to the Ph.D. program who is not already a student at NPS should submit transcripts of previous academic and professional work, plus results of a current Graduate Record Examination (GRE) general test, to the Director of Admissions, Code 01C3, Naval Postgraduate School, Monterey, CA 93943-5100. Detailed admission procedures may vary depending on the individual's location and position. However, in all cases, the student must fulfill the general school requirements for the doctoral degree. Residency for this program generally requires three years beyond completion of a master's degree.

Subspecialty

Completion of this curriculum qualifies an officer as an Operations Analysis Subspecialist with a subspecialty code of 3211P and JPME Phase I education certification for students whose orders include the extra quarter for JPME. The community manager for the OA subspecialty is the Office of the Chief of Naval Operations, Assessment Division (OPNAV N81).

Typical Subspecialty Jobs

Defense Resources Management OPNAV Analyst
JCS Analyst Director, OPS Research: SACLANT
Assistant Staff OPS and PLANS: COMCARGRU Staff
    OPS and PLANS: COMTHIRDFLT
BUPERS OSD Analyst
OPS Analyst: Naval War College Instructor: NPS
Cost Analyst Warfare Analyst

Typical Course of Study (Naval Warfare Option)

Quarter 1

Course	Hours	Title
MA1118	(4-0)	Multivariable Calculus
MA3042	(4-0)	Linear Algebra
OA2801	(4-1)	Computational Methods for Operations Research
OA3101	(4-1)	Probability

Quarter 2

Course	Hours	Title
OA3102	(4-2)	Statistics
OA3201	(4-0)	Linear Programming
OA3301	(4-0)	Stochastic Models I
OA3304	(4-0)	Decision Theory

Quarter 3

Course	Hours	Title
OA3103	(4-1)	Data Analysis
OA3302	(4-0)	Simulation Modeling
OA4202	(4-0)	Network Flows and Graphs
OA4301	(4-0)	Stochastic Models II

Quarter 4

OA4201	(4-0)	Nonlinear Programming
OA4106	(3-1)	Advanced Data Analysis
OA4333	(4-0)	Simulation Analysis
OA4702	(4-0)	Cost Estimation

Quarter 5 (First eight weeks)

OA3602	(4-1)	Search Theory and Detection
OA4655	(4-0)	Introduction to Joint Combat Modeling
OA4801	(3-2)	Spreadsheet Modeling for Military Operations Research
(Last three weeks)		Experience Tour/Thesis Research

Quarter 6

OAXXXX		Elective
OA4602	(4-0)	Joint Campaign Analysis
OA4656	(4-0)	Studies in Defense and Military OR
OA0810	(0-8)	Thesis Research

Quarter 7

OAXXXX		Elective
OA3401	(3-1)	Human Factors in Systems Design
NW3230	(4-2)	Strategy and Policy
OA0810	(0-8)	Thesis Research for Operations Analysis Students

Educational Skill Requirements (ESR)
Operations Analysis - Curriculum 360
Subspecialty Code: 3211P

1. **Basics**: The graduate will possess the mathematical and computer programming skills required to support graduate study in operations research and have the ability to use computers as a tool to aid in analysis.

2. **Probability, Statistics, and Data Analysis:** The graduate will be well-versed in the fundamentals of probability, statistics and data analysis for application to modeling, simulation, and analysis of military decision problems.

3. **Optimization**: The graduate will be able to formulate and solve a wide variety of optimization problems and also be conversant with the major uses of such models in DoD and the private sector.

4. **Stochastic Modeling**: The graduate will be able to formulate and solve problems involving stochastic processes (processes with uncertainty over time) and also be familiar with the major applications of such models.

5. **Simulation**: The graduate will be able to construct and utilize simulations of combat and other processes that evolve in time, and will be able to deal with statistical issues associated with the need for replication.

6. **Analysis of Military Operations**: The graduate will be familiar with U.S./allied and potential enemy capabilities, doctrine, tactical and logistical support concepts. The graduate will be able to model and analyze military operations using operations analysis techniques, and be able to develop new tactical concepts based on theory and exercise reconstruction and analysis.

7. **Systems Analysis**: The graduate will understand the basic principles of systems analysis as a basis for making key decisions on force requirements, weapon systems, and other defense problems.

8. **Practice**: The graduate will have gained experience working on all aspects of an analytical study, and will demonstrate the ability to conduct independent analytical studies and proficiency in presenting the results both orally and in writing.

Curriculum Sponsor and ESR Approval Authority

Curriculum sponsor is Director, Assessment Division (N81), Office of the Chief of Naval Operations. ESR approval authority is Director, Total Force Training and Education (N15), Office of the Chief of Naval Operations. (OA Curriculum Review conducted 21 February 2013.)

Joint Operational Logistics - Curriculum 361

Program Officer

Walter C. DeGrange, CDR, USN
Code OR, Glasgow Hall, Room 254

(831) 656-3026, DSN 756-3026
FAX (831) 656-2595
wcdegran@nps.edu

Academic Associate

Steven E. Pilnick, Ph.D.
Code OR/Ps, Glasgow Hall, Room 291

(831) 656-2283, DSN 756-2283
FAX (831) 656-2595
spilnick@nps.edu

Brief Overview

This program provides education in mathematics, probability and statistics, physical science, economics, logistics, and computer science. These disciplines supply the theoretical background for planning and analysis of naval and joint logistics.

The course of study develops skills in computational capability, identifying relevant information, generating decision criteria, and selecting alternatives. This education enhances performance in all duties throughout a military career, including operational billets, technical management assignments, and policy-making positions.

Requirements for Entry

A baccalaureate degree with above-average grades is required. Completion of mathematics through single variable differential and integral calculus with above-average grades is considered minimal preparation. Students without these quantitative prerequisites will be accepted in cases where their undergraduate records indicate that they are exceptional students and there are other indicators of potential. An academic profile code (APC) of 325 is required. Waivers may be obtained with a one-quarter refresher.

Entry Date

Joint Operational Logistics (JOL) is a seven-quarter course of study (eight quarters including JPME) with entry dates in March and September. If needed, students attend a one-quarter mathematics "refresher" prior to entering the JOL curriculum. The refresher sequence begins in January or July, for the March or September start dates, respectively. If further information is needed, contact the Academic Associate or Program Officer for this curriculum.

Degree

Requirements for the Master of Science in Operations Research degree are met en route to satisfying the Educational Skill Requirements of the curriculum.

Subspecialty

Completion of this curriculum qualifies an officer as an Operational Logistics Subspecialist with a subspecialty code of 3212P. The community manager for this subspecialty is CNO N4, Deputy Chief of Naval Operations (Fleet Readiness and Logistics).

Typical Subspecialty Jobs

Joint Chiefs of Staff: Joint Logistics Planning, Mobility Analyst

OPNAV: Operational Logistics Analyst, Logistics Assessment

Fleet Forces Command: Ordnance Planning Analyst

Commander Pacific Fleet: Logistics Plans Officer

Commander, U.S. Naval Forces Europe: Logistics Plans Officer

TRANSCOM: Operations and Plans Officer, Sealift Analyst

Afloat Staffs: Logistics Planning Officer

Typical Course of Study (with JPME)

Quarter 0 (Refresher, if needed)

MA1113	(4-0)	Single Variable Calculus I
MA1114	(4-0)	Single Variable Calculus II
MA1025	(4-0)	Introduction to Mathematical Reasoning
OA1600	(2-2)	Introduction to Operations Analysis I

Quarter 1

MA1118	(4-0)	Multivariable Calculus
MA3042	(4-0)	Linear Algebra
OA2801	(4-1)	Computational Methods for Operations Research
OA3101	(4-1)	Probability

Quarter 2

OA3102	(4-1)	Statistics
OA3610	(4-0)	Introduction to Naval Logistics
OA3201	(4-1)	Linear Programming
OA3301	(4-0)	Stochastic Models I

Quarter 3

OA3103	(4-1)	Data Analysis
OA4202	(4-0)	Network Flows and Graphs
OA4301	(4-0)	Stochastic Models II
OA3302	(4-0)	Simulation Modeling

Quarter 4

OA4106	(3-1)	Advanced Data Analysis
OA4333	(4-0)	Simulation Analysis
OA3501	(4-0)	Inventory I
OA4201	(4-0)	Nonlinear Programming

Quarter 5 (First eight weeks)

OA4613	(4-0)	Energy Logistics in Warfare Operations
OA4655	(4-0)	Joint Combat Modeling
OA4801	(3-2)	Spreadsheet Modeling for Military Operations Research
(Last three weeks)		Experience Tour/Thesis Research

Quarter 6

OA4611	(4-0)	Joint and Combined Logistics
OA4656	(4-0)	Studies in Defense and Military OR
OA3304	(4-0)	Decision Theory
OA0810	(0-8)	Thesis Research

Quarter 7

OA4xxx	(4-0)	Elective
NW3230	(4-2)	Strategy and Policy
NW3275	(4-0)	Joint Maritime Operations - Part 1
OA0810	(0-8)	Thesis Research

Quarter 8

OA4602	(4-0)	Joint Campaign Analysis
NW3285	(4-0)	National Security Decision Making
NW3276	(2-2)	Joint Maritime Operations - Part 2
OA0810	(0-8)	Thesis Research

Educational Skill Requirements (ESR)
Operational Logistics - Curriculum 361
Subspecialty Code 3212P

1. **Basics**: The graduate will possess the mathematical and computing skills to support quantitative analysis.

2. **Modeling Uncertainty**: The graduate will be well-versed in probability and statistics and their application to operations research (OR) problems.

3. **Optimization**: The graduate will be able to formulate and solve a wide variety of optimization problems and also be conversant with the major uses of such models in DoD and the private sector.

4. **Stochastic Modeling**: The graduate will be able to formulate and solve problems involving stochastic processes (processes with uncertainty over time) and be familiar with the major applications of such models.

5. **Simulation**: The graduate will be able to construct and utilize discrete event and Monte Carlo simulations of combat and other processes, particularly logistics-themed, which evolve in time and space, and will be able to deal with analysis issues associated with stochastic simulation models.

6. **Analysis of Military Operations**: The graduate will be familiar with U.S., allied, and potential enemy capabilities, and will be able to model and analyze joint military operations using OR techniques. The graduate will also be able to develop and evaluate new tactical and logistic concepts for a variety of operations ranging from humanitarian assistance/disaster relief to combat.

7. **Joint Logistics**: The graduate will understand naval and joint logistics systems; joint planning systems; military and commercial transportation systems of all types; supply systems; maintenance, engineering, and health services; and the use of analysis in all aspects of planning for the logistics support of joint forces.

8. **Systems Analysis**: The graduate will understand the basic principles and applications of system analysis, as a basis for making key decisions on force requirements, weapon systems, and other defense problems.

9. **Joint Military Operations, Strategy and Planning:** Graduates will be prepared to transition from specialized technical duties to assignments that require a broad understanding of national policy and strategy, resource allocation and management, and joint and combined operations.

10. **Joint OL Practice**: The graduate will have gained experience working on all aspects of an analytical study in the field of joint operational logistics. Specifically, the graduate will demonstrate the ability to conduct independent analytical studies, and proficiency in presenting the results both orally and in writing.

Curriculum Sponsor and ESR Approval Authority

Curriculum sponsor is Deputy Chief of Naval Operations for Fleet Readiness and Logistics (N4), Office of the Chief of Naval Operations. ESR approval authority is Director, Total Force, Training and Education (N15), Office of the Chief of Naval Operations. (Joint OL Curriculum Review conducted 28 July 2010.)

Human Systems Integration - Curriculum 359 (DL), Curriculum 362 (RES)

Curriculum 359 (DL)

Program Officer

Lawrence G. Shattuck, Ph.D.
Code OR, Glasgow Hall, Room 234

(831) 656-2473, DSN 756-2473
FAX (831) 656-2595
Lgshattu@nps.edu

Academic Associate

Diana K. Kim
Code OR, Glasgow Hall, Room 221

(831) 656-3134, DSN 756-3134
FAX (831) 656-2595
dkkim@nps.edu mailto:dkkim@nps.edu

Curriculum 362 (RES)

Program Officer

Walter C. DeGrange, CDR, USN
Code OR, Glasgow Hall, Room 254

(831) 656-3026, DSN 756-3026
FAX (831) 656-2595
wcdegran@nps.edu

Academic Associate

Lawrence G. Shattuck, Ph.D.
Code OR, Glasgow Hall, Room 234

(831) 656-2473, DSN 756-2473
FAX (831) 656-2595
Lgshattu@nps.edu

Brief Overview

Human Systems Integration (HSI) is an interdisciplinary program that emphasizes human considerations as a priority in systems design and acquisition, to reduce life cycle costs, and improve total system performance. HSI has been divided into several distinct domains that include human factors engineering, manpower, personnel, training, human survivability, health hazards, system safety, and habitability. HSI is based on the understanding that people (operators, maintainers, and support personnel) are critical elements of the system and that a human-centered design perspective promotes system effectiveness, safety, and cost savings. This degree will provide students with the knowledge, skills, and abilities to be effective leaders in the assessment, design, testing, and management of a total human machine system throughout its life cycle.

Requirements for Entry

A baccalaureate degree with above-average grades is required. Students without these quantitative prerequisites will be accepted in cases where their undergraduate records indicate that they are exceptional students and there are other indicators of potential. An academic profile code (APC) of 335 is required for the resident program, and 345 for the distance learning program.

Entry Date

Human Systems Integration is an eight-quarter course of study (including Joint Professional Military Education (JPME)) with entry in the Fall Quarter. If further information is needed, contact the Academic Associate or the Program Officer for this curriculum.

Degree

Master of Human Systems Integration

The degree of Master of Human Systems Integration requires:

1. Eleven 3000-level courses (approx. 43 quarter credits)
2. Five 4000-level courses (approx. 20 quarter credits)
3. Two-part (two-quarter) capstone project

Master of Science in Human Systems Integration

The degree of Master of Science in Human Systems Integration requires:

1. Completion of a minimum of 40 quarter-hours of graduate-level courses with:
   · At least 20 quarter-hours of 4000 level courses.
   · An elective sequence approved by the Chairman, Department of Operations Research.
2. Submission of an acceptable thesis on a subject previously approved by the Chairman, Department of Operations Research.

Subspecialty (RES)

Navy P- Code: 4600P

Typical Course of Study- Curriculum 359 (DL)
(Distance Learning)

Quarter 1
OA3411	(3-0)	Introduction to HSI
MN3301	(4-0)	Acquisition of Defense Systems

Quarter 2
OA3412	(3-0)	HSI in the DoD Acquisition Lifecycle
SE3100	(3-2)	Fundamentals of Systems Engineering

Quarter 3
OA3413	(3-1)	HSI Tools, Tradeoffs, and Processes
OA3401	(3-1)	Human Factors in System Design

Quarter 4
OA4414	(4-0)	HSI Capstone Seminar
OS3111	(3-1)	Probability and Statistics for HSI & MOVES

Quarter 5
OA4401	(4-0)	Individual Performance & Personnel Considerations
OS3112	(4-2)	Statistics and Design of Experiments

Quarter 6
OA4406	(3-1)	Survivability, Habitability, Environmental Safety, and Occupational Health
OA4702	(4-0)	Cost Estimation

Quarter 7
OA4402	(3-1)	Training & Simulation
OA4408	(3-1)	Macroergonomics and Organizational Behavior in Human Systems Integration

Quarter 8
OA4603	(4-0)	Test & Evaluation
OA4415	(4-0)	HSI Case Studies & Applications (Capstone Part 2)

Typical Course of Study- Curriculum 362 (RES)
(Navy, Marine Corps)
(* if the Summer refresher is not taken)

Summer Refresher
MA1113	(4-0)	Single Variable Calculus I
MA1114	(4-0)	Single Variable Calculus II with Matrix Algebra
GB3012	(3-0)	Communications for Managers
NW3230	(4-2)	Strategy and War

Quarter 1
OA3411	(3-0)	Introduction to HSI
OS3111	(3-1)	Probability and Statistics for HSI & MOVES
OA3401	(3-1)	Human Factors in System Design
SE3100	(3-2)	Fundamentals of Systems Engineering

Quarter 2
OA3402	(3-1)	Research Methods for Performance Assessment
OS3113	(4-2)	Data Analysis for HSI and MOVES
MN3331	(5-1)	Systems Acquisition & Program Management
SI3400	(3-2)	Fundamentals of Engineering Project Management

Quarter 3
OA3412	(3-0)	HSI in the DoD Acquisition Lifecycle
OS3112	(4-2)	Statistics and Design

of Experiments

OA4407	(3-1)	Anthropometry and Biomechanics
SE3302	(3-2)	System Sustainability

Quarter 4

OA4406	(3-1)	Survivability, Habitability, Environmental Safety, and Occupational Health
OA4603	(4-0)	Test & Evaluation
OA4109	(4-2)	Survey Research Methods
SE3303	(3-2)	System Assessment Strategy and War
NW3230*	(4-2)	Strategy and Policy

Quarter 5

OA3413	(3-1)	HSI Tools, Tradeoffs, and Processes
MN4115	(4-0)	Foundations of Education and Learning in DoD Organizations
OA4401	(4-0)	Individual Performance & Personnel Considerations
NW3285	(4-0)	National Security Decision Making

Quarter 6

OS4701	(4-0)	Techniques in Manpower Modeling
OA4702	(4-0)	Cost Estimation
OA4408	(3-1)	Macroergonomics and Organizational Behavior in Human Systems Integration
MV4002	(4-1)	Simulation and Training

Quarter 7

MN3111	(4-0)	Analysis of Human Resource Management
OA0810	(0-8)	Thesis Research for Operations Analysis Students
NW3275	(4-0)	Joint Maritime Operations - Part 1
OA0810	(0-8)	Thesis Research for Operations Analysis Students

Quarter 8

OA0810	(0-8)	Thesis Research for Operations Analysis Students
OA0810	(0-8)	Thesis Research for Operations Analysis Students
OA4414	(4-0)	HSI Capstone Seminar
NW3276	(4-0)	Joint Maritime Operations - Part 2

Typical Course of Study
(Army, International, Civilians, Air Force)

Summer Refresher

MA1113	(4-0)	Single Variable Calculus I
MA1114	(4-0)	Single Variable Calculus II with Matrix Algebra
GB3012	(3-0)	Communications for Managers

Quarter 1

OA3411	(3-0)	Introduction to HSI
OS3111	(3-1)	Probability and Statistics for HSI &

MOVES

OA3401	(3-1)	Human Factors in System Design
SE3100	(3-2)	Fundamentals of Systems Engineering

Quarter 2

OA3402	(3-1)	Research Methods for Performance Assessment
OS3113	(4-2)	Data Analysis for HSI and MOVES
MN3331	(5-1)	Systems Acquisition & Program Management
SI3400	(3-2)	Fundamentals of Engineering Project Management

Quarter 3

OA3412	(3-0)	HSI in the DoD Acquisition Lifecycle
OS3112	(4-2)	Statistics and Design of Experiments
OA4407	(3-1)	Anthropometry and Biomechanics
SE3302	(3-2)	System Sustainability

Quarter 4

OA4406	(3-1)	Survivability, Habitability, Environmental Safety, and Occupational Health
OA4603	(4-0)	Test & Evaluation
OA4109	(4-2)	Survey Research Methods
SE3303	(3-2)	System Assessment Strategy and

Quarter 5

OA3413	(3-1)	HSI Tools, Tradeoffs, and Processes
MN4115	(4-0)	Foundations of Education and Learning in DoD Organizations
OA4401	(4-0)	Individual Performance & Personnel Considerations

Quarter 6

OS4701	(4-0)	Techniques in Manpower Modeling
OA4702	(4-0)	Cost Estimation
OA4408	(3-1)	Macroergonomics and Organizational Behavior in Human Systems Integration
MV4002	(4-1)	Simulation and Training

Quarter 7

MN3111	(4-0)	Analysis of Human Resource Management
OA0810	(0-8)	Thesis Research for Operations Analysis Students
OA0810	(0-8)	Thesis Research for Operations Analysis Students

Quarter 8

OA0810	(0-8)	Thesis Research for Operations Analysis Students
OA0810	(0-8)	Thesis Research for Operations Analysis Students
OA4414	(4-0)	HSI Capstone Seminar

Provisional Learning Outcomes

Human Systems Integration - Curriculum 359 (DL)

The goal of the distance learning program is to educate eligible personnel within the federal government and defense contractor organizations in the discipline of Human Systems Integration (HSI). Graduates of this program will possess the skills necessary to function as practitioners of HSI.

1. SYSTEMS APPROACH: Graduates will be able to positively influence the activities the Program Management (PM), Systems Engineering (SE), and Test & Evaluation (T&E) communities as they function within the Department of Defense (DoD) Acquisition Lifecycle.

2. HSI DOMAIN KNOWLEDGE: Graduates will demonstrate a basic knowledge of all HSI domains: Human Factors Engineering, Manpower, Personnel, Training, Environmental Safety and Occupational Health, Survivability, and Habitability. Graduates will be familiar with the primary approaches and techniques used by each HSI domain.

3. HUMAN PERFORMANCE: Graduates will be able to apply their knowledge of the cognitive and physiological capabilities and constraints on human performance in operational settings. Graduates will be able to assess factors that affect human performance such as attention, memory, workload, situation awareness, stress, fatigue, and human error.

4. IMPLEMENTING HSI TRADEOFFS: Graduates will be able to conduct elementary tradeoffs across HSI domains, as well as tradeoffs involving engineering, acquisition, and T&E disciplines. They will be able to articulate the impacts and risks associated with those tradeoffs to technical and non-technical audiences.

5. ANALYTICAL TECHNIQUES: Graduates will be able to conduct fundamental quantitative and qualitative research in both field and laboratory settings within the context of the defense acquisition process.

6. MODELING and SIMULATION: Graduates will be familiar with basic modeling and simulation (M&S) techniques to explore tradeoffs across HSI domains and tradeoffs involving engineering, acquisition, and T&E disciplines.

Provisional Educational Skill Requirements (ESR)
Human Systems Integration - Curriculum 362 (RES)

The goal of this curriculum is to educate Naval Officers of the United States Navy in Human Systems Integration. The delivery method is an in-resident course at the Naval Postgraduate School. Human Systems Integration (HSI) acknowledges that the human is a critical component in any complex system. It is an interdisciplinary approach that makes explicit the underlying tradeoffs across the HSI domains, and other engineering disciplines, logistics, acquisition, and T&E, optimizing total system performance while minimizing total ownership costs. The graduate of this program will possess the skills necessary to function as a practitioner in HSI.

HSI DOMAIN KNOWLEDGE: Graduates will possess a thorough background in all HSI domains: Human Factors Engineering, Manpower, Personnel, Training, Environment, Safety, and Occupational Health, Survivability, and Habitability. Graduates will understand the basis for the decisions made by individual domain specialists and will be familiar with the primary approaches and techniques used by each of the HSI domains.

1. ANALYTICAL TECHNIQUES: Graduates will be able to perform tradeoff analysis across domains and other engineering disciplines, logistics, acquisition, and T&E, and to conduct empirical analysis within the domains of human systems integration. They will be able to apply, at the right place and at the right time, these analytical methods and tools in both field and laboratory settings within the context of the defense acquisition process.

2. MODELING and SIMULATION: Graduates will be able to apply Modeling and Simulation (M&S) techniques to explore HSI domain tradeoffs and tradeoffs within other engineering disciplines, logistics, acquisition, and T&E. They will demonstrate the ability to apply M&S techniques within and across the HSI domains to facilitate the development, T&E, operations, and sustainment of military systems.

3. HUMAN PERFORMANCE: HSI maintains that the human is a critical component in any complex system. Graduates will understand the basis of both individual and team performance in military settings including human information processing, perception, cognition, decision making, and motor control. Graduates will understand current theory and practice in assessing cognitive factors that affect human performance such as attention, memory, situation awareness, stress, fatigue, and motivation. Graduates will understand current scientific knowledge of factors affecting human performance and human error.

4. SYSTEMS APPROACH: Graduates will comprehend the principles and practices of the fields of PM, SE, and logistics, and T&E as related to the DoD Acquisition Lifecycle. Knowledge of HSI influences on PM, SE, and logistics, and T&E will enable graduates to positively influence the DoD Acquisition Lifecycle at appropriate times and in the right manner.

5. IMPLEMENTING HSI TRADEOFFS: Graduates will learn techniques to develop domain level trades, trades within other engineering disciplines, logistics, acquisition, and T&E, impacts, and risk assessments, and the ability to negotiate and communicate to both technical and non-technical audiences. Graduates will understand the political, organizational, social, and economic issues associated with integrating human-machine systems into organizational cultures and environments.

6. JOINT PROFESSIONAL MILITARY EDUCATION: Students will be encouraged to complete the Joint Professional Military Education (JPME) program. This sequence of courses develops an understanding of warfighting within the context of operational art. Topics include: national military capabilities and command structure, joint and service doctrine, joint planning and execution, and joint multinational forces and integration at the operational level of war. JPME includes coursework in wargaming designed to develop an appreciation of the art of war.

Curriculum Sponsor and ESR Approval Authority

Approved as l ESRs; N15 letter "REPORT OF CURRICULUM REVIEW OF MASTER OF SCIENCE IN HUMAN SYSTEMS INTEGRATION (362) AND CERTIFICATE IN HUMAN SYSTEMS INTEGRATION (262)."

Master of Systems Analysis - (DL) - Curriculum 363

Program Officer

Jeffrey F. Hyink, CAPT, USN
Code OR, Glasgow Hall, Room 226

(831) 656-3094, DSN 756-3094
FAX (831) 656-2595
jfhyink@nps.edu

Academic Associate

Steven E. Pilnick, Ph.D.
Code OR/PS, Glasgow Hall, Room 291

(831) 656-2283, DSN 756-2283
FAX (831) 656-2595
spilnick@nps.edu

Brief Overview

The Master of Systems Analysis (MSA) program is a distance learning, graduate degree program, designed to meet the needs of the Navy and other services in the Department of Defense (DoD) for technical graduate education in systems analysis as a basis for aiding key decisions on force requirements, weapon systems, and other defense matters. Students acquire foundation skills and hands-on experience in all aspects of analytical studies, which includes the skills to formulate problems, use the analytical process to design study requirements, highlight critical assumptions, recognize strengths and weaknesses of applied analytical methodologies, and evaluate study recommendations.

This program is especially tailored to students whose career pattern will not allow them to get away for a full-time, graduate education program. The entire degree program can be completed at the student's current duty station. This program consists of a blend of approximately 50% web-based, online instruction, and 50% synchronous distance learning, mainly video-tele-education (VTE). The web-based instruction is paced week-to-week by the instructors, but the students have great flexibility to do their course work at times of their choosing during each week. The synchronous classes, mainly VTE, meet at a scheduled time, once per week, during the workday, with the agreement of the student's current command. Some of the synchronous classes use a web-based interface known as Elluminate Live in lieu of VTE.

Requirements for Entry

A baccalaureate degree is required. Completion of mathematics through single variable differential and integral calculus is considered minimal preparation. An academic profile code (APC) of 335 is required.

Entry Dates

The MSA is an eight-quarter course of study with start dates in late March/early April and late September/early October. If further information is needed, contact the Academic Associate or the Program Officer for this curriculum.

Degree

Master of Systems Analysis

The Master of Systems Analysis degree requires:
· Completion of a minimum of 32quarter-hours of graduate-level courses with:
  · At least 16 quarter-hours of 4000-level courses.
  · Systems analysis core courses and a Systems Analysis context sequence approved by the Chairman, Department of Operations Research.
· Students are required to demonstrate mastery of Systems Analysis practice through satisfactory completion of the thesis-equivalent three-course sequence in Systems Analysis Cases culminating in a final project approved by the Chairman, Department of Operations Research. The quarter-hours earned in the Systems Analysis Cases courses are applied

towards satisfying the minimum graduate-level quarter-hours for the degree.

Program Description

The MSA program is a 24-month, part-time program. Students take two courses per quarter, for eight quarters. The curriculum consists of four blocks. Two of the blocks comprise stand-alone, web-based sequences. One is a four-course sequence leading to a Certificate in Systems Analysis, the second online sequence is a track approved by the student's service sponsor in a particular defense systems area in which systems analysis may be applied. The other two blocks round out the master's program with additional systems analysis core courses and a sequence of systems analysis case studies and projects that are an approved equivalent of a master's thesis. All students who successfully complete the distance-learning course of study will receive:

·   A Certificate in Systems Analysis awarded after completion of the first four quarters.
·   A Master of Systems Analysis degree awarded upon completion of the two-year program.
·   The approved systems analysis context track for Navy Unrestricted Line Officer students is a four-course sequence in Defense Resources Management (DRM). The student's service sponsor may approve another track based on course availability and needs of the sponsor and student.

Subspecialty

Completion of this curriculum is designed to qualify an officer as an Operations Research Analysis Subspecialist with a subspecialty code of 3210P. The curriculum sponsor is Director, Assessment Division (N81), Office of the Chief of Naval Operations.

Typical Subspecialty Jobs

OPNAV staff
JCS staff
Fleet staff
Type Commander staff
Battle Group staff
OSD staff

Typical Course of Study (Navy URL Track)

Quarter 1, Spring/Fall
OS2080   (3-0)   Probability and Statistics I (SA Cert)
MO1180   (3-2)   Topics in Mathematics for Systems Analysis

Quarter 2, Summer/Winter
OS3380   (3-1)   Combat Systems Simulation (SA Cert)
OS3080   (3-0)   Probability and Statistics II

Quarter 3, Fall/Spring
OS3680   (4-0)   Naval Tactical Analysis (SA Cert)
OA4702   (4-0)   Cost Estimation

Quarter 4, Winter/Summer
OS4680   (4-0)   Naval Systems Analysis (SA Cert)
OS3211   (4-0)   Systems Optimization
SA Certificate Award

Quarter 5, Spring/Fall
OS4011   (3-2)   Risk Benefit Analysis
MN4053   (4-0)   Defense Budget and Financial Management Policy (DRM track)

Quarter 6, Summer/Winter
OS3081   (3-0)   Systems Analysis Cases I (MSA Thesis Equivalent)
MN3510   (3-0)   Defense Financial Management Practice (DRM track)

Quarter 7, Fall/Spring
OS3082   (3-0)   Systems Analysis Cases II (MSA Thesis Equivalent)
MN3221   (3-0)   Systems Acquisition and Program Management I (DRM track)

Quarter 8, Winter/Summer
OS4083   (3-2)   Systems Analysis Cases III (MSA Thesis Equivalent)
MN3222   (3-0)   Systems Acquisition and Program Management II (DRM track)
Graduation week at NPS

Educational Skill Requirements (ESR)
Master of Systems Analysis (MSA) - Curriculum 363
Subspecialty Code: 3210P

1. **Systems Analysis**: The graduate of this curriculum will understand and be able to apply the basic principles of systems analysis as a basis for aiding key decisions on force requirements, weapon systems, and other defense matters. The following specific Educational Skill Requirements support this high-level objective.

2. **Basics**: The graduate will possess the mathematical skills required to support graduate study in systems analysis.

3. **Uncertainty Fundamentals**: The graduate will be well versed in uncertainty fundamentals for systems analysis, including applications of probability, statistics, data analysis, and modeling uncertainty.

4. **Simulation**: The graduate will be able to construct and utilize Monte Carlo simulations of combat and other processes that evolve in time, and will be able to deal with statistical issues associated with the need for replication.

5. **Tactical Analysis**: The graduate will be able to apply operations analysis methods to tactical and operational

problems, including tactical decision analysis, search and detection, and weapons effectiveness.

6. **Cost Analysis**: The graduate will understand the methods and practice of cost analysis including various cost models, with particular emphasis in the relationship of effectiveness models and measures to cost, and applications in cost-benefit analysis.

7. **Risk-Benefit Analysis**: The graduate will be able to apply the principles of probabilistic risk assessment in the context of systems analysis decision problems. This includes a framework for balancing risks and benefits, and analysis under conditions of large financial and technological uncertainties.

8. **Optimization**: The graduate will be able to formulate and solve a wide variety of optimization problems with particular emphasis on applications in optimum allocation of scarce resources and multi-year capital budgeting.

9. **Practice**: The graduate will have gained experience in all aspects of analytical studies, including review, critique, and oversight of the work of others, as well as participation in the conduct of an analytical study. Review, critique, and oversight include the ability to highlight critical assumptions, recognize strengths and weaknesses of applied analytical methodologies, and evaluate study recommendations. Practice in the design and conduct of an analytical study includes the skills to formulate problems, use the analytical process to define study requirements, and apply appropriate analytical methodologies. Practice also includes demonstrating proficiency in presenting results both orally and in writing.

10. **Systems Analysis Context**: The graduate will have completed an approved option sequence in Defense Resource Management, or another approved option sequence in a particular defense systems area in which systems analysis may be applied.

Curriculum Sponsor and ESR Approval Authority

Curriculum sponsor is Director, Assessment Division (N81), Office of the Chief of Naval Operations. ESR approval authority is Director, Total Force Training and Education (N15), Office of the Chief of Naval Operations. (MSA Curriculum Review conducted 21 February 2013.)

Master of Cost Estimating and Analysis (MCEA) - (Distance Learning) - Curriculum 379

Program Manager

Daniel Nussbaum, Ph.D.
Code OR, Glasgow Hall, Room 242
(831) 656-2387, DSN 756-2387
FAX (831) 656-2595
danussba@nps.edu

Greg K. Mislick, LCOL, USMC (Ret.)
Code OR, Glasgow Hall, Room 202
(831) 656-3113, DSN 756-3113
FAX (831) 656-2595
gmislick@nps.edu

Program Officer and Academic Associate

Kevin J. Maher, CDR, USN (Ret.)
Code OR/Mk, Glasgow Hall, Room 227
(831) 656-2691, DSN 756-2691
kjmaher@nps.edu

Program Description

The Master of Cost Estimating and Analysis (MCEA) is a 24-month, distance learning graduate degree program designed to increase the accuracy and proficiency of DoD cost estimates and cost estimators. This curriculum is sponsored by Naval Sea Systems Command as a joint effort between NPS and the Air Force Institute of Technology. Students will learn cost estimating techniques commonly used in both DoD and industry, and acquire foundation skills and hands-on experience in all aspects of cost estimation, including shipbuilding, aircraft, software, and many other areas. Students take two courses per quarter for eight quarters. Case studies and a capstone project will complete the program. This program blends web-based, online instruction, with video tele-education (VTE), and is especially tailored to students whose careers will not allow them to get away for a full-time graduate education program. While web-based courses are paced week-to-week by the instructors, students have the flexibility to do their coursework at times of their choosing during each week. The VTE classes meet at a pre-determined time, once per week for three hours during the workday.

Requirements for Entry

A baccalaureate degree is required. Recent completion (within five years) of mathematics through single variable differential and integral calculus is considered minimal preparation. An academic profile code (APC) of 235 is required. For applicants with an undergraduate GPA below 2.7, a waiver will be considered depending on work experience and attaining a minimum GRE score of 550.

Entry Dates

The MCEA program is an eight-quarter course of study with start dates in late March. If further information is needed, contact the Academic Associate or the Program Manager for this curriculum.

Degree

The Master of Cost Estimating and Analysis is a professional degree awarded for completing a curriculum focused on the practice of the profession rather than the more general arts or sciences behind the profession. It is analogous to the professional focus of an MBA (Master of Business Administration) compared to the more academic focus of an MS (Master of Science) in Management Science.

Required Courses

Quarter 1, Spring

| OS2080 | (3-0) | Probability and Statistics I |
| MN3301 | (4-0) | Acquisition of Defense Systems |

Quarter 2, Summer

| OS3080 | (3-0) | Probability and Statistics II |
| OS3006 | (3-0) | Operations Research for Cost Analysts |

Quarter 3, Fall

| MN4053 | (4-0) | Defense Budget and Financial Management Policy |
| OS3701/ Cost 510 (AFIT) | (3-0) | Cost Estimation I: Methods and Techniques |

Quarter 4, Winter

| MN3510 | (3-0) | Defense Financial Management Practice |
| OS4702/ Cost 520 (AFIT) | (3-0) | Cost Estimation II: Advanced Concepts in Cost Estimating |

Quarter 5, Spring

| OS4012/ Cost 610 (AFIT) | (3-0) | Cost Estimation III: Risk and Uncertainty Analysis |
| OS4703/ Cost 530 (AFIT) | (3-0) | Cost Estimation IV: Applied Cost Analysis |

Quarter 6, Summer

| SE4012/ SENG610 (AFIT) | (4-0) | Management of Advanced Systems Engineering |
| OS4080/ Cost 620 (AFIT) | (3-0) | Cost Estimation V: Cost Estimating and Analysis Cases |

Quarter 7, Fall

| SE4011/ SENG52 | (3-2) | Systems Engineering for Acquisition Managers |
| OS4081/ Cost798 (AFIT) | (3-4) | Cost Estimating and Analysis Capstone I (MCEA Thesis Equivalent) |

Quarter 8, Winter

| OS4013/ Cost630 (AFIT) | (4-0) | Cost Estimation VI: Decision Analysis for Cost Estimators |
| OS4082/ Cost798 (AFIT) | (3-4) | Cost Estimating and Analysis Capstone II (MCEA Thesis Equivalent) |

Educational Skill Requirements (ESR)

Master of Cost Estimating and Analysis (MCEA) - Curriculum 379

1. **Basics**: The graduate will possess the mathematical skills required to support graduate study in Cost Analysis/Cost Estimating.
2. **Cost Analysis:** The graduate will understand the methods and practice of cost analysis including various cost models, with particular emphasis in the relationship of effectiveness models and measures to cost, and applications in cost-benefit analysis.
3. **Statistics and Probability:** The graduate will have a firm understanding of statistics and probability analysis and be able to apply that knowledge in the development of cost estimating relationships. The graduate will also be able to correctly interpret statistical measures of any data set.
4. **Uncertainty Fundamentals:** The graduate will be well versed in uncertainty fundamentals for cost analysis, including applications of probability, statistics, data analysis, and modeling uncertainty.
5. **Simulation:** The graduate will be able to construct and utilize Monte Carlo simulations in cost estimates of cost and schedule drivers, and will be able to deal with statistical issues associated with estimating costs of programs with limited financial resources.
6. **Rates Development:** The graduate will be able to construct a rate-set for direct labor, overhead, general and administrative costs, and inflation. The graduate will also be able to construct costs for various contract types, such as cost-plus, fixed-fee plus incentive, etc.
7. **Cost-Benefit Analysis:** The graduate will be able to apply the principles of probabilistic cost assessment in the context of resource allocation problems. This includes a framework for balancing costs and benefits, and analysis under conditions of large financial and technological uncertainties.
8. **Optimization:** The graduate will be able to formulate and solve a wide variety of optimization problems with particular emphasis on applications in optimum

allocation of scarce resources and multi-year capital budgeting.

9. **Systems Engineering and Analysis:** The graduate of this curriculum will understand and be able to apply the basic principles of systems analysis as a basis for aiding key decisions on force requirements, weapon systems, and other defense matters.

10. **Practice:** The graduate will have gained experience in all aspects of analytical studies, including review, critique, and oversight of the work of others, as well as participation in the conduct of an analytical study. Review, critique, and oversight include the ability to highlight critical assumptions, recognize strengths and weaknesses of applied analytical methodologies, and evaluate study recommendations. Practice in the design and conduct of an analytical study includes the skills to formulate problems, use the analytical process to define study requirements, and apply appropriate analytical methodologies. Practice also includes demonstrating proficiency in presenting results both orally and in writing.

11. **Cost Analysis Context:** The graduate will have completed an approved option sequence in Naval Sea Systems, Air Force Systems, Naval Air Systems, or another approved option sequence in a particular defense systems area in which systems analysis may be applied.

12. **Defense Acquisition University (DAU) Certification:** The graduate, through program course work, will have satisfied all DAU academic requirements for Level III Certification in Cost Estimating.

Curriculum Sponsor and ESR Approval Authority

Curriculum sponsor is Commander, Naval Sea Systems Command and Commander, Naval Air Systems Command

As a new and rapidly evolving discipline that intersects a variety of traditional studies, these degree programs have been carefully constructed with a large number of unique courses under the cyber purview.

Graduates will be prepared to lead offensive and defensive operations and optimally employ the GIG in support of all Navy missions. Immersed in the active challenges facing the Navy, graduates will return to the fleet equipped with the tools and foresight to recognize and solve current and future cyber-related challenges.

Certificate in Cyber Wargaming (DL & Res) - Curriculum 225/226

Program Manager

Cynthia Irvine, Ph.D.
Glasgow East, Room 211

831-656-2461
irvine@nps.edu

Brief Overview

The Cyber Wargaming certificate is a graduate-level, non-degree program designed to enable DoD and U.S. Government personnel to effectively plan for and participate in cyber wargames based upon scenarios of interest to the DoD and U.S. Government.

The objective of the program is to prepare students to maintain a high state of readiness for cyber systems in the face of hostile action. Students will learn the fundamentals of cyber wargaming including basic game theory, scenario selection and development, and wargame execution. Students will be able to apply their understanding of risk assessment in cyber space and employment of forces and assets to achieve or support both cyber and overall mission objectives. They will be able to incorporate early detection and maintenance services in environments that may be severely degraded.

The program consists of three courses to be taken over a minimum of a three-quarter period. The total number of NPS graduate credits obtained for the certificate is 13 or 13.5, depending upon the choice of courses. This certificate program may be applicable toward a master's degree program in Curriculum 326.

Requirements for Entry
- A baccalaureate degree is required.
- Recent completion, viz. within the past 5 years, of courses in computer and network security, computer and communications networks. Students lacking these prerequisites may be acceptable to the program

through their undergraduate records and other indicators of success.
- An Academic Profile Code (APC) of 344 is required.

Entry Dates
At the beginning of the Spring or Fall quarters. (March or September)

Program Length
Three quarters

Required Courses
One of the following electives.

CY3520	(3-3)	Practical Network Operations
CY3602	(3-2)	Network Operations II
CS3690	(4-1)	Network Security
DA3104	(4-1)	Computer Network Attack and Defense

And both of the following.

CY4700	(2-5)	Cyber Wargame: Blue Force Operations
CY4710	(2-5)	Cyber Wargame: Red Force Operations

Cyber Operations Infrastructure (DL & Res) - Curriculum 227/228

Academic Associate

Duane T. Davis, Ph.D.

Code CS/Ce, Glasgow East, Room 309

Program Manager

Cynthia Irvine, Ph.D.
Code Cs/Ic, Glasgow East, Room 211

831-656-2461, DSN 656-2461
irvine@nps.edu

Brief Overview

The Cyber Operations Infrastructure certificate is a graduate-level, non-degree program designed to enable DoD and U.S. Government personnel to differentiate the various components of the infrastructure underpinning cyber operations for its effective use in all aspects of cyber operations.

The objective of the program is to prepare students to deploy cyber-specific assets appropriately within the DoD cyber infrastructure. Students will be able to assess how differing elements of the underlying cyber infrastructures impact cyber operations. Students will learn about the communications systems that support cyber operations and

will be able to choose communications modes most suitable for a given cyber mission. They will be able to develop information usage strategies across distributed platforms and will be able to adapt their choices based upon the capabilities of these data-centric systems. They will be able to evaluate the

benefits and weaknesses of infrastructure-dependent choices and will be able to integrate these choices in cyber mission planning. Students will be able to develop strategies for cyber operations in contested situations based upon their understanding of the infrastructure.

The program consists of four courses to be taken over a minimum of a four-quarter period in the case of distance learning students. Resident students may be able to complete the certificate in three academic quarters. The total number of NPS graduate credits obtained for the certificate is 15, depending upon the choice of courses. This certificate program may be applicable toward a master's degree program in Curriculum 326.

Requirements for Entry
· A baccalaureate degree is required.
· Recent completion, viz. within the past 5 years, of courses in computer and network security, computer and communications networks. Students lacking these prerequisites may be acceptable to the program through their undergraduate records and other indicators of success.
· An Academic Profile Code (APC) of 344 is required.
· Command or company endorsement
· A TS/SCI clearance is required

Entry Dates
At the beginning of the Winter or Summer quarters. (January or July)

Program Length
Three quarters (9 months)

Graduate Certificate Requirements
The academic certificate program must be completed within three years of admission to the program. A student must maintain a 3.0 GQPR in the certificate program to be awarded a certificate.

Required Courses
Both courses below are required.

CY3300	(4-0)	Cyber Communications Architectures (SECRET)
CY4400	(3-0)	Cyber Mission Planning (TS/SCI)

And one course from Group 1 and one course from Group 2 are required:

Group 1

CY4600	(3-2)	Network Operations in a Contested Environment (TS/SCI)

EC3760	(3-2)	Information Operations Systems (TS/SCI)

Group 2

CY4650	(4-0)	Information Management for Cyber Operations
CS3670	(3-2)	Information Assurance: Secure Management of Systems

Cyber Systems and Operations (CSO) - Curriculum 326

Program Officer
Eric McMullen, LCDR
Code CY, Glasgow East, Room 309
elmcmull@nps.edu

Academic Associate
Duane T. Davis
831-656-7980, DSN 756-7980

Code CY, Glasgow East, Room 309
dtdavi1@nps.edu

Brief Overview

The Cyber Systems and Operations (CSO) degree addresses a broad range of cyberspace operations: computer network attack, defense, and exploitation; cyber analysis, operations, planning and engineering; and cyber intelligence operations and analysis. Complementing focused and technically deep programs in the traditional departments, the Master of Science in Cyber Systems and Operations degree addresses the broad range of cyber topics needed by leaders, managers, and operators serving military missions.

Designed for a cadre of students with diverse backgrounds, this degree program is intended to provide a deep understanding of the national and military application of integrated lines of operation including operation of the global information grid (GIG), defensive and offensive cyber operations, and the required technical and nontechnical intelligence operations underpinning these. Students will learn how to seize and sustain an information advantage through all stages of operations, from early warning through detection, planning, targeting, cyber fires, assessing effects and resetting for follow-on plans and operations.

Site visits, laboratory exercises, seminars, guest speakers, and practical workshops complement traditional instruction. A semiannual cyber exercise is integrated into the curriculum. Thesis research or a capstone project will allow students to address topics of interest to stakeholders under the supervision of faculty experts. Tight integration with the front line war fighter and with relevant U.S.

Government elements will ensure that thesis research and capstone projects are on target and rapidly integrated.

Requirements for Entry

This curriculum is open to officers of the U.S. Armed Forces and civilian employees of the U.S. Federal Government. A baccalaureate degree, or the equivalent, with grades resulting in an APC of at least 344 is required for direct entry. A TOP SECRET clearance is required with eligibility for SCI access.

Entry Date

Cyber Systems and Operations is a six-quarter resident course of study with entry dates in March and September. The duration will depend upon the number of simultaneous courses taken. If further information is needed, contact the Academic Associate or Program Officer for this curriculum.

Degree

The Master of Science in Cyber Systems and Operations degree is comprised of courses that, in combination, provide a coherent, logical approach to a complex and rapidly evolving military and government domains. In addition to course work, each student must complete a Master's thesis or a capstone project.

The Master of Science in Cyber Systems and Operations is awarded after the satisfactory completion of a program meeting, as a minimum, the following degree requirements:

·   All courses must be satisfied through the course of study or through validation prior to graduation.
·   Completion of a minimum of 40 quarter-hours of graduate-level courses, of which at least 16 quarter hours are CY 4000 level courses.
·   To ensure a sufficient breadth in operational understanding of the cyber domain, the following course topics must be satisfied as part of the course of study or through validation prior to graduation: Cyber Policy and Strategy (CY4600), Network Operations in a Contested Environment (CY4600), Cyber Wargame: Blue Force Operations (CY4700), Cyber Wargame: Red Force Operations (4710).
·   Minimum degree requirements of the NPS must be met.
·   Completion of an acceptable thesis or capstone project on a subject previously approved by the Chair, Cyber Academic Group.

Program Length

Six Quarters with JPME.

Typical Course of Study

Quarter 1

CY3000	(3-0)	Introduction to Cyber Systems and Operations
CY3100	(4-1)	Introduction to Communications Networks
CY3110	(3-1)	Internet Protocols
CS3030	(4-0)	Fundamentals of Computer Architecture and Operating Systems

Quarter 2

CY3520	(3-3)	Practical Network Operations
CS3600	(4-2)	Introduction to Computer Security
CY3300	(4-0)	Cyber Communications Architectures
DA3105	(4-1)	Conflict and Cyberspace
CY4900	(1-0)	Research Topics in Cyber Systems and Operations

Quarter 3

CY3690	(4-1)	Network Security
CY3800	(3-0)	Signals Operations
CY4700	(2-5)	Cyber Wargame: Blue Force Operations
NW3230	(4-2)	Strategy and War
CY4901	(1-0)	Cyber Systems and Operations Research Methods

Quarter 4

EC3760	(3-2)	Information Operations Systems (TS/SCI)
CY4400	(3-0)	Cyber Mission Planning
NW3275	(4-0)	Joint Maritime Operations - Part 1
CY0810	(0-8)	Thesis

Quarter 5

CY4750	(3-1)	Advanced Cyber Systems & Operations
CY4710	(2-5)	Cyber Wargame: Red Force Operations
NW3276	(2-2)	Joint Maritime Operations - Part 2
CY0810	(0-8)	Thesis

Quarter 6

CY4650	(4-0)	Information Management for Cyber Operations
CY4410	(3-0)	Cyber Policy and Strategy
NW3285	(4-0)	National Security Decision Making
CY0810	(0-8)	Thesis

Students not required to complete the JPME course of study while working on a degree at NPS may omit NW3230, NW3285, NW3275, and NW3276.

Curriculum Major Area Sponsor

DCNO for Information Dominance (N2/N6).

Educational Skill Requirements

1. **Cyber Functions and Fundamentals.** In order to provide officers skilled in the effective use of cyberspace to support military requirements, graduates of the Cyber

Systems and Operations (CSO) program will have competence in the following cyber functional areas:

· Securely Provision
· Operate and Maintain/Network Operations/DoD Global Information Grid Operations (DGO)
· Active Defense/Defensive Cyberspace Operations (DCO)
· Operate and Collect/Cyber Intelligence
· Analyze and Advise
· Offensive Cyberspace Operations (OCO)
· Investigate
· Communications Electronic Attack (Comms EA)
· Friendly Cyber Defense Forces

2. **Military Applications and Cyberspace Operations.** The officer will be able to analyze cyber requirements of military operations and direct the effective employment of cyber assets in support of national and military objectives. In particular, the officer will be able to develop, compare, and evaluate courses of action for the incorporation of cyber capabilities in all CONPLAN/OPLAN stages of operation to achieve Assured C2, and maintain Freedom of Maneuver in Cyberspace, and deliver COCOM effects (including both non-kinetic effects and non-kinetic means of facilitating kinetic attack).

3. **Organizational Construct and Policy.** The officer will have an in-depth understanding of the administrative and operational structure and command relationships of the organizations and commands that will be operating in the cyberspace domain. Additionally, the officer will be able to recall and apply strategy, policy, and authorities (ROE, U.S. law, the Law of Armed Conflict, and national policy) as it pertains to the use of non-kinetic force.

4. **Cyber System Engineering.** The officer will be able to analyze existing and proposed cyber systems for the purpose of assessing cyber requirements, capabilities and limitations, identifying capability gaps, and devising system improvements. Further, the officer will be able to develop concepts of operations for new systems including integration with existing systems and assessment of test and evaluation plans.

5. **Independent Research.** The officer will understand friendly and adversarial cyber infrastructures and will be able to diagram and explain subsystem relationships, interactions, and functions. Specifically, the officer will be able to describe and critique existing and planned infrastructures including (1) bottom-up systems for data collection or effects delivery, (2) middleware systems for smart push/pull services in a cloud/service-oriented-architecture, (3) top-down systems for command and control with a common operational picture, and (4) core infrastructure systems providing enabling communications. Additionally, the officer will be able to analyze specific cyber system implementations to identify adaptive cyber vulnerabilities and effects for defensive and offensive operations in both permissive and contested environments. The officer will be able to apply these analytic and problem-solving skills in Joint Information Environment operations to augment manpower with automated intelligence analytics for processing high volume, heterogeneous data sets to automatically produce high value alerts and actions in support of mission objectives.

6. **Space.** The officer will understand and be able to explain the nature of Space Operations as it is applied within the realm of cyber operations. He/she will be able distinguish between the four JP 3-14 defined mission areas (Space Control, Space Support, Force Enhancement, Force Application) and interpret how current and planned space capabilities contribute to the satisfaction of these mission areas.

7. **Independent Research.** The officer will demonstrate the ability to conduct independent investigation through the completion of a thesis or capstone project. Thesis or capstone work will be conducted in a framework that exercises the practice of innovation, critical thinking, problem solving, and real-world applicability. Further, the officer will be able to present research goals and results in both written and oral form.

8. **Joint Professional Military Education (JPME).** Per community requirements, the officer will have an understanding of warfighting within the context of operational art to include: strategy and war, theater security decision making, and joint maritime operations. This requirement is fulfilled by completing the Naval War College four-course series leading to Intermediate Level Professional Military Education and JPME phase I certification.

Cyber Systems and Operations (CSO)-Curriculum 326

Program Manager
Diana Chung
831-656-2726, DSN 765-2726

Glasgow East, Room 210
dkchung@nps.edu

Academic Associate
Duane T. Davis

831-656-7980, DSN 756-7980

Code CY, Glasgow East, Room 309
dtdavi1@nps.edu

Brief Overview

The Cyber Systems and Operations (CSO) degree addresses a broad range of cyberspace operations: computer network attack, defense, and exploitation; cyber analysis, operations, planning and engineering; and cyber intelligence operations and analysis. Complementing focused and technically deep programs in the traditional departments, the Master of Science in Cyber Systems and Operations degree addresses the broad range of cyber topics needed by leaders, managers, and operators serving military missions.

Designed for a cadre of students with diverse backgrounds, this degree program is intended to provide a deep understanding of the national and military application of integrated lines of operation including operation of the global information grid (GIG), defensive and offensive cyber operations, and the required technical and nontechnical intelligence operations underpinning these. Students will learn how to seize and sustain an information advantage through all stages of operations, from early warning through detection, planning, targeting, cyber fires, assessing effects and resetting for follow-on plans and operations.

Laboratory exercises, seminars, guest speakers, and practical workshops complement traditional instruction. Individual laboratory exercises will be conducted on student owned or sponsor-provided computers. Group exercises will utilize the remote access capabilities of the Cyber Battle Lab. DL student participation in seminars, workshops, and guest lectures will be via VTC.

A semiannual cyber exercise is integrated into the curriculum. Thesis research or a capstone project will allow students to address topics of interest to stakeholders under the supervision of faculty experts. Tight integration with the front line war fighter and with relevant U.S. Government elements will ensure that thesis research and capstone projects are on target and rapidly integrated.

This curriculum is a DL version of an existing resident curriculum. Unclassified courses will be offered synchronously using VTC or asynchronously. The asynchronous mode is computer-based where students log onto a website and attend class via a prerecorded lecture which includes a series of power point slides. Asynchronous courses require online discussion boards and chat. All classified courses will be offered synchronously via VTE in a secure facility.

Requirements for Entry

A baccalaureate degree, or the equivalent, with grades resulting in an APC of at least 344.

Entry Date

The CSO DL curriculum consists of 17 courses offered over nine quarters. Specific start dates will be as directed by the sponsoring agency, but it is anticipated that cohorts will convene for fall and spring quarter starts.

Degree Requirements

The Master of Science in Cyber Systems and Operations degree is comprised of courses that, in combination, provide a coherent, logical approach to a complex and rapidly evolving military and government domains. In addition to course work, each student must complete a Master's thesis or a capstone project.

The Master of Science in Cyber Systems and Operations is awarded after the satisfactory completion of a program meeting, as a minimum, the following degree requirements:
·   All courses must be satisfied through the course of study or through validation prior to graduation.
·   Completion of a minimum of 40 quarter-hours of graduate-level courses, of which at least 16 quarter hours are CY 4000 level courses.
·   To ensure a sufficient breadth in operational understanding of the cyber domain, the following course topics must be satisfied as part of the course of study or through validation prior to graduation: Cyber Policy and Strategy (CY4600), Network Operations in a Contested Environment (CY4600), Cyber Wargame: Blue Force Operations (CY4700), Cyber Wargame: Red Force Operations (4710).
·   Minimum degree requirements of the NPS must be met.
·   Completion of an acceptable thesis or capstone project - on a subject previously approved by the Chair, Cyber Academic Group.

Program Length

27 months

Course Requirements

CY4410	(3-0)	Cyber Policy and Strategy
EC3760	(3-2)	Information Operations Systems (TS/SCI)
CY4700	(2-5)	Cyber Wargame: Blue Force Operations
CY4710	(2-5)	Cyber Wargame: Red Force Operations

In addition to the courses for the degree, the curriculum requires the following courses:

CY3000	(3-0)	Introduction to Cyber Systems and Operations
CS3030	(4-0)	Fundamentals of Computer Architecture and Operating Systems
CY3100	(4-1)	Introduction to Communications

		Networks
CY3110	(3-1)	Internet Protocols
DA3105	(4-1)	Conflict and Cyberspace
CY3300	(4-0)	Cyber Communications Architectures
CY3520	(3-3)	Practical Network Operations
CS3600	(4-2)	Introduction to Computer Security
CY3690	(4-1)	Network Security
CY4400	(3-0)	Cyber Mission Planning
CY4650	(4-0)	Information Management for Cyber Operations
CY4900	(1-0)	Research Topics in Cyber Systems and Operations
CY4901	(1-0)	Cyber Systems and Operations Research Methods

Curriculum Major Area Sponsor

DCNO for Information Dominance (N2/N6).

Educational Skill Requirements

1. **Cyber Functions and Fundamentals.** In order to provide officers skilled in the effective use of cyberspace to support military requirements, graduates of the Cyber Systems and Operations (CSO) program will have competence in the following cyber functional areas:
   - Securely Provision
   - Operate and Maintain/Network Operations/DoD Global Information Grid Operations (DGO)
   - Active Defense/Defensive Cyberspace Operations (DCO)
   - Operate and Collect/Cyber Intelligence
   - Analyze and Advise
   - Offensive Cyberspace Operations (OCO)
   - Investigate
   - Communications Electronic Attack (Comms EA)
   - Friendly Cyber Defense Forces

2. *Military Applications and Cyberspace Operations.* The officer will be able to analyze cyber requirements of military operations and direct the effective employment of cyber assets in support of national and military objectives. In particular, the officer will be able to develop, compare, and evaluate courses of action for the incorporation of cyber capabilities in all CONPLAN/OPLAN stages of operation to achieve Assured C2, and maintain Freedom of Maneuver in Cyberspace, and deliver COCOM effects (including both non-kinetic effects and non-kinetic means of facilitating kinetic attack).

3. **Organizational Construct and Policy.** The officer will have an in-depth understanding of the administrative and operational structure and command relationships of the organizations and commands that will be operating in the cyberspace domain. Additionally, the officer will be able to recall and apply strategy, policy, and authorities (ROE, U.S. law, the Law of Armed Conflict, and national policy) as it pertains to the use of non-kinetic force.

4. **Cyber System Engineering.** The officer will be able to analyze existing and proposed cyber systems for the purpose of assessing cyber requirements, capabilities and limitations, identifying capability gaps, and devising system improvements. Further, the officer will be able to develop concepts of operations for new systems including integration with existing systems and assessment of test and evaluation plans.

5. **Independent Research.** The officer will understand friendly and adversarial cyber infrastructures and will be able to diagram and explain subsystem relationships, interactions, and functions. Specifically, the officer will be able to describe and critique existing and planned infrastructures including (1) bottom-up systems for data collection or effects delivery, (2) middleware systems for smart push/pull services in a cloud/service-oriented-architecture, (3) top-down systems for command and control with a common operational picture, and (4) core infrastructure systems providing enabling communications. Additionally, the officer will be able to analyze specific cyber system implementations to identify adaptive cyber vulnerabilities and effects for defensive and offensive operations in both permissive and contested environments. The officer will be able to apply these analytic and problem-solving skills in Joint Information Environment operations to augment manpower with automated intelligence analytics for processing high volume, heterogeneous data sets to automatically produce high value alerts and actions in support of mission objectives.

6. **Space.** The officer will understand and be able to explain the nature of Space Operations as it is applied within the realm of cyber operations. He/she will be able distinguish between the four JP 3-14 defined mission areas (Space Control, Space Support, Force Enhancement, Force Application) and interpret how current and planned space capabilities contribute to the satisfaction of these mission areas.

7. **Independent Research.** The officer will demonstrate the ability to conduct independent investigation through the completion of a thesis or capstone project. Thesis or capstone work will be conducted in a framework that exercises the practice of innovation, critical thinking, problem solving, and real-world applicability. Further, the officer will be able to present research goals and results in both written and oral form.

8. **Joint Professional Military Education (JPME).** Per community requirements, the officer will have an understanding of warfighting within the context of operational art to include: strategy and war, theater security decision making, and joint maritime operations. This requirement is fulfilled by completing the Naval War College four-course series leading to Intermediate Level Professional Military Education and JPME phase I certification.

Applied Cyber Operations (MACO) - Curriculum 336

Program Manager & Academic Associate
Duane T. Davis
831-656-7980, DSN 756-7980

Code CY, Glasgow East, Room 309
dtdavi1@nps.edu

Brief Overview

The Applied Cyber Operations (ACO) curriculum addresses a range of operational and technical topics in defensive and offensive cyberspace operations. This includes computer network attack, active and passive defense, exploitation, cyber analysis via automated and manual toolsets, operations, policy, and engineering. Complementing the Cyber Systems and Operations curriculum, the Applied Cyber Operations curriculum covers a focused set of cyber topics suited for the technical enlisted workforce by providing graduates with a rigorous foundation in cyber security necessary for defensive and offensive cyber operations, as well as maintenance operations for the Global Information Grid (GIG). The degree covers the range of cyber topics needed by technicians serving military missions.

Designed to serve Navy enlisted personnel with Cryptologic Technician Networks (CTN) and Information Systems Technician (IT) ratings, as well as the respective enlisted personnel in other military services, the Applied Cyber Operations curriculum is intended to provide a deep understanding of the implementation of national and military application of integrated lines of operation, including operation of the DoD Global Information Grid (GIG), Defensive Cyberspace Operations (DCO), and Offensive Cyberspace Operations (OCO), cyber security fundamentals and the required technical operations underpinning these. Students will learn to seize and sustain an information advantage through all stages of operations, from compliance and early warning through detection, planning, targeting, cyber fires, assessing effects and resetting for follow-on plans and operations.

Site visits, laboratory exercises, seminars, guest speakers, and practical workshops complement traditional instruction. A cyber exercise is integrated into the curriculum. A capstone project allows students to apply concepts introduced, demonstrated and practiced earlier in the curriculum by working and reporting on topics of interest to stakeholders under the supervision of faculty experts. Tight integration with front-line war fighters ensures that capstone research is on target and rapidly integrated.

Requirements for Entry

A baccalaureate degree, or the equivalent, with grades resulting in an APC of at least 344 is required for direct entry. Applicants must possess a Bachelor of Science degree in a technical field, such as Computer Science, Electrical Engineering, Information or Engineering Technology, or a Bachelor's degree accompanied by completion of the following training: A and C Schools for the CTN and IT respectively, namely, Joint Cyber Analysis Course (JCAC) or IT A School and IT System Administrator C School or equivalent enlisted service schools for USA, USAF and USMC. A TOP SECRET clearance is required with SPECIAL INTELLIGENCE clearance obtainable for all students.

Entry Date

Applied Cyber Operations is a four-quarter resident course of study with entry dates in September. If further information is needed, contact the Academic Associate or Program Officer for this curriculum.

Degree

The Applied Cyber Operations curriculum is comprised of courses that, in combination, provide a coherent, logical approach to learning applied cyber systems and operations in a complex and rapidly evolving military domain. Of these courses, a subset comprises a specialization track. In addition to course work, each student must complete a capstone project.

The Master of Science in Applied Cyber Operations is awarded after satisfactory completion of a program that meets, as a minimum, the following degree requirements:

·
· All required courses must be satisfied through the course of study or through validation prior to graduation.
· Completion of a minimum of 40 quarter-hours of graduate-level courses.
    At least 12 quarter-hours of courses must be at the 4000 level.
· Completion of a specialization track.
· Submission of an acceptable capstone project on a subject previously approved by the Chair, Cyber Academic Group.

Program Length

Four Quarters. No JPME.

Specialization Tracks

Each student in the Applied Cyber Operations curriculum will choose a specialization track no later than the start of the second quarter of study. The current specializations offered by the Cyber Academic Group are as follows:

Network Operations (NetOps) Specialization

CS3670 Information Assurance: Secure Management of Systems

CS3695 Network Vulnerability Analysis and Risk Mitigation

Defense Specialization

CS4677 Computer Forensics

CS4684 Cyber Security Incident Response and Recovery

Adversarial Techniques Specialization

CS4648 Advanced Cyber Munitions

CS4678 Advanced Cyber Vulnerability Analysis

Typical Course of Study

Quarter 1

CY3000*	(3-0)	Introduction to Cyber Systems and Operations
CY3100	(4-1)	Introduction to Communications Networks
CY3110	(3-1)	Internet Protocols
CS3030	(4-0)	Fundamentals of Computer Architecture and Operating Systems

Quarter 2

CY3300*	(4-0)	Cyber Communications Architectures
CS3600*	(4-2)	Introduction to Computer Security
CS3690	(4-1)	Network Security
IS3502	(3-2)	Network Operations I

Quarter 3

CY3602	(3-2)	Network Operations II
CY4700/ 10*	(2-5)	Cyber Wargame: Blue Force Operations (CY4700) or Red Force Operations (CY4710)
CYXXXX		Track Requirement
CY0809*		Capstone Project

Quarter 4

CY4410	(3-0)	Cyber Policy and Strategy
CY4600*	(3-2)	Network Operations in a Contested Environment
CYXXXX		Track Requirement
CY0809*		Capstone Project

*Required Core Courses for the Masters of Science in Applied Cyber Operations

Educational Skill Requirements

Cyber Functions and Fundamentals. In order to provide graduates skilled in the applications of Cyberspace to military needs, the graduate will have competence in the following functional areas:

· Securely Provision
· Operate and Maintain/Network Operations/DoD Global Information Grid Operations (DGO)
· Active Defense/Defensive Cyberspace Operations (DCO)
· Operate and Collect/Cyber Intelligence
· Analyze and Advise
· Offensive Cyberspace Operations (OCO)
· Investigate
· Communications Electronic Attack (Comms EA)
· Friendly Cyber Defense Forces

Cyber Infrastructure, Security, and Compliance. The graduate will be able to combine analytical methods with technical expertise and operational experience for effective utilization of the Global Information Grid (GIG) within the following areas: provide hardware and software support to multi-media Automated Information Systems; advise on capabilities, limitations, and conditions of equipment; implement production control procedures including input/output quality control support; implement and monitor security procedures; understand and advise on assigned mission organization0level compliance and defense of Command, Control, Communications, Computer and Intelligence (C4I) systems. The graduate will understand the technical mechanisms and non-technical procedures associated with the enforcement of policies in cyber systems, and their synergistic relationships. Through an understanding of security threats and vulnerabilities, the graduate will be able to develop and deploy procedures, systems, and tools for defending cyber assets.

Military Applications and Cyberspace Operations. The graduate will have a thorough knowledge of problem identification, formulation, and application of tools necessary to support decision making through all stages of operations in support of national and military objectives in the cyberspace domain to include DGO, DCO, and OCO. Attention will be given to military applications with particular focus on the ways in which cyber active defensive mechanisms and offensive effects can be assimilated at high speed in conjunction with other warfare areas and the ability to deliver COCOM-desired effects.

Organizational Construct and Policy. The graduate will have an in-depth understanding of the administrative and operational structure and command relationships of the organizations and commands that will be operating in the cyberspace domain. Additionally, the graduate will be able to recall and apply strategy, policy, and authorities (ROE,

U.S. law, the Law of Armed Conflict, and national policy) as it pertains to the use of non-kinetic force.

Cyber Infrastructure in Support of the Joint Information Environment. The graduate will understand friendly and adversarial cyber infrastructures and will be able to diagram and explain subsystem relationships, interactions, and functions. Specifically, the graduate will be able to describe the characteristics and applications of existing and planned infrastructures including (1) bottom-up systems for data collection or effects delivery, (2) middleware systems for smart push/pull services in a cloud/service-oriented-architecture, (3) top-down systems for command and control with a common operational picture, and (4) core infrastructure systems providing enabling communications. Additionally, the graduate will be able to analyze specific cyber system implementations to identify adaptive cyber vulnerabilities and effects for defensive and offensive operations in both permissive and contested environments. The graduate will be able to apply these analytic and problem-solving skills in Joint Information Environment operations to augment manpower with automated intelligence analytics for processing high volume, heterogeneous data sets to automatically produce high value alerts and actions in support of mission objectives.

Academic Research. The graduate will demonstrate the ability to conduct investigation in the context of the Joint Information Environment through the completion of a capstone project. Capstone work will be conducted in a framework that exercises problem solving, critical thinking, and real-world applicability. Further, the graduate will be able to present research goals and results in both written and oral form.

CY Courses

CY0809 Capstone Project (0-8) As Required
Every student engaged in a curriculum capstone project will enroll in this course.

CY0810 Thesis Research (0-8) As Required
Every student conducting thesis research will enroll in this course.

CY3000 Introduction to Cyber Systems and Operations (3-0) As Required
This course provides an overview of the national and military application of integrated lines of operations including operation of the Global Information Grid (GIG), defensive cyber operations, offensive cyber operations and the required technical and non-technical intelligence underpinning these. Through a series of guest lectures, students will be exposed to all aspects of cyber systems and operations ranging from the best in industry to actual plans and operations at the national and Combatant Command and component levels. This course is classified SECRET. Prerequisites: None.

CY3100 Introduction to Communications Networks (4-1) As Required
The purpose of this course is to develop literacy and familiarity with the technologies, techniques, and systems that provide the physical communications and point-to-point communications control upon which all communications networks are based. Physical layer topics include concepts in signals, information, analog and digital signals, signal corruption, signal reception, binary and non-binary data communications, communications channels, and radio communications concepts, IEEE standards 802.11 and 802.16, network interface controllers, switches, repeaters, multiplexers, antennas, A/D & D/A converters, and vocoders. Datalink layer concepts include connection vs. connectionless oriented, packet vs. circuit mode, error control, flow control, synchronization, framing, logical link control, media access control, Ethernet, Point-to-Point Protocol (PPP), and High-level Data Link Control (HDLC). Emphasis is on military communications systems to include Link 16, DSCS, Milstar, and WNW. Prerequisites: None.

CY3110 Internet Protocols (3-1) As Required
This course covers basic device (computers, smart-phones and PDAs) communications and networking through the study of the fundamental principles and technologies employed to implement the upper three layers of the TCP/IP protocol stack. The lower two-physical (1) and link (2)-layers are addressed only insofar as to provide a complete bit-level to message-level overview regarding each layer's role in supporting end-to-end communications. For the three upper layers, the course delves into analysis of the dominant protocols employed (e.g., IP, DNS, ICMP, HTTP, DHCP, TCP, UDP, RIP, OSPF, BGP, MobileIP, VoIP, and MPLS). In addition to understanding the basic operation, each protocol is also considered in the context of basic security challenges (confidentiality, integrity, availability) encountered in a distributed, internetworked environment. Prerequisites: None.

CY3300 Cyber Communications Architectures (Same as EO3730) (4-0) As Required
The purpose of this course is to develop literacy and familiarity with Navy, DoD, and allied enterprise information systems and emerging technology trends. It presents basic concepts in conventional and military telephony and telecommunication networks; examines DoN implementations from intra-ship, ship-to-ship and long haul and discusses architectures and components of the GIG including both classified and unclassified networks. It discusses interoperability of diverse network architectures and the impact of mobile platforms on operations. Prerequisites: CY3100, CY3110, CS3030, or consent of the instructor. Classification: SECRET.

CY3520 Practical Network Operations (3-3) Winter/Summer
This course develops fluency in applying computer security principles in the context of deploying and configuring network services and architectures. Emphasis is placed on utilizing an understanding of network protocols and their vulnerabilities to defend and construct a network. Students will gain hands-on experience building a network, analyzing the interaction of network and host based security mechanisms, and maintaining continuous awareness of security relevant events. Prerequisites: CY3110, CS3502, or consent of instructor.

CY3602 Network Operations II (3-2) As Required
This course is a sequel to Network Operations I, with a focus on how to deal with network attacks and compromises. The goal is a resilient network that can meet operational and mission needs even in the face of attacks. Students will learn how to detect and respond to attacks and compromises while keeping the network operational to the extent possible. Topics covered include self-assessment through vulnerability and penetration testing, using firewalls and intrusion detection and prevention systems to monitor network

traffic and system activity; and an introduction to established processes for cyber forensics and attribution, incident response, and recovery. Prerequisites: IS3502, CS3600, or consent of the instructor. Corequisite for students in Curriculum 326: CY4700.

CY3800 Topics in Signals Operations (3-0) Fall/Spring

Students will be introduced to concepts and systems for managing and ensuring effective employment of the electromagnetic spectrum (EMS). Topics include DoD, other government and Intelligence Community systems for communications; Signals Intelligence (SIGINT), Radio Frequency (RF) exploitation, electronic counter measures, electronic counter-counter measures, Precision Navigation and Timing (PNT), and EMS management. Students will better understand the role of these in building to and ensuring Naval Information Dominance and a US strategic and operational electronic advantage. Prerequisites: CY3100, CY3300, or consent of the instructor. Classification: U.S. citizenship and TOP SECRET clearance with eligibility for SCI access.

CY4400 Cyber Mission Planning (3-0) Winter/Summer

This course details the process of mission planning in the cyber warfare domain and its integration of cyber with other warfare domains. All phases of mission planning and execution for cyber missions in both direct and supporting roles are covered. Topics include requirements development/solicitation, managing expectations, targeting considerations, munitions development and selection, preparation of the environment, mission deconfliction in the cyber battlefield, balancing the needs of offensive and defensive stakeholders, and cyber battle damage assessment. Classification: U.S. citizenship and TOP SECRET clearance with eligibility for SCI access. Prerequisites: CY4700. Co-requisite: CY4600, or consent of the instructor.

CY4410 Cyber Policy and Strategy (3-0) As Required

This course explores the emerging strategies, policies and doctrine associated with cyber operations and military operations affected by cyberspace. The student will review the latest guidance provided by the US government at the national, interagency, DOD, and naval levels and relate these materials to the national strategy of the US. Special emphasis is provided for the products of US Cyber Command and Fleet Cyber Command/Tenth Fleet. These materials are compared to the emerging strategies and doctrine of other countries. Prerequisites: CY3000, DA3105, or consent of the instructor. Classification: TS/SCI.

CY4600 Network Operations in a Contested Environment (3-2) Winter/Summer

This is a course in offensive cyber operations and effects achievable by cyber means in a contested environment. It examines the network environment as a domain under contention and related information operations. Existing architectures and infrastructures for conducting offensive operations are studied. This course develops the literacy and competencies necessary to understand potential problems and realistic solutions for critical non-kinetic, cyber-related warfare issues for the United States. Classification: U.S. citizenship and TOP SECRET clearance with eligibility for SCI access. Prerequisites: CY3520. Co-requisite: CY4400, or consent of the instructor.

CY4650 Information Management for Cyber Operations (4-0) As Required

This course covers the acquisition and management of information for timely and effective decision-making. Topics include the collection, storing and processing of large amounts of data; autonomous processing including mining, matching, filtering and translating data; issues relating to scalability, performance and real-time requirements; and identification of appropriate data sources and tools. Prerequisites: DA3105, CY4400, CY4600, or consent of the instructor.

CY4700 Cyber Wargame: Blue Force Operations (2-5)

This course explores the development of cyber-oriented war games and exercises from the perspective of maintaining a high state of readiness in the face of hostile action. Topics include fundamentals of game theory, scenario selection, scenario development, and execution. Following scenario definition, students will develop a strategy for defending and operating their networks while responding to hostile activities. Emphasis is placed on risk assessment, employment of forces and assets, early detection of threats and maintaining services in an increasingly degraded environment. This course is designed to be offered simultaneously with Cyber Wargame Red Force Operations and culminates in a week-long cyber exercise in which the students participate in the blue force role. Prerequisites: CY3520 or CS3600 or CY3602 or CS3690 or DA3104 or consent of the instructor.

CY4710 Cyber Wargame: Red Force Operations (2-5)

This course explores the development of cyber-oriented war games and exercises from the perspective of maintaining a high state of readiness in the face of hostile action. Topics include fundamentals of game theory, scenario selection, scenario development, and execution. Following scenario definition, students will develop a strategy for defending and operating their networks while responding to hostile activities. Emphasis is placed on risk assessment, employment of forces and assets, early detection of threats and maintaining services in an increasingly degraded environment. This course is designed to be offered simultaneously with Cyber Wargame Blue Force Operations and culminates in a week-long cyber exercise in which the students participate in the red force role. Prerequisites: CY4600 and CY4700; or any one of: CS3695, CS4678, CS4558, EC4755, EC4765, EC4785; or consent of the instructor.

CY4750 Advanced Cyber Systems and Operations (3-1) As Required

This course serves as a capstone experience in which the students are immersed in a current operational or policy challenges related provided by the Information Dominance Corps community stakeholders. The assigned task will involve proposed cyber operations in support of an existing or anticipated operational plan. Student teams will develop courses of action (COA) that address legal, ethical, political, technical, tactical, operational and strategic implications. The recommended COA will be presented to the stakeholders. Prerequisites: CY4100, CY4400, CY4600. Classification: TS with eligibility for SCI.

CY4900 Research Topics in Cyber Systems and Operations (1-0) As Required

This course is designed to help students determine, shape and explore the foundational research for their theses and to introduce them to advances in cyber technologies and research. Students are expected to register for this course in the second quarter of their course of study.

CY4901 Cyber Systems and Operations Research Methods (1-0) As Required

The objective of this course is to introduce students to research design and execution in the context of cyber systems and operations. Topics include a review of quantitative, qualitative, and

heterogeneous research methods. Framing a hypothesis, collection of background material and literature review, the use of models and experimentation as part of a scientific process, testing and analysis, and the determination of well-grounded conclusions will be covered. The development of the thesis, writing techniques and thesis management will be covered. Students are expected to register for this course in the third quarter of their studies.

SCHOOL OF INTERNATIONAL GRADUATE STUDIES (SIGS)

Website
www.nps.edu/sigs
http://www.nps.edu/Academics/Schools/SIGS/

Dean

James J. Wirtz, Ph.D.

Naval Postgraduate School
Code 04, Herrmann Hall, Room 308
1 University Circle
Monterey, CA 93943

(831) 656-3781, DSN 756-3781, FAX (831) 656-1018
jwirtz@nps.edu

Associate Dean

Bernie Wang, CAPT, USN
Code 04, Herrmann Hall, Room 307A

(831) 656-3782, DSN 756-3782, FAX (831) 656-1018
bpwang@nps.edu

The School of International Graduate Studies includes:

Center for Homeland Defense and Security	NS
Department of National Security Affairs	NS
Defense Resource Management Institute	DR
Center for Civil-Military Relations	CM
Center for Contemporary Conflict	NS
Center for Stabilization and Reconstruction Studies	CM
International Graduate Programs Office	IGPO

Overview

The School of International Graduate Studies (SIGS) conducts research and offers Master's and Ph.D. degrees in Security Studies. Its programs seek to identify and address current and emerging security challenges, and to strengthen multi-lateral and bilateral defense cooperation between the United States and other nations. SIGS offers innovative interdisciplinary curricula, both in-residence and via distance learning, in regional and international security studies, civil-military relations, defense resource management, and homeland security.

Programs Offered

Doctor of Philosophy in Security Studies

The Ph.D. in Security Studies awarded by the Department of National Security Affairs requires one year of in-residence course work beyond the Master's plus at least two years to develop and execute a satisfactory dissertation. While the entirety of the dissertation need not be written in-residence, candidates for the Ph.D. should plan on a three-year tour, which is the norm for doctoral work at NPS.

Master of Arts in Security Studies (in-residence)

The Department of National Security Affairs offers Master of Arts degrees in a variety of regional and topical specialties within the field of Security Studies. MA programs require between twelve and eighteen months of in-residence study to complete.

Master of Arts in Security Studies (hybrid distance learning)

The Department of National Security Affairs and the Center for Homeland Defense and Security offer a Master of Arts in Security Studies (Homeland Security and Defense), which may be obtained via a combination of web-based distance learning and brief periods of intense in-residence study.

Short Courses and Executive Education (in residence)

The Department of National Security Affairs, the Center for Civil-Military Relations, the Center for Homeland Defense and Security, and the Defense Resource Management Institute offer a variety of in-residence, non-degree short courses, ranging from one to four weeks length. Topics vary from year to year, and are chosen to provide senior leaders with a concise, academically-grounded understanding of matters of particular current importance.

Mobile Education Teams

Mobile education teams comprised of or led by SIGS faculty provide a wide range of off-site short courses, senior executive seminars, and lecture series, similar in character to our in-residence short courses. Such programs may be delivered overseas, at other locations in the United States, or afloat and in-country with deployed forces.

Department of National Security Affairs (NSA)

Website
www.nps.edu/nsa

Chairman

Harold Trinkunas, Ph.D.
Code NS, Glasgow Hall, Room 319

(831) 656-2863, DSN 756-2863, FAX (831) 656-2949
hatrinku@nps.edu

Donald Abenheim, Associate Professor (1985); Ph.D., Stanford University, 1985.

David Anderson, Senior Lecturer (2012); Ph.D., University of Virginia, 1974.

Helen Anderson, Senior Lecturer (2011); Ph.D., University of Virginia, 1980.

Naazneen Barma, Assistant Professor (2010); Ph.D., University of California at Berkeley, 2007.

Anne Marie Baylouny, Associate Professor (2003); Ph.D., University of California at Berkeley, 2003.

Thomas C. Bruneau, Professor (1987); Ph.D., University of California at Berkeley, 1970.

Anshu Chatterjee, Lecturer (2003); Ph.D., University of California at Berkeley, 2003.

Victoria Clement, Assistant Professor (2009); Ph.D., Ohio State University, 2005.

Anne L. Clunan, Associate Professor (2002); Ph.D., University of California at Berkeley, 2001.

Erik Dahl, CDR, USN (ret.), Assistant Professor (2008); Ph.D., Tufts University, 2008.

Zachary S. Davis, Visiting Research Professor (2007); Ph.D., University of Virginia, 1989.

Sophal Ear, Assistant Professor (2007); Ph.D., University of California at Berkeley, 2006.

Ryan Gingeras, Assistant Professor (2010); Ph.D., University of Toronto, 2006.

Michael Glosny, Assistant Professor (2012); Ph.D., Massachusetts Institute of Technology, 2012.

Mohammed Hafez, Associate Professor (2008) and Associate Chair for Instruction; Ph.D., London School of Economics, 2000.

Carolyn C. Halladay, Senior Lecturer (2010); J.D. Stanford University Law School, 2002; Ph.D., University of California at Santa Cruz, 1997.

Jennith Hoyt, CAPT, USN, Senior Intelligence Officer (2009); MBA, Illinois Benedictine College, 1993.

Wade Lee Huntley, Senior Lecturer (2009); Ph.D., University of California at Berkeley, 1993.

Maiah Jaskoski, Assistant Professor (2008); Ph.D., University of California at Berkeley, 2008.

Scott E. Jasper, CAPT, USN (ret.), Lecturer (2002); M.A., Naval War College, 1997; MBA, San Jose State University, 1988.

Thomas H. Johnson, Research Professor (2003); M.A., University of Southern California, 1976.

Abbas Kadhim, Assistant Professor (2005); Ph.D., University of California Berkeley, 2005.

S. Paul Kapur, Professor (2008); Ph.D., University of Chicago, 1999.

Feroz Khan, BRIG, Pakistan Army (ret.), Lecturer (2008); M.A., School of Advanced International Studies, The Johns Hopkins University, 1991.

Jeffrey W. Knopf, Senior Lecturer (2000); Ph.D., Stanford University, 1991.

Letitia Lawson, Visiting Assistant Professor (1996); Ph.D., University of California at Davis, 1995.

Ted Lewis, Professor (1993); Ph.D., Washington State University, 1971.

Robert Edward Looney, Professor (1979); Ph.D., University of California at Davis, 1969.

Tristan Mabry, Assistant Research Professor (2009); Ph.D., University of Pennsylvania, 2007.

Michael Malley, Lecturer (2004); Ph.D., University of Wisconsin-Madison.

Eugene Michael Mensch II, COL, USA (ret.), Senior Lecturer (2009); M.A., US Naval Postgraduate School, 1978.

Alice Lyman Miller, Senior Lecturer (1999); Ph.D., George Washington University, 1974.

James Clay Moltz, Professor (2012), Associate Chair for Research, and Director of the Project on Advanced Systems and Concepts for Countering Weapons of Mass Destruction; Ph.D., University of California Berkeley, 1989.

Daniel Moran, Professor (1994); Ph.D., Stanford University, 1982.

Rodrigo Nieto-Gomez, Assistant Research Professor (2010); Ph.D. University of Paris VIII, 2009.

Edward Allan Olsen, Professor Emeritus (1980); Ph.D., American University, 1974.

Jessica Piombo, Associate Professor (2003); Ph.D., Massachusetts Institute of Technology, 2002.

Douglas Porch, Professor (1996); Ph.D., Cambridge University, 1972.

Maria Rasmussen, Associate Professor (1993); Ph.D., Yale University, 1990.

James Russell, Associate Professor (2001); Ph.D., King's College, University of London, 2009.

Zachary Shore, Associate Professor (2006); D.Phil., Oxford University, 1999.

Arturo Sotomayor, Assistant Professor (2009), Ph.D., Columbia University, 2004.

Robert Springborg, Professor (2008); Ph.D., Stanford University, 1974.

Harold A. Trinkunas, Associate Professor (1999); Ph.D., Stanford University, 1999.

Mikhail Tsypkin, Associate Professor (1987); Ph.D., Harvard University, 1985.

Christopher Twomey, Associate Professor (2004); Ph.D., Massachusetts Institute of Technology, 2004.

Robert Weiner, Lecturer (2007), Ph.D., University of California at Berkeley, 2003.

James J. Wirtz, Professor (1990); Ph.D., Columbia University, 1989.

David Scott Yost, Professor (1979); Ph.D., University of Southern California, 1976.

Thomas-Durell Young, Senior Lecturer (2009), Ph.D., University of Geneva (CH), 1988.

Brief Overview

The Department of National Security Affairs (NSA) specializes in the study and teaching of international relations, regional politics and security, international and military history, international political economy, and United States security policy. NSA brings together a faculty comprised of historians, political scientists, and economists, with students from all the U.S. armed forces, from various defense agencies, and officers and civilians from dozens of countries around the world.

Requirements for Entry

Applicants for MA programs must have obtained a Bachelor's degree from a regionally accredited academic institution. Graduate Record Examination (GRE) scores are not required for Navy and Marine Corps applicants, but Army and Air Force applicants must include scores from the GRE, taken within five years of the date of application. Ph.D. admissions requirements are described under curriculum 694, below.

International students whose native language, or language of prior instruction, was other than English, are required to have obtained a minimum total score of 90 on the internet-based Test of English as a Foreign Language (TOEFL), or a score of 560 on the written test.

Degree

NSA offers Master of Arts and Ph.D. programs in Security Studies. Master of Arts degrees always entail concentration in a particular regional or topical specialty, which is noted as part of the degree.

Regional Security Studies

NSA Regional Security curricula meet the high standards set by the U.S. armed forces for Foreign Area Officer education. Students can enroll in one of four curricula:
·   Curriculum 681 - Middle East, South Asia, and Sub-Saharan Africa
·   Curriculum 682 - Far East, Southeast Asia, and the Pacific
·   Curriculum 683 - Western Hemisphere
·   Curriculum 684 - Europe and Eurasia

International Security Studies

NSA offers a number of degree programs focusing on topics or problems with broad application to international security generally:
·   Curriculum 685 - Civil-Military Relations
·   Curriculum 686 - Stabilization and Reconstruction
·   Curriculum 687 - Defense Decision Making and Planning
·   Curriculum 688 - Strategic Studies
·   Curriculum 691 - Homeland Defense
·   Curriculum 692 - Homeland Security and Defense
·   Curriculum 693 - Combating Terrorism: Policy and Strategy
·   Curriculum 694 - Doctor of Philosophy in Security Studies

Curricular Structure

All NSA curricula share a common structure, which is designed to provide a firm foundation in the basics of security studies, along with in-depth exposure to a particular regional or topical specialty. This structure varies slightly depending on whether or not a degree program requires a Master's Thesis.

1. Disciplinary core courses. All NSA students are expected to complete five disciplinary core courses. These provide a basic familiarity with the underlying academic disciplines that constitute the multidisciplinary field of security studies: history, international relations, comparative politics, and economics. A course in writing and research methods is also required. Because of their foundational purpose, disciplinary core courses should be completed early in a student's stay at NPS.

2. Curricular core courses and elective courses. All NSA curricula require students to complete at least eight graduate-level courses in their subject of concentration. These are divided between curricular core courses and curricular electives. The ratio of core and elective course

varies from one curriculum to the next, but the minimum total is always eight, of which at least three (12 hours minimum) must be at the 4000-level.

3. General Electives. NSA degree programs usually afford some opportunity for students to take courses in subjects outside their area of specialization. Such courses are called "general" electives, and they may be chosen from among all courses offered at NSA. General electives exist to provide an opportunity for students to take courses relevant to their thesis research, but which may lie outside their particular regional or topical area of concentration. They are not optional. Curricula that provide scope for general electives also require that a certain number must be taken in order to complete the degree. The number of general electives available to students in a given program will vary, depending on sponsor requirements. In some cases such requirements may preempt a student's choice of general electives.

4. Thesis research. Students who are required to write a thesis must complete NS4080, Thesis Proposal, no later than six months prior to graduation. Afterward, they may take NS0810, Thesis Research, up to three times. NS4080 is a Pass-Fail course. It does not count toward the minimum of 12 credit hours of 4000-level course work described above.

4a. Comprehensive examination. NSA's regional curricula allow successful completion of language training at the Defense Language Institute to serve as a partial substitute for a Master's thesis. Curriculum 687 allows students the option of substituting significant additional course work at the 4000 level in lieu of thesis research. In addition to either language training or additional course work, students who do not write a thesis also must take a comprehensive examination, for which they prepare by enrolling in NS0811 during their final quarter. NS0811 counts as a regular course, and should not be taken as an overload.

Additional Requirements

1. SECNAV Requirement. The Secretary of the Navy has ordered that all DoN students at NPS take at least four hours of graduate-level course work addressing:

…the historical, current, and evolving elements of maritime strategy. Instruction in developments in naval warfare will include an analysis and comparison of present and emerging tactical and strategic naval doctrine as well as an analysis of emerging technical developments and their potential effect upon the prosecution of tactical and strategic naval warfare by the United States, our allies, and our potential adversaries.

Navy and Marine officers who complete the JPME program offered by the Naval War College satisfy this requirement automatically. Those who do not must take NW3230, *Strategy and War,* in lieu of a general elective. Marine officers who either have attended or will attend the Command and Staff College may validate this requirement.

2. **Naval Intelligence Requirement.** All Naval Intelligence officers in NSA are required to take NS4159,Seminar on Joint Intelligence Support to Crisis Operations, in lieu of a general elective. This course does not count toward the requirement of three 4000-level courses in a student's area of concentration, unless it is actually included among the curricular electives of a particular program.

3. JPME. Students at NPS have the opportunity to complete a sequence of Naval War College courses that convey JPME Phase I Credit. Completion of JPME is not a requirement for any NSA degree, but is available as an option for curriculum sponsors, and for students whose programs afford sufficient time (one additional academic quarter) to complete the work. JPME courses may not be taken as an overload and do not satisfy any curricular requirements in NSA.

Additional information about NSA academic programs, including an up-to-date schedule of course offerings, can be found on the NSA web site, www.nps.edu/nsa.

National Security Affairs Course Descriptions

FL Courses

FL0001-0009 Language As Required
This course is a generic identifier for a foreign language course taken at the Defense Language Institute (DLI). Prerequisites: None.

NS Courses

NS0810 Thesis Research (0-8) Quarterly
Students conducting thesis research will enroll in this course. Prerequisites: NS4080, or permission of the Academic Associate.

NS0856 Cultural Immersion Experience Tour (0-2) Quarterly
This course provides overseas cultural immersion experience for designated FAO/RAS officers. Enrollment requires prior authorization by the FAO/RAS proponent of the student's service, and permission from the cognizant Academic Associate of the student's curriculum. A trip report prepared in line with the requirements of each student's service branch is required. Course is graded Pass/Fail, and may be repeated.

NS0811 Preparation for Comprehensive Examination (0-8) Quarterly
Students preparing for comprehensive examinations will enroll in this course. Prerequisites: None.

NS2013 Research and Writing for Homeland Security (2-0) Quarterly
Offered through the Center for Homeland Defense and Security. The purpose of the research sequence (NS2013 and NS4081) is to advance your critical thinking, research and inquiry skills; you will use these skills to produce a strong thesis proposal (in this course sequence), and then later for the final thesis. We will identify and practice the main steps and modalities of good research. This will include exposure to a variety of research methods from which you will choose at least one for your thesis project and develop with the help of your thesis committee. Prerequisites: None.

NS2079 Foreign Language Maintenance (2-0) As Required
Intended for students with beginning or intermediate proficiency in a foreign language. Such students may maintain or improve their proficiency by arranging for individualized instruction with appropriately qualified faculty at NPS or DLI. Such arrangements must be made by the student. Enrollment in NS2079 requires the approval of the cognizant Academic Associate and the Department Chairman, and is accomplished using the same procedure required for enrollment in NS3079 and NS4079.

NS3000 War in the Modern World (4-0) Quarterly
This course provides an introduction to war as a political and social phenomenon, and as a force in the international system. Major themes include: the development of leading ideas about war; the mutual interactions of politics, society, and warfare; the impact of military doctrine on war fighting; allocation of resources and coordination of effort among land, sea, and air forces; national strategic cultures, and their implications for strategic practice. Prerequisites: None.

NS3001 War and Its Impact on Post-Conflict Reconstruction (4-0) Annually
The problem of post-conflict reconstruction is hardly a new one. In the past, victors in wars frequently had to manage and rebuild societies shattered by conflict. This course will examine historical examples of post-conflict reconstruction. War creates a competitive environment exploited by groups who seek political power. This competition begins while the war is under way. Competitors seek to place themselves in a position to take advantage of the new post-war environment by choosing allies and enemies, perhaps also arming themselves. On the new post-war playing field, old antagonisms assume new guises. Groups who might have been insignificant or repressed before the conflict can often exploit the new post-war environment to seek power. The military may also be strengthened by war, posing challenges to civilian governments or occupying powers. Social disorder, economic dislocation, and the de-legitimization of old political groups or ideas may invite chaos and even civil war. Prerequisites: None.

NS3003 Nationalism and Revolution (4-0) As Required
This course surveys the history of revolution in modern times, with particular emphasis on their role in the creation and development of modern nation states, and on the role of nationalism, more broadly, in the development of modern society. Prerequisites: None.

NS3011 Research and Writing for National Security Affairs (4-0) Quarterly
This course provides students with the basic tools to understand and produce research in relevant areas of history, social science and policy analysis. The general objectives of the course are to make you a more critical reader and thinker and better writer and researcher. The course is designed to help you with your other classes at NPS, which require you to read and write research papers. The course will also introduce students to basic elements of research design and methodology. In addition, the course will provide information on the thesis process at NPS. By the end of the course, every student should be able to produce a well-designed and well-written research paper or thesis. Prerequisite: None.

NS3021 Defense Capability Development (4-0) Annually
This course examines Service, Joint, and Multinational Concept Development and Experimentation programs for developing defense capabilities that are necessary to meet the anticipated operational challenges of the future security environment. The course explores the capabilities-based approach to defense planning that assesses how to effectively counter transnational, regional, and emergent peer competitors. The course considers what innovative capabilities are required to defeat adversaries who wage warfare across the maritime, land, air, space and cyberspace domains. The course analyzes emerging operational concepts, organizational configurations, technological advances, and people innovations, including doctrinal and training adjustments, for shifting the conduct of warfare to maintain competitive advantage in the 21st Century. Prerequisites: None.

NS3023 Introduction to Comparative Politics (4-0) Quarterly
This course is designed to introduce students to the major intellectual approaches to the study of comparative politics. Readings will be drawn from major theorists and leading schools of thought. Students will confront the central questions on the nature of economic, political, and cultural development. Prerequisites: None.

NS3024 Introduction to International Relations (4-0) Quarterly
This course provides an overview of the prominent theories of international relations. It surveys explanations based on decision-making, organizational behavior, domestic politics, international regimes and international systems, especially in terms of the insights they offer into the conduct of international relations in the post-Cold War world. Prerequisites: None.

NS3025 Introduction to Civil-Military Relations (4-0) Annually
This course introduces students to the basic concepts and issues in civil-military relations. It offers a historical and comparative analysis of different patterns of military participation in politics, defense policy making and national development. The course also introduces alternative models for structuring civil-military relations, and examines the problems associated with the models adopted by the United States and other nations. Prerequisites: None.

NS3026 Introduction to Post-Conflict Security Building (4-0) Annually
This course introduces students to the fuller program, intended to prepare them to work together in operations that build security in post-conflict environments. As such, it provides both conceptual tools for thinking about post-conflict security building and empirical referents to ground later study. Military strategists have written much about going to war, but have given less consideration to the movement from war to peace. How can one think strategically about the post-conflict environment? This course introduces students to characteristics of post-conflict environments and the diverse actors seeking to shape it. The course draws upon real-world cases to identify patterns of conflict and their consequences for post-conflict transition. In particular, the course will focus on interventions by external actors, civilian and military, in peace implementation. What are the typical components of post-conflict security building programs? This course covers practical issues in, and normative dimensions of, post-conflict security building. Prerequisites: None.

NS3028 Comparative Government for Homeland Security (4-0) Annually
Offered through the Center for Homeland Defense and Security. The objectives of the NS3028 course are: (1) to understand the trans-national nature of terrorism, organized crime, pandemics and other homeland security threats, (2) to assess homeland security strategies employed by liberal democracies around the world; (3) to distil and extrapolate policy implications from these examples; and

(4) to apply these lessons to the organizational and functional challenges faced by homeland security leaders in the United States. Prerequisite: None.

NS3030 American National Security Policy (4-0) As Required

An overview of U.S. national security policy formulation. Covers the processes and actors involved, both governmental and non-governmental. At instructor's discretion, course might also address recent developments in U.S. national security strategy. Prerequisites: None.

NS3037 The Role of Congress in U.S. National Security Policy (4-0) As Required

Survey of the roles, processes and orientations of the U.S. Congress in making national security policy. The course examines the powers and responsibilities granted to Congress by the Constitution, how the role of Congress has changed over time, and the way the role may evolve in the future. Specific topics include the budget process, War Powers, security assistance, and the problems of executive-legislative coordination in foreign and military policy making. Prerequisites: None.

NS3040 The Politics of Global Economic Relations (4-0) Quarterly

Examination of the world economy. Focuses on implications for the United States over changes in the world trading and financial systems. Topics covered include trade patterns, economic integration, trade blocs, new international economic order, and international economic organizations. Prerequisites: None.

NS3041 Comparative Economic Systems (4-0) As Required

Examination of the economic systems and development problems in developing countries, including post-communist states. The course focuses on the political and ideological bases of economic organizations, and the nature of basic economic problems in these regions. Special attention is given to the socio-economic strategies and tactics used in the management of the economy, and institutions and techniques of decision making. Attention is also given to problems of economic stabilization in the developing world. Prerequisites: None.

NS3042 Economics of Insurgencies for Security Building (4-0) As Required

The course examines the economic issues related to civil wars and insurgencies, and reconstruction and development after conflict. Prerequisites: None.

NS3077 Practicum in Regional Security Studies (4-0) As Required

This course supports student research conducted under the auspices of the Center for Civil-Military Relations and the Joint Foreign Area Officer Sustainment Program. Students work overseas under NSA faculty supervision, and participate in seminars, exercises, and other programs offered in Monterey or abroad, dealing with the region that is the focus of the research. The Practicum is open to students in any NSA curriculum, but is limited to those selected for participation by the organization supervising the program. Grading is Pass/Fail. Prerequisite: Permission of the instructor.

NS3079 Directed Studies in National Security Affairs (4-0) As Required

(Credit 1-0 to 4-0) Format and content vary. Normally involves extensive assigned readings, individual discussions with the instructor, papers and/or examinations. Prerequisites: None.

NS3155 Intelligence and Democracy (4-0) As Required

This course examines the methods civilian authorities in emerging democracies can use to establish strong, effective controls over their intelligence agencies. The course begins by examining the intelligence process in the United States and the United Kingdom, and the potential problems that intelligence activities can pose to democratic governance. Next, students will analyze the mechanisms used by the U.S., the U.K., France and other long-established democracies to maintain control over their intelligence organizations. These instruments of control include use of the power of the purse, structural and organizational arrangements, legislative oversight, and legal mechanisms. Employing the case study approach, students will examine the recent efforts by democracies in Latin America, Central Europe, Africa, and Asia to establish their own democratic controls over intelligence, and the challenges that such nations will face in the future. Prerequisites: None.

NS3159 Principles of Joint Operational Intelligence (4-0) As Required

This course examines the intelligence process, organizational structure and related C4I architecture within the context of intelligence support to the planning and conduct of joint and combined operations at the operational level of war. This course addresses the conduct of intelligence to include the development of requirements, collection management, threat analysis, assessments, and dissemination of intelligence to the decision maker. The course includes an overview of intelligence data systems and associated connectivity. Students are required to prepare and present intelligence briefings and staff intelligence studies, incorporating the knowledge gained in the course. Classification: U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI.

NS3160 Human Intelligence (4-0) As Required

This course familiarizes students with the concepts, principles, and methodology of Human Intelligence collection. Additionally, students will comprehend the capabilities and limitations of various collectors and programs, learn the organizational architecture and understand the collection management process of Human Intelligence. This course is a requirement for all students in the Regional Intelligence Track of the Joint Intelligence Curriculum. Classification: Student must be a U.S. citizen holding a TOP SECRET clearance with eligibility for access to Sensitive Compartmented Information.

NS3161 Principles of Open Source Intelligence (4-0) As Required

This course examines open source intelligence (OSINT) with a focus on the following areas: definition and nature of OSINT, OSINT policy and management, history and development of OSINT, current OSINT trends, OSINT-focused organizations, challenges, reform, and future prospects. Classification: SECRET NOFORN. Prerequisites: None.

NS3180 Introduction to Homeland Security (4-0) Winter

Offered through the Center for Homeland Defense and Security. This course provides an overview of the essential ideas that constitute the emerging discipline of homeland security. It has two

central objectives: to expand the way participants think, analyze and communicate about homeland security; and to assess knowledge in critical homeland security knowledge domains. Prerequisites: None.

NS3181 Introduction to Homeland Defense and Security (4-0) Annually

This course surveys the distinctive features and challenges of homeland defense and security, with emphasis on the interagency process by which the contributions of the armed forces and defense agencies are integrated with those of civilian federal agencies and state and local governments.

NS3225 Civil-Military Relations and Defense Budgeting (4-0) As Required

Accelerated course, offered through the Defense Resource Management Institute. This course provides a detailed analysis of the budget process used by the United States and other democracies to allocate defense resources. Students will become familiar with the planning, programming and budgeting system (PPBS) and other budgeting models and techniques. Students will also examine the sources of civil-military conflict in defense budgeting, and analyze different structures to resolve those conflicts.

NS3230 Innovation and Adaptation in the Military (4-0) Annually

This course provides an introduction to and critical examination of the role the military plays in U.S. strategic planning and national security policy formulation. The focus will be on the institutions and actors involved in strategic planning, the planning process itself, and the outputs of that process. Theory and process meet through case study and analysis of the evolution of U.S. military planning practices, including the changing roles of the Joint Staff, combatant commands and service components, joint task forces, and service staffs following passage of the Goldwater-Nichols Act and post-Cold War international security developments. Prerequisites: None.

NS3245 Comparative Defense Organization and Management (4-0) Annually

This course is intended to introduce students to contemporary best practices in defense organization and management. Topics include the identification of appropriate military roles and missions within a framework of constitutional and budgetary constraint; the periodic defense "review" process as a basic tool of defense management; and the application of contemporary "best practices" in the reform and removal of legacy bureaucratic structures that no longer serve national ends. Prerequisite: None.

NS3246 Comparative Defense Planning (4-0) Annually

The course seeks to acquaint students with the historical development and contemporary requirements of effective defense planning. It is organized around comparative case studies of defense planning as practiced by small and medium-sized states at varying stages of economic and military development, and seeks to provide students with firm understanding of the essential methodologies of both defense budget management and operational level war planning. Prerequisite: None.

NS3260 Drug Control Strategy and Policy (4-0) As Required

This course provides an overview of the challenges posed by the production, trafficking, and consumption of illegal drugs, both in the U.S. and abroad, and evaluates government drug control efforts. It addresses the presidential, congressional, and bureaucratic politics that shape the formulation of domestic and international drug control policies. The challenges of implementing drug control policies will be analyzed, in particular the need for interagency coordination and international cooperation to address this complex threat. Both supply-side and demand-side policies will be discussed in detail and their effectiveness assessed. Prerequisites: None.

NS3280 Nuclear Weapons and National Strategies (4-0) Annually

This course surveys the history of nuclear weapons policies both in the United States and internationally, focusing in particular on comparative national strategies. It considers requirements for deterrence, incentives for arms control and nonproliferation policies, and new challenges posed by nuclear proliferation. Prerequisite: None.

NS3285 Nuclear, Biological, and Chemical Weapons: Proliferation and Nonproliferation (4-0) Annually

This course examines the proliferation of nuclear, biological, and chemical (NBC) weapons. It is an introductory survey course that covers the history and causes of NBC proliferation, the impact of proliferation on U.S. and international security, and the range and effectiveness of past efforts to restrain and/or mitigate proliferation. The class focuses on the changing nature of NBC proliferation problems, evaluating contemporary challenges and assessing potential future policy responses. It assumes no specialized prior knowledge of the subject matter. For this reason, it reviews the basic technologies of NBC weapons and current perspectives on proliferation problems and debates on means to overcome them. Prerequisite: None.

NS3300 Islam (4-0) Annually

Islam is one of the great monotheistic faiths of the modern world. This survey course examines the history and tenets of Islam and the breadth of Muslim cultures and civilizations. Prerequisites: None.

NS3301 African History and Cultures (4-0) Annually

This course provides a broad overview of African history, with an emphasis on understanding the historical foundations of important contemporary issues. In addition, it examines the process of cultural change in Africa over the course of the twentieth century, through an in-depth study of the fiction of Chinua Achebe. Prerequisites: None.

NS3310 Middle Eastern History to 1918 (4-0) Annually

This course surveys the history of the Middle East from the founding of the Ottoman Empire through the end of the First World War. Also included in this period is the history of the Safavid and Qajar dynasties that ruled Iran and maintained rivalry with the Ottomans. Given the nature of Egypt's special status within the Ottoman Empire as of the 19th century, Egypt will be studied independently within this course. Prerequisites: None.

NS3311 Government and Politics in Sub-Saharan Africa (4-0) Annually

This course is designed for graduate students with little or no background in the study of African government and politics. It introduces students to the main structures and processes of contemporary African politics, and to important theoretical debates in the field of African studies. The emphasis is less on formal institutions of government and more on the informal practices that comprise the primary arena of African government and politics. Prerequisites: None.

NS3315 Modern Arab History (4-0) Annually

This course studies the history of the Arab Middle East from the end of the First World War to the present. It will examine Western engagement in the region and the eventual creation of the current nation-states. The political and social evolution of the region and its relations with the West will be broadly surveyed. Prerequisites: None.

NS3320 U.S. Foreign Policy in the Middle East (4-0) Annually

The course reviews the historical background and current status of American interests and policies in the Middle East. The course focuses on how different U.S. administrations in the post-World War II era defined American interests in the Middle East, and on the major policies enacted to pursue those interests. Prerequisites: None.

NS3330 Comparative Politics of the Middle East (4-0) Annually

Focuses on the Middle East region's role in world events in the post-World War I era, including the impact of great power rivalries in the region, transnational movements, and environ-strategic considerations. Prerequisites: None.

NS3340 Middle East in the International Economy (4-0) As Required

This course explores timely international and regional economic development issues. We will examine both international and regional economic interactions and possibilities, including regional trade agreements, negative and positive international agreements (sanctions, foreign aid, the WTO, etc.) and shared international resources such as water. We will tackle the problem of late development, the effects of oil, labor migration, and tax regimes on the economies and business-government relations, privatization moves, and current prospects for employment and poverty-alleviation. Prerequisites: None.

NS3351 Anthropology of Africa (4-0) As Required

Examines various facets of African anthropology. Prerequisites: None.

NS3360 Politics and Security in North Africa (4-0) As Required

A survey course on the politics and security of North Africa in the post-World War I era. The geographic focus is on the countries of Egypt, Libya, Tunisia, Algeria and Morocco. Prerequisites: None.

NS3361 Politics and Security in Levant (4-0) As Required

A survey course on the politics and security of the Levant in the post-World War I era. The geographic focus is on the countries of Syria, Jordan, Lebanon, Israel and Palestine. Prerequisites: None.

NS3362 Politics and Security in the Northern Tier (4-0) As Required

A survey course on the politics and security of the Northern Tier in the post-World War I era. The geographic focus is on the countries of Turkey, Iran and Afghanistan. Prerequisites: None.

NS3365 Politics and Security in the Persian Gulf (4-0) As Required

A survey course on the politics and security of the Persian Gulf in the post-World War I era. The geographic focus is on the countries of Iraq, Saudi Arabia, Kuwait, Bahrain, Qatar, Oman and the UAE. Prerequisites: None.

NS3366 Modern Turkish History (4-0) As Required

This course surveys the history of the Turkish people and state from Ottoman times to the present. Important topics include the continuing influence of pre-Islamic Turkish culture; Turkish responses to colonialism, nationalism, and modernity; secularism and Westernization; the place of ethnic minorities in modern Turkey; and the tension between Kemalism and Islamism in contemporary Turkish culture and politics.

NS3400 History of Russia and Eurasia (4-0) Annually

An examination of the history of Russia, Eastern Europe, and Central Asian nations. The emphasis is on historical influences, political institutions, ethnic and social problems, and the economy. Prerequisites: None.

NS3401 Contemporary Politics of Russia (4-0) Annually

This course introduces students to the contemporary politics of Russia focusing on the post-Soviet. Prerequisites: None.

NS3412 Government and Security in the Central Asian Republics (4-0) As Required

With China and Russia taking an ever-increasing greater interest in central Asia, U.S. policy makers face the challenge of maintaining an influential presence in the region. Over a decade since the breakup of the Soviet Union, the five Central Asian Republics have emerged as a critical security issue as WMD, terrorists and hard-line regimes have come to dominate the landscape. In a land where Islam is more cultural than religious, communism more trusted than capitalism, and ethnic divisions a Soviet invention, how can stable democracies emerge? This course will represent a comprehensive assessment of the newly formed states of central Asia that were formerly parts of the Soviet Union. Through examination of the complex historical, ethnic, religious, and linguistic factors that unite and divide the Central Asian Region, we will better understand the challenges of political modernization, economic reform, and integration into the international community. The course topics will include: the history of the region; the relationship between Islam and Central Asia; environmental issues; economic development and emerging energy markets in the region; the contemporary political scene; and the role of the region in world affairs. Special emphasis will be placed on the contemporary crises in the region. Prerequisites: None.

NS3450 Military Strategy in Russia, Eastern Europe and Central Asia (4-0) As Required

The course examines the international factors that condition military strategy and doctrine in Russia, Eastern Europe, and Central Asia. It focuses on contemporary strategic concepts and strategy: conventional war fighting capabilities, strategy for nuclear war, roles played by the fleets in military strategy, threat and net assessment, and arms control. Emphasis is on the strategic and operational levels of warfare. Prerequisites: None.

NS3460 Government and Security in Eastern Europe (4-0) As Required

This course examines the countries of east central Europe that fell in the Soviet sphere of influence after World War II. It is concerned in particular with the complex relationship of Marxism and nationalism, the nature of communist revolution from abroad, revolutions against communist states including Hungary in 1956 and Poland in 1980, and the present situation of the Central European states in the transition from communism to democracy. Prerequisites: None.

NS3466 Modern Central Asian History (4-0) As Required
This course studies the history of Central Asia from the late Russian empire to post-Soviet independence. Topics to be covered include Turkic and Persian cultural influences and Russian political influences in the region. The political and social changes experienced during the Soviet era and the major issues of independence that will be discussed, including relations among ethnic groups, the role of Islam in everyday life and politics, and the politics and economics of energy. Prerequisites: None.

NS3501 History and Cultures of Latin America (4-0) Annually
This introductory course examines the heritage of Latin America from pre-Columbian Indian traditions and Iberian colonial patterns, through the independence movements of the early 19th century, and the global economic relationships that re-oriented the region toward Northwestern Europe and the United States. Prerequisites: None.

NS3510 Government and Politics in Latin America (4-0) Annually
This introductory course is designed to familiarize students with the politics of contemporary Latin America. The course will cover such topics as the various types of political systems found in Latin America, the political economy of development and the issue of regime transition. Prerequisites: None.

NS3520 Latin American International Relations (4-0) Annually
This course surveys the international relations of Latin American nations. It analyzes the relations of Latin America with the United States and other nations, both within and outside of the region. Attention is given to political, economic, and cultural issues. Prerequisites: None.

NS3560 Political and Social Change in the Andes (4-0) Annually
This course focuses exclusively on the Andean sub-region, which is currently experiencing the highest levels of social change, political volatility, and institutional distress in all of Latin America. The course is structured around the in-depth examination of similar challenges in five different countries: Bolivia, Colombia, Ecuador, Peru and Venezuela. These challenges include the mobilization of indigenous populations, the breakdown of traditional party systems, tensions in civil-military relations, and illicit flows of drugs across national borders. Prerequisites: None.

NS3578 Society, Politics, and Security in Contemporary Brazil (4-0) Annually
Brazil is the largest county in South America, a major regional power that is rapidly emerging as an important global actor. This course will provide students with the historical and social background required to better understand contemporary Brazil. It will survey its recent history and current condition as a consolidating democracy, and focus on security issues both as perceived by the Brazilian elite, and as projected upon Brazil by the United States and Brazil's neighbors in South America. Prerequisites: None.

NS3580 Comparative Border Security (4-0) Annually
This course offers a thorough introduction to the border as a geopolitical construct that materializes in territories of linear configuration the balance of power among nations or regions (both internal and supranational). We will study and compare the elements that make borders a singular geographic space with unique management challenges and institutions, its relation with conflict, security and war. Prerequisites: None.

NS3600 History of Modern East Asia (4-0) Annually
This course surveys the interaction between the traditional civilizations of east Asia and the Western great powers since the early 19th century. It emphasizes the evolution of the modern international system in the region, beginning with the imposition of the treaty port system on China, Japan, and Korea, and follows the separate responses of those countries to Western influences though the era of the world wars and down to the present. Prerequisites: None.

NS3601 History and Cultures of Southeast Asia (4-0) As Required
This course addresses the historical development of the peoples of mainland and island Southeast Asia from their origins to the end of the nineteenth century. It focuses on the political, military, social and economic development of these societies and on their belief systems, including Hinduism, Buddhism, and Islam. Prerequisites: None.

NS3602 U.S.-Asian Relations: 18th Century to WWII (4-0) As Required
Examines U.S. Asian relations during the 18th Century through WWII. Prerequisites: None.

NS3605 History and Traditional Cultures of East Asia (4-0) As Required
This course offers a general introduction to the history and cultures of China, Japan and Korea down to the early 19th century. It presumes no previous acquaintance with this subject. It highlights those themes that are useful for understanding these countries' modern development, and it focuses in particular on the foundations for modern state-making in these traditional societies. It also provides a glimpse of the historiographic controversies that carry implications for interpretations of these countries' behavior today. Prerequisites: None.

NS3607 South Asian History and Contemporary Conflict (4-0) As Required
Overview of South Asian history and conflicts. Prerequisites: None.

NS3620 Survey of Asian Politics (4-0) Annually
This course surveys the major themes of Asian politics. The goals of the course are to introduce students to major debates and various modes of political interaction and patterns of political development in Asia. Half of the course is devoted to Northeast Asia and the other half to Southeast Asia. Prerequisites: None

NS3621 International Relations of Southeast Asia (4-0) Annually
This course focuses on the contemporary international relations of Southeast Asia, to include Thailand, Malaysia, Singapore, Indonesia, and Oceania. Prerequisites: None.

NS3645 Political Economy of Asia (4-0) Annually
This course explores the reasons for the different timing and paths of economic development in Japan, China, Taiwan and South Korea. It examines the reasons for the lateness of development of East Asia relative to the West, and especially the lateness of development of China compared to Japan. Emphasis will be on the evolution of institutions in the course of state building, and the

international geopolitical context of Asian development. Prerequisites: None.

NS3661 Government and Security in China (4-0) As Required

An examination of the rise of the Chinese Communist Party and the establishment of the Communist state; its domestic achievements and problems; the special problem of Taiwan; changing foreign policies and the current role of the People's Republic of China in world affairs. Includes an examination of U.S. relations with China. Prerequisites: None.

NS3662 Government and Security in Japan (4-0) As Required

An examination of Japan in the contemporary world, focusing on Japan's political dynamics, economic evolution, social transformation, the National Self Defense Forces and alternatives for ensuring national security. Includes examination of U.S. relations with Japan. Prerequisites: None.

NS3663 Government and Security in Korea (4-0) As Required

An examination of the division of the Korean nation into two states; the aftermath of the Korean war; domestic political, economic and social problems of North Korea and South Korea; the prospects for reunification; the military balance and the changing strategic environment; and the relations of Pyongyang and Seoul with their key allies. Includes an examination of U.S. relations with Korea. Prerequisites: None.

NS3664 Government & Security in Southeast Asia (4-0) Annually

This course examines the development of Southeast Asian politics from decolonization to the present day. Prerequisites: None.

NS3665 US-Japan Security Relations (4-0) Annually

This course is designed to explore the history and contemporary politics of the US and Japan security relationship. Prerequisites: None.

NS3668 Politics and Security in South Asia (4-0) Annually

This course traces the history and evolution of South Asian politics leading up to the partition of the Subcontinent. It familiarizes students with the key debates and future trajectories in contemporary South Asia. This course creates a sound base for advance seminars on NS4668, which should be a logical follow-up and other regional security seminars. Prerequisites: None.

NS3700 History of Modern Europe (4-0) Annually

Review and analysis of the political and military history of Europe, including Russia, from the Congress of Vienna to the present. Prerequisites: None.

NS3710 Government and Security in Western Europe (4-0) Annually

Survey and analysis of government and security issues in contemporary Western Europe. The course emphasizes the post-1945 history, government, political system, and security policies of Britain, France, Italy, and Germany. Major topics include relations with the United States and policies concerning the future of NATO and the European Union.

NS3720 European Security Institutions (4-0) Annually

Survey and analysis of the main international institutions dealing with European security: the North Atlantic Treaty Organization (NATO), the Organization for Security and Cooperation in Europe (OSCE), the European Union (EU), and the United Nations (UN). The survey includes selected challenges facing each organization, particularly NATO, and their relation to specific European countries and to U.S. foreign and defense policy.

NS3730 The Balkans: History & Politics (4-0) Annually

A survey of the historical background of and contemporary developments in the Balkans region, with a special focus on the collapse of the former Yugoslavia, the various conflicts that followed, including that in Kosovo, the role of other regional actors in these events, and the prospects for future stability and progress in the region. Prerequisites: None.

NS3801 Introduction to Terrorism (4-0) Annually

This course provides an in-depth examination of the origins, nature, and political/military roles of contemporary international terrorism. It briefly examines the early history of terrorism, the contending theories that purport to explain the sources of terrorist behavior, the different types of terrorism and terrorist actions, and the challenge international terrorism poses for American interests and foreign policy. Functional topics, such as the special problems posed by state-sponsored terrorism, the relationship between terrorism and the media, and the range of possible military responses to terrorism are also examined. The course will conclude by comparing and contrasting different national responses to the problem of international terrorism, and examining the difficulties faced by the United States in its efforts to find an effective policy response. Prerequisites: NS3023 or consent of instructor.

NS3802 Counterterrorism Policy in Comparative Perspective (4-0) Annually

This course studies counterterrorist policy in a variety of countries, including the United States. It considers the means by which policies are formulated, and their effectiveness evaluated, as well as the implementation of counterterrorist policies as they affect human rights, civil liberties, and the population at large. We also look at issues such as oversight of institutions charged with internal security, executive power, and the impact of international law on domestic politics. Prerequisites: None.

NS3900 International Law and Organizations (4-0) Annually

An introduction to the principles of international law including origins, sources, sovereignty, states, territory, jurisdiction, persons, treaties, settlement of disputes and the Law of the Sea. The course also traces the evolution of international organizations from the Concert of Europe, through the League of Nations, United Nations, European Economic Community, NATO, and various forms of multi-national and transnational organizations. Prerequisites: None.

NS3903 Ethical Theory for Military Officers (4-0) As Required

This course is a philosophical survey of major ethical theories that individuals or societies use to form their moral worldview. One presupposition of the course is that, as moral agents by virtue of being in various relationships with others, everybody has a philosophy--a way of thinking about and engaging others—that is, our social behavior. Thus, the course will also seek to move the student, as a military officer and a moral agent, beyond an external understanding of the major ethical theories and ask them to articulate their moral worldview and the ethical framework (theory) that forms the skeleton of that worldview. Such introspection is also vital for engaging other cultures when deployed as operators, analysts, or staff officers. In short, this course is designed to enable

military officers to gain that inner knowledge and engage others from positions of ethical strength rather than of weakness. Prerequisites: None.

NS3904 Comparative Ethics in Five World Religions (4-0) As Required

This course will examine where the concept of something being right began and how it has evolved over the ages, paying particular attention to the religions and philosophies of various cultures and how they have influenced that society's sense of what is right. We will explore the distinctive characteristics of the world's major religions and the cultures we are most likely to deal within the military, as well as the significance of fundamentalism in all religions. We will look at tools for planning, negotiation, and meaningful dialogue in many settings. Prerequisites: None.

NS4021 Seminar on Europe and the United States (4-0) As Required

A historical-political advanced seminar on the evolution of U.S. policy towards Europe from the end of the 19th century until the present; the character of anti-European ideas in U.S. political and strategic culture; the role of leading personalities in the formulation of U.S. policy towards Europe in the critical periods of the twentieth century; the character of anti-U.S. sentiment in continental Europe; U.S. alliance cohesion and cultural diplomacy in continental Europe. The seminar analyzes readings in common and requires a larger independent research project. Prerequisites: None.

NS4022 Soldiers and Politics in the Euro-Atlantic Region (4-0) As Required

A comparison in an advanced seminar format via historical case studies of the evolution of the soldier and the state in the Anglo-Saxon countries and their continental European counterparts. The evolution of civil-military relations from dynastic, absolutist Europe to the era of total war in the twentieth century, with special attention to the German, British and U.S. cases of the evolution of state, national and military institutions, alliance cohesion, and wars of ideology. Further attention is also paid to the proliferation of warfare, ideology, and mass politics and the professional soldier in modern history. An analysis of common readings as well as an independent research paper round out the seminar. Prerequisites: None.

NS4023 State, Nation, and Nationalism in Europe, 1500-1945 (4-0) As Required

An advanced seminar on the evolution of the state, nation, and nation-state in western, central and eastern Europe from the seventeenth century until the middle of the twentieth. Special emphasis falls on the rise of national ideas in the eighteenth century, case studies of nation building and the propagation of nationalism in the nineteenth and twentieth centuries, as well as the transformation of nationalism into a force of total war and genocide in the twentieth century. An analysis of the common readings as well as an independent research project is required. Prerequisites: None.

NS4024 Political Economy of China (4-0) As Required

This course explores how state, society and politics impinge on the Chinese economy in its transition from planned to market economy; and examines what political and economic adjustments China has to make as the country becomes increasingly integrated with the world economy. Prerequisites: None.

NS4025 Special Topics: East Asia (4-0) As Required

We use a paired comparative method in order to assess some of the leading theories on market transformation, and examine the geopolitical context, the strategies, process of institutional adjustment, and the coalition of interests formed to support or resist change as Japan, North and South Korea, China and Russia undertake market reform. Prerequisites: None.

NS4026 Capstone Seminar: Reconstruction of Civil Society (4-0) As Required

This course pulls together empirical, experiential and theoretical student learning in the post-conflict security building track. It explores multiple approaches to reconstruction and the conditions under which they tend to work in post-conflict transitions. Fundamental questions are addressed. From the perspective of international financial institutions, how can societies experiencing humanitarian emergencies make transition from relief to development? From the perspective of external actors, civilian and military, what patterns of interventions emerge in peace implementation? Considering perspectives of the host nation and external implementers of peace agreements, what are the costs and benefits of outside intervention? How can program responsibility shift effectively from military officials to civilians? What institutions and processes are vital to reconstruction of civil society, and how might military demobilization, reconstitution programs and police reform programs fit with those institutions and processes? How can indigenous stakeholders "own" the reconstruction in the face of outside intervention? Students participating in this course will share their insights from case analyses and build a data set for future students and researchers. Prerequisites: None.

NS4028 Vietnam (4-0) Annually

Seminar on the history, and culture of Vietnam. A series of contemporary issues are also covered. Prerequisites: None.

NS4032 Special Topics: International Relations (4-0) As Required

This course will focus on current topics in the broader international system. The list of issues to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. Prerequisites: Consent of instructor.

NS4035 Special Topics: Joint Intelligence (4-0) As Required

This seminar will focus on contemporary topics involving joint intelligence and related areas. The list of issues to be analyzed for the seminar is announced one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. Prerequisites: Consent of instructor. Classification: U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI.

NS4036 Comparative Strategic Cultures (4-0) As Required

Overview of strategic cultures around the world and the manner in which they affect defense/military strategies.

NS4037 NATO (4-0) As Required

This advanced seminar is a colloquium on the past and present policy and strategy of NATO via an examination of its leading crises from 1949 until 2003 in an effort to understand the nature of alliances in the Euro-Atlantic world, their strategies and issues of cohesion amid crisis. The class examines such themes as: a.) the evolution of ideas in the formulation of alliance statecraft and strategy; b.) the dimension of burden sharing in alliance statecraft and bi-lateral relations; c.) the problems of defense and military

transformation in the past, especially connected with alliance politics and political biography; d.) the past instances of severe discord in national strategy and alliance statecraft with enduring importance for the essence of NATO; the modalities of NATO enlargement in the era 1989-1999 and beyond; the post-1990 shift from forward defense in central Europe to the rise of peace enforcement operations in S.E. Europe. Finally, attention is also given to the issues of the present connected with the role of NATO in ongoing security operations on a wide front. This class is taught in a colloquium format; further, it requires an additional book report and the preparation of large synthetic essay on the sum of the readings. Prerequisites: None.

NS4040 Conflict in Africa (4-0) As Required

This course examines multiple aspects of ethnic conflict in Africa. In the first half, we consider theoretical approaches to ethnicity, ethnic conflict, cross border contagion, and regional conflict. The second half of the course is dedicated to case studies, to be prepared and presented by the students. Prerequisites: None

NS4051 Special Topics: Comparative Politics (4-0) As Required

This course introduces students to specialized subjects or problems within its particular field of study. The topic of each segment will be specified via a subtitle in departmental course scheduling documents. Detailed information should be sought from the professor offering the course. Special Topics courses with the same number may be repeated with different subtitles. Prerequisites: Prior completion of NS3023, or permission of the instructor.

NS4052 Special Topics: International and Military History (4-0) As Required

This course introduces students to specialized subjects or problems within its particular field of study. The topic of each segment will be specified via a subtitle in departmental course scheduling documents. Detailed information should be sought from the professor offering the course. Special Topics courses with the same number may be repeated with different subtitles. Prerequisites: Prior completion of NS3000, or permission of the instructor.

NS4053 Special Topics: Political Economy (4-0) As Required

This course introduces students to specialized subjects or problems within its particular field of study. The topic of each segment will be specified via a subtitle in departmental course scheduling documents. Detailed information should be sought from the professor offering the course. Special Topics courses with the same number may be repeated with different subtitles. Prerequisites: Prior completion of NS3040 or NS3041, or permission of the instructor.

NS4054 Special Topics: Strategic Studies (4-0) As Required

This course introduces students to specialized subjects or problems within its particular field of study. The topic of each segment will be specified via a subtitle in departmental course scheduling documents. Detailed information should be sought from the professor offering the course. Special Topics courses with the same number may be repeated with different subtitles. Prerequisites: Prior completion of NS3000 or NS3023, or permission of the instructor.

NS4055 Special Topics: Africa (4-0) As Required

This course introduces students to specialized subjects or problems within its particular field of study. The topic of each segment will be specified via a subtitle in departmental course scheduling documents. Detailed information should be sought from the professor offering the course. Special Topics courses with the same number may be repeated with different subtitles. Prerequisites: Prior completion of at least one 3000-level course on Africa, or permission of the instructor.

NS4056 Special Topics: South Asia (4-0) As Required

This course introduces students to specialized subjects or problems within its particular field of study. The topic of each segment will be specified via a subtitle in departmental course scheduling documents. Detailed information should be sought from the professor offering the course. Special Topics courses with the same number may be repeated with different subtitles. Prerequisites: Prior completion of at least one 3000-level course on South Asia, or permission of the instructor.

NS4057 Special Topics: Southeast Asia (4-0) As Required

This course introduces students to specialized subjects or problems within its particular field of study. The topic of each segment will be specified via a subtitle in departmental course scheduling documents. Detailed information should be sought from the professor offering the course. Special Topics courses with the same number may be repeated with different subtitles. Prerequisites: Prior completion of at least one 3000-level course on Southeast Asia, or permission of the instructor.

NS4058 Special Topics: Eurasia (4-0) As Required

This course introduces students to specialized subjects or problems within its particular field of study. The topic of each segment will be specified via a subtitle in departmental course scheduling documents. Detailed information should be sought from the professor offering the course. Special Topics courses with the same number may be repeated with different subtitles. Prerequisites: Prior completion of at least one 3000-level course on Eurasia, or permission of the instructor.

NS4059 Special Topics: Latin America (4-0) As Required

This course introduces students to specialized subjects or problems within its particular field of study. The topic of each segment will be specified via a subtitle in departmental course scheduling documents. Detailed information should be sought from the professor offering the course. Special Topics courses with the same number may be repeated with different subtitles. Prerequisites: Prior completion of at least one 3000-level course on Latin America, or permission of the instructor.

NS4060 Special Topics: Stabilization and Reconstruction (4-0) As Required

This course introduces students to specialized subjects or problems within its particular field of study. The topic of each segment will be specified via a subtitle in departmental course scheduling documents. Detailed information should be sought from the professor offering the course. Special Topics courses with the same number may be repeated with different subtitles. Prerequisites: NS3026 or permission of the instructor.

NS4061 Special Topics: Homeland Security and Defense (4-0) As Required

This course introduces students to specialized subjects or problems within its particular field of study. The topic of each segment will be specified via a subtitle in departmental course scheduling documents. Detailed information should be sought from the professor offering the course. Special Topics courses with the same number may be repeated with different subtitles. Prerequisites: NS3181 or permission of the instructor.

NS4062 Special Topics: Terrorism (4-0) As Required

This course introduces students to specialized subjects or problems within its particular field of study. The topic of each segment will be specified via a subtitle in departmental course scheduling documents. Detailed information should be sought from the professor offering the course. Special Topics courses with the same number may be repeated with different subtitles. Prerequisites: NS3801 or NS3802, or permission of the instructor.

NS4079 Advanced Directed Studies in National Security Affairs (V-0) As Required

(Variable credit, from 1-0 to 4-0.) Format and content vary. Normally involves extensive individual research under direction of the instructor and submission of a substantial paper of graduate seminar quality and scope. Prerequisites: Consent of instructor.

NS4080 Thesis Proposal (0-8) Quarterly

This course is intended to assist students in the preparation of their Master's thesis proposals. A completed proposal, endorsed by the thesis advisors, the Academic Associate, and the department chair, is required to pass this course. Grading: Pass/Fail. Prerequisites: None.

NS4081 Research Colloquium (2-0) Quarterly

The purpose of the research sequence (NS2013 and NS4081) is to advance your critical thinking, research and inquiry skills; you will use these skills to produce a strong thesis proposal (in this course sequence), and then later for the final thesis. We will identify and practice the main steps and modalities of good research. This will include exposure to a variety of research methods from which you will choose at least one for your thesis project and develop with the help of your thesis committee. Prerequisites: NS2013.

NS4133 The Psychology of Fear Management and Terrorism (4-0) Winter

Offered through the Center for Homeland Defense and Security. This course serves as an introduction for homeland security professionals to terrorism as a psychological phenomenon. Government agencies involved in homeland security need to understand the psychological consequences of mass-casualty terrorist attacks and other disasters. This course provides a broad overview of psychological effects of terrorism. Prerequisites: None.

NS4141 Economic Intelligence (4-0)

Economic intelligence. Requires instructor permission for add request. Prerequisites: None.

NS4156 Intelligence for Homeland Security: Organizational and Policy Challenges (4-0) Spring

Offered through the Center for Homeland Defense and Security. This course examines key questions and issues facing the U.S. intelligence community and its role in homeland security and homeland defense. Students will have the opportunity to fully address policy, organizational and substantive issues regarding homeland intelligence support. Prerequisites: None.

NS4157 Intelligence for Homeland Defense and Security (4-0) Annually

This course will provide students with a fundamental knowledge of U.S. operational intelligence capabilities to detect and deter terrorist and other unconventional threats to the United States. Topics will include the structure and function of U.S. intelligence organizations, systems, architecture, and capabilities. Issues in intelligence oversight, joint and inter-agency intelligence sharing, intelligence community administration, and intelligence support to

national decision-making will be discussed. Classification: SECRET. Prerequisites: NS3181 or consent of the instructor.

NS4159 Seminar on Joint Intelligence Support to Crisis Operations (4-0) As Required

Advanced seminar on intelligence support to military commanders and national-level policy makers. Using case studies, the course examines concepts of individual and organizational factors affecting the analytic process. Students will identify near-to mid-term regional events with force employment implications, develop associated intelligence support requirements, and create collection plains in support of indications and warnings, crisis shaping and identified operational mission areas. Prerequisites: NS3159, or consent of instructor. Open to intelligence specialists. Classification: U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI.

NS4160 Foreign Intelligence Services (4-0) As Required

This course examines selected foreign intelligence services. It emphasizes their organization, missions, and functions. This course is intended for students in the Joint Intelligence Curriculum and others upon consent of instructor. Prerequisites: NS3160 or consent of instructor. Classification: U.S. citizen holding a TOP SECRET clearance with eligibility for access to SCI.

NS4225 Civil-Military Relations and Transitions to Democracy (4-0) As Required

A seminar which reviews selected cases of transitions from authoritarian rule in the post-1945 period. The course compares the various roles played by the military and other actors in these transitions, examines the participation of the military in the consolidation of democracy and the problem of democratic consolidation. Students will also examine different theories and concepts of democratic transition and consolidation. Prerequisites: NS3025 or consent of instructor.

NS4231 Seminar on Terrorism Financing and State Response (4-0) As Required

This course examines exactly how far we have come in understanding how terrorists raise, store, and transfer funds. It also evaluates challenges facing the U.S. government and international community in responding to this problem. In each module, we use a mix of official reports, academic papers, and other works to explore the subject and identify problems with the received wisdom about terrorist financing. Prerequisites: None.

NS4232 Knowledge into Practice: A Homeland Security Capstone Course (4-0) As Required

Offered through the Center for Homeland Defense and Security. This course is intended to provide participants the opportunity to expand their ability to enact the knowledge and technical learning acquired in the courses leading up to the capstone. This course will provide students with the motivation and skills to perform their professional roles in new ways, ways that will initiate and sustain change even at the level of the broader institutional context of governance in which they must function. Prerequisites: None.

NS4235 Seminar in Peace Operations (4-0) As Required

This seminar examines the issues and the outcomes related to employing military forces to conduct peace operations and post-conflict stability operations. Theories of conflict and conflict resolution, the evolution of modern peacekeeping, peace enforcement, and stability operations, and the ongoing debates on

the use force and diplomacy in contemporary international relations will be critically analyzed. Prerequisites: None.

NS4239 Special Topics in American Government for Homeland Security (4-0) Quarterly

Offered through the Center for Homeland Defense and Security. The purpose of this course is to provide participants with an insight into the structural, conceptual and intellectual underpinnings and implications of the homeland security project. Looking at a wide range of topics and problems, the course seeks to stimulate a comprehensive discussion of how homeland security professionals and the general public think about homeland security; whether/why there may be significant differences in professional and public perceptions of homeland security; and how those differences constrain/leverage various elements of the homeland security effort. By incorporating a selection of key texts in Western political and social thought alongside current topical writings, the course seeks to equip participants with a deeper understanding of the prevailing discourse and its impact on the homeland security project. Prerequisites: None.

NS4240 Seminar on Regional Security Planning Problems (4-0) As Required

This seminar, which is the national security policy capstone course in the Resource Planning for Management and International Defense (RePMID) curriculum, provides advanced study of regional and inter-regional security problems which are likely to confront emerging democracies in the immediate and mid-range future. Potential roles of individual countries and coalitions are explored to develop new and innovative strategies for dealing with both common and unique security problems in diverse regions. Through the course readings, students critically analyze the implications of the most likely future security environment challenges and opportunities for each region. Prerequisites: Completion of previous RePMID courses, or consent of instructor.

NS4251 Seminar on Net Assessment (4-0) As Required

The seminar examines the methodology of comparative threat analysis (net assessment), including: security policies, forces, the RMA, and capabilities of the world's military superpowers. The course introduces the student to original source material. Prerequisites: NS3024. Classification: U.S. citizen holding a TOP SECRET clearance with eligibility access to SCI.

NS4253 Seminar on Technology and Strategic Planning (4-0) As Required

This course is intended to develop an understanding of the interrelationship of technology and strategic planning. Issues include technological risk, affordability, institutional impediments to innovation, and a strategy for long range technology investments. Prerequisites: consent of instructor.

NS4256 Maritime Strategy (4-0) As Required

This course studies maritime strategy from the Age of Sail to the present. Topics include the history and theory of war on and from the sea; sanctions regimes and coercive diplomacy; neutral rights and the law of the sea; maritime security and sea-borne trade; imperialism and globalization. Prerequisites: Any two NSA disciplinary core courses, or consent of the instructor.

NS4285 Counter-proliferation (4-0) As Required

This course will prepare students to counter nuclear, biological, and chemical (NBC) weapons threats in future operational or staff assignments by improving their understanding of the causes and consequences of NBC weapons proliferation and use and the strategies and capabilities available to counter these threats.

Prerequisites: None. Classification: U.S. citizen holding a TOP SECRET clearance with eligibility access to SCI.

NS4300 Special Topics: Middle East (4-0) As Required

A research seminar on politics in contemporary Middle East. Students conduct and present original research on selected issues concerning Middle Eastern politics. Since the topic of the seminar will vary, the registrar will be provided with the full title each quarter the course is taught. Sample subject areas include the Arab-Israeli conflict, the politics of oil, and the revolution in the Middle East. This course may be repeated as long as the subject material and title of the class is different. Prerequisites: Two 3000 level Middle East courses or consent of instructor.

NS4301 African Political Economy (4-0) Annually

This course examines economic development issues in Sub-Saharan Africa from a very broad perspective. We will consider how political and social as well as economic structures impact economic growth and development, assess policy and performance in the postcolonial period, and discuss the challenges for the twenty-first century. Prerequisites: None.

NS4305 Military, Polity and Society in the Middle East (4-0) As Required

Seminar in Middle East military affairs, politics and society. Prerequisites: None.

NS4310 Seminar on Middle Eastern Security Issues (4-0) As Required

A research seminar on security issues in the contemporary Middle East. Students conduct and present original research on selected issues concerning Middle Eastern security. Since the topic of the seminar will vary, the registrar will be provided with the full title each quarter the course is taught. Sample subject areas include the domestic security implications of Middle East peace, environmental security in the Middle East, and terrorism in the Middle East. This course may be repeated as long as the subject material and title of the class is different. Prerequisites: Two 3000 level Middle East courses or consent of instructor.

NS4311 Contemporary Issues in African Politics (4-0) As Required

This course will survey the major issues confronting African states today: the HIV/Aids epidemic, endemic civil wars, dimensions of ethnicity and ethnic conflict, issues of democratization and authoritarian rule, the nature of states and the phenomenon of state collapse, and patterns of trade and economic development. The focus will cover the entire sub-Saharan region, while utilizing country case studies to elaborate each of the main issue areas. Designed as an upper-level seminar, the course will focus on discussion and debate of weekly reading assignments. Prior coursework in African Politics is desired, but not required.

NS4313 Government and Security in West Africa (4-0) As Required

This course introduces students to government and politics in West Africa, with an emphasis on political, economic, and social change since the end of the Cold War. Why are some countries in the sub-region making peaceful progress toward democratic consolidation while others are dissolving into violent conflict? How does the coexistence of zones of conflict and peace affect regional security? Prerequisites: None.

NS4315 Security and Politics in Iran (4-0) As Required
Iran has been one of the most important countries in the Middle East region. It is located strategically, connecting the Caucasus and Central Asia to the Persian Gulf on the one side, and South Asia to the Arab Middle East on the other. Iran is home to one of the principal languages and cultures of the region. It is also one of the most populous countries in the Middle East with one of the largest economies. Iran has been a politically and strategically significant country for most of the past century. It was a frontline state during the Cold War. It was the scene of a major revolution that changed the face of the Muslim world and the relations between the United States and regional powers. Since 1979, Iran has been an avowedly Islamic state that has been engaged in a protracted war with the West. However, Iran has also witnessed profound political, social, and cultural changes that can be consequential for the future of the region. This course provides an overview of Iranian politics. It also uses social science theory to examine what factors have determined the evolution of Iranian politics, and how those developments in turn change our views on political change in the Muslim world and beyond. Prerequisites: None.

NS4320 Islamic Fundamentalism (4-0) Annually
A research seminar on the ideology and practice of Islamic fundamentalists in the Middle East. Students read primary source translations of major fundamentalist ideologues, such as Ayatollah Khomeini and Sayyid Qutb, in addition to focusing on the strategies and histories of specific fundamentalist groups. Students will conduct and present original research on this topic. Prerequisites: NS3000 or consent of instructor.

NS4321 U.S. Foreign Policy towards Africa (4-0) Annually
This course examines U.S. foreign policy in Sub-Saharan Africa since 1960, with emphasis on the post-Cold War period. Prerequisites: None.

NS4322 Seminar on U.S. Security Strategy in the Middle East and Persian Gulf (4-0) As Required
Examines current United States security strategy in the Middle East and Persian Gulf region. Prerequisites: None.

NS4325 War in the Middle East (4-0) As Required
This course studies the international history of the Middle East and North Africa since the fall of the Ottoman Empire, with a particular focus on the origin, conduct, and consequences of the region's major wars. Prerequisites: Prior completion of NS3000 and at least one 3000 level Middle East course, or permission of the instructor.

NS4326 Social Mobilization and Conflict in the Middle East (4-0) As Required
This course analyzes the organization, incentives, and goals of non-state actors. Subjects include protest and mobilization of civil society and their relations with violent actions, how available alternatives shape the form for opposition action takes, and the effects of repression and political inclusion. Prerequisites: Prior completion of at least one 3000 level Middle East course, or permission of the instructor.

NS4327 Southern African Politics (4-0) As Required
The countries of the Southern African region are closely linked by economics, social demographics, and history. This course will examine the dynamics of Southern Africa combining detailed studies of individual countries with themes that cross the region, such as migration, trade, regional security, economic development, and post-conflict reconstruction. Some of the topics we will cover include attempts by Southern African countries to strengthen regional integration; the role of South Africa as local hegemony; how recent events in Zimbabwe have impacted on regional dynamics; democratization and demobilization in South Africa, Namibia and Mozambique, and the peace process in Angola. Designed as an upper-level seminar, the course will focus on discussion and debate of weekly reading assignments. Prior coursework in African Politics is desired, but not required. Prerequisites: None.

NS4328 Government and Security in the Horn of Africa (4-0) As Required
Addresses government and security issues in the Horn of Africa. Its main focus is on how conflicts in the region -- persistent civil war in Sudan, state collapse in Somalia, contentious ethnic politics and secessionist movements in Ethiopia and Djibouti, state formation processes in (internationally recognized) Eritrea and (internationally unrecognized) Somaliland -- interact to produce a particularly challenging regional security environment. We conclude with a consideration of what this regional security environment means for the War on Terrorism, as well as how the War on Terrorism is impacting the regional security environment. Prerequisites: None.

NS4332 Ethnicity and Ethnic Conflict in the Developing World (4-0) As Required
The goal of this course is to examine issues of ethnicity and ethnic identity as they relate to conflict and democracy in the non-Western world. This course will be offered as an elective that will fit in with the regional studies curricula for students in the Africa, Latin America, Middle East, and Asian curricula in the NS department. The course will provide students with the theoretical tools and approaches to the study of ethnicity and ethnic conflict in multiple-country contexts. The course is divided into three main subject areas: (1) the nature of ethnicity, (2) the nature of and explanations for ethnic conflict, and (3) solutions to ethnic conflict. Weekly course readings present a mix of theoretical approaches and case studies, and will cover all the major areas of the world: Africa, the Middle East, Latin America, Asia, and Eastern Europe. Prerequisites: None.

NS4361 Politics in Egypt (4-0) As Required
Course investigates contemporary Egyptian politics, including the roles of institutions, personalities and external forces, and the socio-economic context. Prerequisite: None.

NS4362 The Arab-Israeli Conflict (4-0) Annually
This course studies the evolution and current state of the Arab-Israeli conflict from the end of the 19th century to the present, including a consideration of its historical development, the principal individual and institutional actors involved, and an assessment of current prospects for conflict resolution. Prior completion of at least one NSA course on the Middle East.

NS4410 Seminar on Security Issues in Russia, Eastern Europe and Central Asia (4-0) Annually
This advanced seminar addresses the security problems of the successor states to the former Soviet Union, focusing on the military, the security environment, political culture, Russian and non-Russian nationalism, and the relationship between domestic and foreign policies. Prerequisites: NS3400 or NS3410, or NS3450, or consent of instructor.

NS4415 Seminar on Security Issues in Central Asia (4-0) As Required
For the purpose of this course, Central Asia refers to Kazakhstan Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. The

seminar will consist of three parts. In the first part, the students will gain a general background in history of Central Asia. In the second part, the students will survey the current situation in Central Asia. The seminar sessions in the third part of the course will be dedicated to presentations of students' research. Prerequisites: None.

NS4420 Seminar on History & Politics of Central Europe (4-0) As Required

NS4425 Russian Foreign Policy (4-0) Annually

This advanced seminar introduces theoretical approaches to the study of foreign policy and focuses on the content of post-Soviet Russia's foreign policy. Students will learn what Russia's foreign policy consists of and who or what makes it. The course aims to give students a greater ability to analyze the critical determinants of foreign policy and an in-depth understanding of the various aspects of contemporary Russia's foreign policy interests. Prerequisites: None.

NS4501 Politics, Film and Fiction in Latin America (4-0) As Required

This course explores how Latin American film and fiction has portrayed politics. Specific novels, short stories and films (all with a political context) will be compared with social scientific readings analyzing the same topics. All movies will be in Spanish with English subtitles. All readings will be available in Spanish and English versions. Prerequisites: NS3501.

NS4502 Russian Film and Fiction (4-0) As Required

Examination of Russian culture through that country's film and fiction. Prerequisites: None.

NS4510 Seminar on Latin America Government and Politics (4-0) As Required

An advanced seminar on Latin American politics in government. The topics analyzed include those of most current relevance including political transitions, the changing role of different political movements and institutions, and the prospects for economic growth and political stability. Prerequisites: NS3510 or NS3520, or consent of instructor.

NS4540 The Political Economy of Latin America (4-0) As Required

This course examines the complex relationship between politics and economics in Latin America. The course is structured around two overarching sets of questions. First, how can political science help us understand the economic development strategies that Latin American countries have pursued at different points in time? How have political actors and forces shaped the paths of economic development and what national patterns have emerged in the conflict over economic policy making? Second, reversing the direction of causation, when these economic development strategies succeed or fail, what is the impact on politics across Latin America? How has the pursuit of different economic ideologies, ranging from Marxism to neo-liberalism, altered politics in the region? Prerequisites: None.

NS4550 Government and Politics in Mexico (4-0) Annually

The purpose of this course is to explore the complexities of the Mexican political environment, its power structure, its profound contradictions and the multi stakeholder conflicts that shape Mexican decision making today. While a certain historical perspective is always necessary and unavoidable, this class is about Mexico's current political environment, its security ecosystem and how those two elements affect the homeland security enterprise and North American security in general. Prerequisites: NS3510 or NS3181, or permission of the instructor.

NS4560 Seminar on Latin American Security Issues (4-0) Annually

A research seminar on security issues in contemporary Latin America. Students focus on challenges to regional security, regime stability, and public safety. Students conduct and present original research on selected issues concerning Latin American security. Prerequisites: NS3510 or NS3520, NS3024 or consent of instructor.

NS4610 Asian Seminar: United States-Asian Relations (4-0) As Required

Overview of the current state of U.S.-Asia relations. Prerequisites: None.

NS4620 Seminar on the Chinese People's Liberation Army (4-0) As Required

This course is a reading seminar on the evolution of the PRC's military and its domestic and foreign policy roles. It reviews the evolution of Maoist and post-Mao security strategies, military decision making, professionalism versus politicization of the army, the calculus of deterrence and the use of force in PRC foreign policy, and party-army and civil military relations. Prerequisites: None.

NS4630 Seminar on Northeast Asian Security (4-0) Annually

Advanced research on national, regional, and global security dynamics among the states of Northeast Asia. The course explores policy options facing North Korea, South Korea, Russia, Japan, and China, their regional interaction, and the likely implications for the United States. Non-traditional security topics such as energy and space will be covered along with questions of military modernization, weapons, proliferation, alliance behavior, and deterrence. Prerequisites: Prior completion of at least one course in Asian politics and security (NS3620, NS3661, NS3662 or NS3663) or consent of the instructor.

NS4640 Seminar on Wars in Asia (4-0) As Required

This course studies the history of war and international relations in South Asia and the Asia-Pacific region in the nineteenth and twentieth centuries. It emphasizes the relationship between military action and political developments within the region, and also seeks to explore the impact of regional developments on the larger world system. Students will write an independent research paper in this class. Prerequisites: Consent of instructor.

NS4641 Political and Ethnic Violence in Southeast Asia (4-0) As Required

This course will examine the sources of political and ethnic violence in the Southeast Asia region. Prerequisites: NS3620.

NS4642 Chinese Foreign Policy (4-0) As Required

This seminar examines and analyzes the major developments in Chinese foreign policy since 1949. It introduces historical legacies and traces the major developments during the Cold War, such as Chinese intervention in the Korean War, the rise and fall of the Sino-Soviet alliance, and improvement in Sino-American relations. The course focuses on understanding and analyzing Chinese foreign policy in the post-Cold War world and China's rise, including topics such as China's grand strategy, China's relations with the U.S., Taiwan, and Asia, and PLA modernization. This seminar also provides an opportunity for students to conduct

original analysis and research on Chinese foreign policy. Prerequisite: At least one NS Asia/China course (two preferred) or consent of the instructor.

NS4645 Asian Security: Theory and Practice (4-0) As Required

East Asia contains four "great powers," three-plus nuclear powers, two countries still divided since WWII, and several of the most dynamic economies on the globe. This course considers the prospects for war and peace in this complex constellation of powers in the current era. Will the United States and China become rivals? What are the prospects for stability on the Korean Peninsula and in the Taiwan Strait? Will Japan become a "normal" nation? What role do nuclear and other WMD play in shaping regional affairs? Why are security institutions so few in East Asian Security affairs? Is international cooperation fundamentally different in East Asia? What is the nature of civil-military relations across the countries of the region? Each of these questions will be addressed. The course will begin with a brief discussion of international security theory before turning toward specific regional security topics. Throughout the quarter we will make use, however, of theoretically informed arguments regarding East Asian security issues. Prerequisites: Prior completion of NS3024, plus at least one course on Asian politics and security, numbered NS3600-3667; or permission of the instructor.

NS4660 Seminar on Asia in World Affairs (4-0) As Required

Advanced study of Asia's contemporary economic, security, diplomatic and cultural roles in world affairs, with special emphasis on the policy interaction of China, Japan, India and other key states with the United States, Russia, Europe, and the developing world. Prerequisites: A NS3000 level course on Asia or consent of instructor.

NS4661 Contemporary Afghan Politics (4-0) As Required

This seminar examines the complex historical, ethnic, religious, and linguistic factors that unite and divide Afghanistan as it struggles with the challenges of political modernization, economic reform, and integration into the international community. The seminar places a fundamental emphasis on current Afghan politics as well as questions of U.S. interests and policy options. Prerequisites: None.

NS4662 Seminar on the Politics of Southeast Asia (4-0) As Required

Advanced seminar on the contemporary politics of Southeast Asia. Prerequisites: None.

NS4663 Politics and Security in Pakistan and Afghanistan (4-0) As Required

This course focuses on the political and security dynamics of Pakistan and Afghanistan. In recent history the region has been a hotbed of instability and s focal point of terrorism. The course will explore the complex interplay of history, geography and ethno-religious politics of the two contagious countries, analyze its impact on regional stability, and examine the implications for global security.

NS4664 Religious Activism in South Asian Politics (4-0) As Required

The events of September 11 have underscored the importance of religious activism in South Asian politics. These movements have impacted regional politics and international security and are likely to continue to do so in the years to come. This course aims to provide students with an in-depth understanding of the role of religion in South Asian politics by familiarizing them with the historical context for religion's involvement in South Asian politics,

introducing the important actors, key ideas and major events. The course will deal with both Islamic and Hindu religious movements in the Afghanistan-Pakistan-India arc. This will provide a comprehensive approach to the topic and will provide students with a comparative framework to analyze relevant issues. The course will use important works in the disciplines to provide a historical framework for the study of religion and politics in South Asia. Prerequisites: None.

NS4666 Seminar on U.S. Policy in South Asia (4-0) Annually

Overview of U.S. Policy in South Asia. Focus is on current issues. Prerequisites: None.

NS4667 Political Development in South Asia (4-0) Annually

This course covers a selected range of topics for understanding current South Asian political developments and towards answering the larger question of why South Asia is the way it is: What are the internal and external structures and institutions in South Asian countries that shape their political activities and stance? In this course we study contemporary issues in the context of regional, national, and local political developments in India, Pakistan, Bangladesh, Nepal, and Sri Lanka. This will assist in thinking relationally and comparatively across nations of the region, as well as provide an understanding of different movements and events that shape this region. Prerequisites: None.

NS4668 Security in South Asia (4-0) Annually

The seminar places particular emphasis on the conditions affecting the occurrence, conduct and aftermath of war in the region. Topics covered in the seminar include the independence of India and Pakistan in 1947 and the creation of political, ethnic, religious, and territorial disputes between the two countries; ethnic and religious sources of instability in the region; civil-military relations; South Asia during the Cold War; South Asia and the global war against terrorism; the foreign relations of India and Pakistan with the United States, Russia, China and neighboring countries; the origins and military conduct of the three India-Pakistan wars; and the acquisition of nuclear weapons by India and Pakistan and their impact on regional security and international stability. Depending on student interest, the course also will cover security dynamics of smaller South Asian states (Afghanistan, Bangladesh, Nepal, Sri Lanka, and Bhutan). Prerequisites: None.

NS4669 Conflict and Cooperation in World Politics (4-0) As Required

This course introduces students to representative literature on key topics in the fields of strategic studies and security studies. The course is taught as a research seminar. It is organized around four main topic areas: the parameters of strategic studies and security studies, and alternative definitions of security; alternative approaches to maintaining order at a regional or global level, with the main focus on the prospects for stability when there is a hegemonic power; the concept of strategic culture; and the effectiveness of alternative strategies for influencing states in bilateral relations so as to reduce security threats and the chances of military conflict. Prerequisites: NS3024.

NS4677 Space and International Security (4-0) Annually

This course studies the political history of the space age from the perspective of U.S. national security, as well as U.S. relations with other major, space-faring countries. It also covers arms control treaties, legal issues, international negotiations, and space management questions from a current policy perspective. An independent research paper or policy memo on an assigned topic is

required. Prerequisites: NS3011 and NS3024 or consent of instructor.

NS4690 Seminar on International Security Issues of Asia (4-0) As Required

Advanced study of Asian security issues with special emphasis on the balance of forces, regional and external alliances, prospects for conflict, and Asian concepts of security and strategy. Prerequisites: A NS3000 level course on Asia or consent of instructor.

NS4710 Seminar on European Politics (4-0) Annually

A research seminar on politics in contemporary Europe. Students conduct and present original research on selected issues concerning European politics, with an emphasis on defense and security problems. Prerequisites: NS3710 or consent of instructor.

NS4720 Seminar on European Security Issues (4-0) Annually

A research seminar on security issues in contemporary Europe. Students conduct and present original research on selected issues concerning European security. Prerequisites: NS3720 or consent of instructor.

NS4722 Special Topics: Europe (4-0) As Required

Upper level seminar that debates advanced issues in European Security. Specifics topic vary by instructor. Prerequisites: None.

NS4755 Thinking and Management Seminar (4-0) Summer Offered through the Center for Homeland Defense and Security.

Employing a system based approach to the strategic process, this course will provide students with the necessary methodological tools and content to think differently about strategy, manage complex challenges, and facilitate a planning process that fosters innovation and positive change in the homeland security enterprise. Prerequisites: None.

NS4801 Seminar on Terrorism (4-0) As Required

This course attempts to provide a broad sweep of the field of terrorism. We explore general issues — the structure of terrorist groups, the motivation of those who join, the patterns of authority and decision making within groups, and the impact of different types of operations on governments and the public. In the second portion of the course, we discuss in greater depth the campaigns of a few selected terrorist organizations. We will also look at what some scholars call the "new" terrorism. Prerequisites: None.

NS4805 Modeling Terrorism: New Analytical Approaches (4-0) Spring/Summer

Terrorism and the groups that foment it are at the forefront of concern for policymakers and defense analysts worldwide. This seminar and associated lab will focus on applying a variety of proven analytic techniques to terrorism for the purpose of understanding it, building actionable models of it, and suggesting policy alternatives aimed at successfully deterring, disrupting and defeating it. The course will use as a test bed a particular global terrorist organization. Appropriate readings and background materials will be augmented with hands-on lab exercises analyzing group, organization, environment, process and narrative-related dimensions of terrorism. Instruction will be augmented by subject matter experts and guest speakers. Approaches to be covered include system dynamics, game theory, Bayesian analysis, cross-impact analysis, and rhetorical modeling and simulation. Prerequisite: None.

NS4806 Seminar on Applied Terrorism/Insurgency Research Methods (4-0) Annually

This course studies the use and application of advanced methodologies for investigating the organizational dynamics of terrorist and insurgent movements. A significant independent research paper is required. Prerequisite: Prior completion of NS4805 or consent of instructor.

NS4880 Legal and Military Responses to Political Violence (4-0) Annually

The course will first review the variety of legal and military policy options open to any state that confronts political violence, with particular attention to short versus long-term consequences of different policy options. It then analyzes a few individual cases (the British in Ulster, violence in Spain) in depth, in order to assess how different policy options combine or cancel each other. Prerequisites: Consent of instructor.

NS4881 Multi-Discipline Approaches to Homeland Security (4-0) Summer

Offered through the Center for Homeland Defense and Security. Homeland security efforts in the United States constitute a project framed by the rule of law. Constitutional concerns, civil rights issues and the roles if the various disciplines engaged in the effort are driven and impacted by the various local, state, and federal systems of law. This course allows students to explore the homeland security project in relation to the laws that support and constrain it. Prerequisites: None.

NS4920 Special Topics: Civil-Military Relations (4-0) As Required

Selected special issues in Civil-Military relations. Prerequisites: None.

NS4930 Media and War (4-0) As Required

This seminar will analyze the interaction between the media, in the United States and abroad, and society during wartime. Prerequisites: None.

NS4940 Seminar on International Political Economy (4-0) Annually

This course addresses how governance is and can be created at the global level. It examines how states are coping with the multiplicity of global issues that affect them and how these issues and efforts impact state sovereignty. It will address how political actors respond to and create the drivers of globalization — the global processes, such as the spread of ideas such as neo-liberal market economic theory and universal human rights, as well as environmental, demographic and resource changes, that make actors dependent on each other for their management. Prerequisites: NS3024 and NS3040 or consent of instructor.

NS4941 National Security Law for Homeland Security and Defense (4-0) As Required

The course studies the legal framework within which defense strategy is formulated and executed, with emphasis on the identification and resolution of jurisdictional conflicts, the interaction of municipal and international law governing the use of force, and the organization challenges presented by the coordination of military activities with those of civilian law enforcement agencies and the judiciary. Prerequisites: NS3000, NS3023, or NS3024 or consent of the instructor.

NS4990 Seminar in Strategic Studies (4-0) Annually

This course studies the theory and practice of national defense strategy, approached by means of selected theoretical texts and

historical case studies in military and political decision-making. Topics include combined-arms land warfare, maritime strategy, strike warfare, nuclear strategy, and revolutionary insurgency. A significant independent research paper is required. Prerequisites: NS3000, plus at least one other 4000-level seminar in National Security Affairs.

NS4991 Seminar in United States Foreign Policy (4-0) Annually

This course studies the conduct of foreign policy by the United States from the founding of the American Republic through the end of the Cold War. A significant research paper is required. Prerequisites: NS3024, plus at least one 4000-level seminar in National Security Affairs, or consent of instructor.

NS5810 Dissertation Research (0-8) As Required

Dissertation research for doctoral studies. Required in the quarter following advancement to candidacy and then continuously each quarter until dissertation is approved by the Academic Council.

International Defense Planning Certificate - Curriculum 245

Program Officer

Jorge Garcia, CDR, USN
Glasgow Hall Room 336

(831) 656-2067, DSN 756-2067
jfgarci1@nps.edu http://www.

Academic Associate

Thomas-Durell Young, Ph.D.
Code 38, Bldg. 259, Room 220

(831) 656-2011, DSN 756-2011
tdyoung@nps.edu Mailto:tdyoung@nps.edu

Brief Overview

The Certificate Program in International Defense Planning is intended to provide international students with a compact introduction to the processes and methods of effective defense planning, as well as analytical tools they can employ to evaluate and improve defense planning in their own countries. Students are required to have completed a Bachelor's degree at an accredited university, and to possess substantial fluency in English, as demonstrated by a minimum total score of 90 on the internet-based Test of English as a Foreign Language (TOEFL), or a score of 560 on the written test.

Entry Date

Summer

Required Courses

NS3000	War in the Modern World
NS3230	Innovation and Adaptation in the Military
NS3245	Comparative Defense Organization and Management
NS3246	Comparative Defense Planning

Regional Security Studies (Middle East, South Asia, and Africa) Certificate - Curriculum 246

Program Officer

Jorge Garcia, CDR, USN
Glasgow Hall Room 336

(831) 656-2067, DSN 756-2067
jfgarci1@nps.edu http://www.

Academic Associate

Ryan Gingeras, Ph.D.
Code 38, Glasgow Hall, Room 355

(831) 656-2863, DSN 756-2863
rgingera@nps.edu Mailto:rgingera@nps.edu

Brief Overview

The Academic Certificate Program in Regional Security Studies (Middle East, South Asia, and Sub-Saharan Africa) is designed primarily to support senior Foreign Area Officers (O-5s and O-6s) who will benefit from a renewed period of serious engagement with current academic and policy work on their region of specialization. The Certificate requires successful completion of a minimum of three graduate courses focusing on the region (12 credit hours), of which at least one course (4 credit hours) must be at the 4000-level. Each student's required course work is developed individually under the direction of the cognizant Academic Associate, based on the relevant regional courses available during the quarter(s) when the student is in residence. Language maintenance courses at the Defense Language Institute may be taken simultaneously in conjunction with the Certificate Program, but do not count toward the Certificate. Students may begin their course of study in any academic quarter.

Entry Date

All quarters

Required Courses

Course offerings in NSA vary from year to year. The following illustrate what a (minimum) acceptable combination of courses might look like. Many other combinations are possible.

Example 1 (Middle East concentration)

NS3320, United States Foreign Policy in the Middle East	4-0
NS3330, Comparative Politics of the Middle	4-0

East

NS4315, Security and Politics in Iran	4-0

Example 2 (South Asian concentration)

NS3668, Politics and Security in South Asia	4-0
NS4661, Contemporary Afghan Politics	4-0
NS4664, Religious Activism in South Asian Politics	4-0

Example 3 (Sub-Saharan Africa concentration)

NS3301, African History and Cultures	4-0
NS3311, Government and Politics in Sub-Saharan Africa	4-0
NS4328, Government and Security in the Horn of Africa	4-0

Regional Security Studies (East & South East Asia) Certificate - Curriculum 247

Program Officer

Jorge Garcia, CDR, USN
Glasgow Hall Room 336

(831) 656-2067, DSN 756-2067
jfgarci1@nps.edu http://www.

Academic Associate
Robert Weiner, Ph.D.
Code 38, Glasgow Hall, Room 375

(831) 656-3952, DSN 756-3952
rjweiner@nps.edu Mailto:rjweiner@nps.edu

Brief Overview

The Academic Certificate Program in Regional Security Studies (East and Southeast Asia) is designed to support primarily senior Foreign Area Officers (O-5s and O-6s) who will benefit from a renewed period of serious engagement with current academic and policy work on their region of specialization. The Certificate requires successful completion of a minimum of three graduate courses focusing on the region (12 credit hours), of which at least one course (4 credit hours) must be at the 4000-level. Each student's required course work is developed individually under the direction of the cognizant Academic Associate, based on the relevant regional courses available during the quarter(s) when the student is in residence. Language maintenance courses at the Defense Language

Institute may be taken simultaneously in conjunction with the Certificate Program, but do not count toward the Certificate. Students may begin their course of study in any academic quarter.

Entry Date

All quarters

Required Courses

Course offerings in NSA vary from year to year. The following illustrate what a (minimum) acceptable combination of courses might look like. Many other combinations are possible.

Example 1 (East Asia [general regional] concentration)

NS3600, History of Modern East Asia	4-0
NS3662, Government and Security in Japan	4-0
NS4645, Asian Security: Theory and Practice	4-0

Example 2 (Southeast Asian concentration)

NS3601, History and Cultures of Southeast Asia	4-0
NS3621, International Relations of Southeast Asia	4-0
NS4641, Political and Ethnic Violence in Southeast Asia	4-0

Example 3 (East Asia [China] concentration)

NS3661, Government and Security in China	4-0
NS4642, Chinese Foreign Policy	4-0
NS4024, Political Economy of China	4-0

Regional Security Studies (Western Hemisphere) Certificate - Curriculum 248

Program Officer

Jorge Garcia, CDR, USN
Glasgow Hall Room 336

(831) 656-2067, DSN 756-2067
jfgarci1@nps.edu http://www.

Academic Associate
Arturo Sotomayor, Ph.D.

Code 38, Glasgow Hall, Room 380

(831) 656-2798, DSN 756-2798
acsotoma@nps.edu Mailto:acsotoma@nps.edu

Brief Overview

The Academic Certificate Program in Regional Security Studies (Western Hemisphere) is designed to support primarily senior Foreign Area Officers (O-5s and O-6s) who will benefit from a renewed period of serious engagement with current academic and policy work on their region of specialization. The Certificate requires successful completion of a minimum of three graduate courses focusing on the region (12 credit hours), of which at least one course (4 credit hours) must be at the 4000-level. Each student's required course work is developed individually under the direction of the cognizant Academic Associate, based on the relevant regional courses available during the quarter(s) when the student is in residence. Language maintenance courses at the Defense Language Institute may be taken simultaneously in conjunction with the Certificate Program, but do not count toward the Certificate. Students may begin their course of study in any academic quarter.

Entry Date

All quarters

Required Courses

Course offerings in NSA vary from year to year. The following illustrate what a (minimum) acceptable combination of courses might look like. Many other combinations are possible.

Example 1

NS3501, History and Cultures of Latin America	4-0
NS3510, Government and Politics in Latin America	4-0
NS4560, Seminar on Latin American Security Issues	4-0

Example 2

NS3520, Latin American International Relations	4-0
NS3560, Political and Social Change in the Andes	4-0
NS4540, The Political Economy of Latin America	4-0

Example 3

NS3501, History and Cultures of Latin America	4-0
NS4501, Politics, Film, and Fiction in Latin America	4-0
NS4059, Special Topics: Latin America	4-0

Regional Security Studies (Europe and Eurasia) Certificate - Curriculum 249

Program Officer

Jorge Garcia, CDR, USN
Glasgow Hall Room 336

(831) 656-2067, DSN 756-2067
jfgarci1@nps.edu http://www.

Academic Associate
Mikhail Tsypkin, Ph.D.
Code 38, Glasgow Hall, Room 313

(831) 656-2218, DSN 756-2218
mtsypkin@nps.edu

Brief Overview

The Academic Certificate Program in Regional Security Studies (Europe and Eurasia) is designed to support primarily senior Foreign Area Officers (O-5s and O-6s) who will benefit from a renewed period of serious engagement with current academic and policy work on their region of specialization. The Certificate requires successful completion of a minimum of three graduate courses focusing on the region (12 credit hours), of which at least one course (4 credit hours) must be at the 4000-level. Each student's required course work is developed individually under the direction of the cognizant Academic Associate, based on the relevant regional courses available during the quarter(s) when the student is in residence. Language maintenance courses at the Defense Language Institute may be taken simultaneously in conjunction with the Certificate Program, but do not count toward the Certificate. Students may begin their course of study in any academic quarter.

Entry Date

All quarters

Required Courses

Course offerings in NSA vary from year to year. The following illustrate what a (minimum) acceptable combination of courses might look like. Many other combinations are possible.

Example 1 (Europe concentration)

NS3700, History of Modern Europe	4-0
NS3720, European Security Institutions	4-0
NS4021, Europe and the United States	4-0

Example 2 (Eurasia concentration)

NS3466, Central Asian History	4/0
NS3401, Contemporary Politics in Russia	4/0
NS4410, Seminar on Security Issues in Russia, Eastern Europe, and Central Asia	4/0

Example 3 ([Western] Europe concentration)

NS3710, Introduction to European Politics	4-0
NS4037, NATO	4-0
NS4022, Soldiers and Politics in the Euro-Atlantic Region	4-0

Regional Security Studies - Middle East, South Asia, and Sub-Saharan Africa - Curriculum 681

Program Officer

Jorge Garcia, CDR, USN
Glasgow Hall Room 336

(831) 656-2067, DSN 756-2067
jfgarci1@nps.edu http://www.

Academic Associate
Ryan Gingeras, Ph.D.
Code 38, Glasgow Hall, Room 355

(831) 656-1118, DSN 756-1118
rgingera@nps.edu Mailto:rgingera@nps.edu

Brief Overview

Curriculum 681 studies politics and security in the Middle East, South Asia and Sub-Saharan Africa. Degree requirements vary somewhat depending upon which of these sub-regions is the focus of effort. Separate tracks, with their own sets of requirements, exist for each of these three regions, as indicated in NSA's on-line course schedule. Depending upon sponsor requirements, study at NPS may be preceded or followed by language instruction at the Defense Language Institute, co-located on the Monterey Peninsula. In addition, courses conveying Phase I JPME certification, as well as selected U.S. Marine Corps PME courses, are available to NSA students while in residence at NPS.

Entry Date

For thesis students who wish to complete JPME Phase I while in residence, curriculum 681 is a six-quarter (18-month_ program. For non-thesis students who wish to complete JPME Phase I in residence, curriculum 681 is a five-quarter (15-month) program. For non-thesis student who do not wish to complete JPME Phase I in residence, curriculum 681 is a four-quarter (12-month) program. In all cases, students may enter in any quarter, with study commencing in January, April, July or October.

Degree

Master of Arts in Security Studies (Middle East, South Asia, and Sub-Saharan Africa).

Subspecialty

Navy P-Codes: 2101P

Typical Subspecialty Jobs

Defense Attaché
Foreign Area Officer
Intelligence Officer
Plans Officer, Staff Planner
Various joint command positions
Service Headquarters - Political / Military officers
Major staff jobs in Combatant Commands and Fleet
    Commands

Curriculum Requirements
Students in curriculum 681 must complete five (5) disciplinary core courses, as follows:

NS3011	Research and Writing in National Security Affairs
NS3023	Introduction to Comparative Politics
NS3024	Introduction to International Relations
	One of the following three:
NS3000	War in the Modern World
NS3001	War and its Impact on Post-Conflict Reconstruction
NS 3003	Nationalism and Revolution
	One of the following three:
NS3040	Politics of Global Economic Relations
NS3041	Comparative Economic Systems
NS3042	Economic Development for Security Building

In addition, students must complete a minimum of eight (8) curricular core and elective courses in their regional specialization, of which at least three (3) must be at the 4000-level. The courses that satisfy these requirements, and the quarters when they are offered, can be found on

the NSA website at
http://www.nps.edu/Academics/Schools/SIGS/DegreePro
g/NSA/Academics/schedule.html
http://www.nps.edu/Academics/Schools/SIGS/DegreePro
g/NSA/Academics/schedule.html. Students are also
required to take sufficient general electives to maintain a
full-time course load (16 hours). The number of general
elective slots will vary somewhat depending upon service
affiliation and sponsor requirements.

Students who write a thesis must also complete NS4080,
Thesis Proposal, no later than six months prior to intended
graduation. NS4080 does not count as one of the three
4000-level courses required above. Thereafter thesis
students may enroll in NS0810, Thesis Research, up to
three times; or they may take additional course work in
their area of specialization, if they prefer.

Students in curriculum 681 who substitute language
training plus a comprehensive examination for the thesis
must enroll in NS0811, Preparation for Comprehensive
Examination, during their final quarter.

Educational Skill Requirements (ESR)

1. **Basic Graduate Level Skills:**
   a. **Conduct Research:** Assemble information from the
      full range of data sources to understand
      international political, economic, and military
      issues.
   a. **Analyze Problems:** Frame issues as research
      questions; logically combine evidence and theory
      to analyze and explain international political,
      economic, and military developments; and
      formulate innovative solutions to strategic
      problems.
   b. **Communicate Information:** Clearly summarize
      large quantities of information and persuasively
      present positions and courses of action using a
      broad range of verbal and written communications
      formats, including short oral arguments, visual
      briefs, policy memos, position papers, and
      comprehensive student theses.

2. **General Political Science, International Relations, and
   Security Studies:**
   a. **International and Comparative Politics:** Understand
      international relations theories, including realist,
      liberal, and cultural paradigms; the conditions and
      worldviews that shape state interactions in the
      international system; the history of modern
      nationalism and the state system; and the roles of
      domestic politics, non-state actors, and
      transnational social movements in shaping
      international politics.
   b. **International Economy:** Understand the economic
      factors that shape the international security
      environment, including the economic dimensions

of national security policy and the ways in which
economic policies and interests affect military
strategy and force structure.
   c. **International and Military History:** Grasp the
      principal causes of war in the modern era, and
      understand the political, technological, economic,
      and other influences that have governed its
      conduct; understand the social, political,
      economic, and cultural forces that have
      contributed to periods of stable peace; and analyze
      relations between states, including negotiations of
      peace settlements, military alliances, arms
      limitation agreements, economic arrangements,
      and human rights accords.
   d. **International Organizations:** Understand the
      history of international organizations and their
      role in world politics, including international
      mediation and negotiations, formal and informal
      security arrangements, treaty regimes, and the role
      of international institutions and non-governmental
      organizations in peacekeeping and humanitarian
      operations.
   e. **U.S. Security Policy and Strategy:** Understand how
      U.S. national security policy and strategy are
      formulated. Understand the roles of nuclear forces
      in the security policies of the United States and
      other nuclear powers; U.S. nuclear force
      acquisition, planning, deterrence policy, and
      employment concepts from the Second World
      War to the present; and the role of nuclear
      weapons in alliance politics and international
      relations.

3. **Regional Security Studies:**
   a. **Identities, Interests, and Politics:** Grasp the most
      significant political, economic, historical, cultural,
      and religious drivers that shape national identities
      and interests within their region of concentration.
   b. **Emerging Security Challenges:** Know the regional
      sources of political and social instability and
      become familiar with the roots of ethnic conflict,
      insurgencies, and terrorism, and their effect on
      regional and U.S. security.
   c. **Regional Conflicts:** Understand the patterns of
      violent conflicts, the likely sources and character of
      regional wars in the present and future, and the
      historical and prospective impact of such wars on
      the international system.
   d. **Military Forces and Strategic Posture:** Understand
      the main factors determining the strategic postures
      of countries in the region, including strategic
      culture and goals, threat perceptions, and military
      force structures.

e. **U.S. Regional Security Policy:** Understand U.S. foreign policy objectives in a given region and be able to explain U.S. political, economic, and military strategy in the region, including U.S. engagement policy and security assistance programs.

f. **Economic Factors:** Grasp the importance of underlying economic conditions on regional stability and conflict, as well as the tools of economic statecraft that the United States and international organizations may employ to try to influence these conditions.

Regional Security Studies - Far East, Southeast Asia, and the Pacific - Curriculum 682

Program Officer

Jorge Garcia, CDR, USN
Glasgow Hall Room 336

(831) 656-2067, DSN 756-2067
jfgarci1@nps.edu http://www.

Academic Associate

Robert Weiner, Ph.D.
Code 38, Glasgow Hall, Room 375

(831) 656-3952, DSN 756-3952
rjweiner@nps.edu Mailto:rjweiner@nps.edu

Brief Overview

Curriculum 682 studies politics and security in the Far East, Southeast Asia, and the Pacific. Depending upon sponsor requirements, study at NPS may be preceded or followed by language instruction at the Defense Language Institute, co-located on the Monterey Peninsula.

Entry Date

For thesis students who wish to complete JPME Phase I while in residence, curriculum 682 is a six-quarter (18-month) program. For non-thesis students who wish to complete JPME Phase I in residence, curriculum 682 is a five-quarter (15-month) program. For non-thesis student who do not wish to complete JPME Phase I in residence, curriculum 682 is a four-quarter (12-month) program. In all cases, students may enter in any quarter, with study commencing in January, April, July or October.

Degree

Master of Arts in Security Studies (Far East, Southeast Asia, and the Pacific)

Subspecialty

Navy P-Codes: 2102P

Typical Subspecialty Jobs

Defense Attaché
Foreign Area Officer
Intelligence Officer
Plans Officer, Staff Planner
Various joint command positions
Service Headquarters - Political / Military officers
Major staff jobs in Combatant Commands and Fleet
    Commands

Curriculum Requirements

All Students in curriculum 682 must complete five (5) disciplinary core courses, as follows:

NS3011	Research and Writing in National Security Affairs	
NS3023	Introduction to Comparative Politics	
NS3024	Introduction to International Relations	
	One of the following three:	
NS3000	War in the Modern World	
NS3001	War and its Impact on Post-Conflict Reconstruction	
NS3003	Nationalism and Revolution	
	One of the following three:	
NS3040	Politics of Global Economic Relations	
NS3041	Comparative Economic Systems	
NS3042	Economic Development for Security Building	

In addition, students must complete a minimum of eight (8) curricular core and elective courses in their regional specialization, of which at least three (3) must be at the 4000-level. The courses that satisfy these requirements, and the quarters when they are offered, can be found on the NSA website at http://www.nps.edu/Academics/Schools/SIGS/DegreePro g/NSA/Academics/schedule.html http://www.nps.edu/Academics/Schools/SIGS/DegreePro g/NSA/Academics/schedule.html. Students are also required to take sufficient general electives to maintain a full-time course load (16 hours). The number of general elective slots will vary somewhat depending upon service affiliation and sponsor requirements.

Students who write a thesis must complete NS4080, Thesis Proposal, no later than six months prior to intended graduation. NS4080 does not count as one of the three 4000-level courses required above. Thereafter thesis students may enroll in NS0810, Thesis Research, up to three times; or they may take additional course work in their area of specialization, if they prefer.

Students in curriculum 682 who substitute language training plus a comprehensive examination for the thesis

must enroll in NS0811, Preparation for Comprehensive Examination, during their final quarter.

Educational Skill Requirements (ESR)

1. **Basic Graduate Level Skills**
   a. **Conduct Research:** Assemble information from the full range of data sources to understand international political, economic, and military issues.
   b. **Analyze Problems:** Frame issues as research questions; logically combine evidence and theory to analyze and explain international political, economic, and military developments; and formulate innovative solutions to strategic problems.
   c. **Communicate Information:** Clearly summarize large quantities of information and persuasively present positions and courses of action using a broad range of verbal and written communications formats, including short oral arguments, visual briefs, policy memos, position papers, and comprehensive student theses.

2. **General Political Science, International Relations, and Security Studies**
   a. **International and Comparative Politics:** Understand international relations theories, including realist, liberal, and cultural paradigms; the conditions and world views that shape state interactions in the international system; the history of modern nationalism and the state system; and the roles of domestic politics, non-state actors, and transnational social movements in shaping international politics.
   b. **International Economy:** Understand the economic factors that shape the international security environment, including the economic dimensions of national security policy and the ways in which economic policies and interests affect military strategy and force structure.
   c. **International and Military History:** Grasp the principal causes of war in the modern era, and understand the political, technological, economic, and other influences that have governed its conduct; understand the social, political, economic, and cultural forces that have contributed to periods of stable peace; and analyze relations between states, including negotiations of peace settlements, military alliances, arms limitation agreements, economic arrangements, and human rights accords.
   d. **International Organizations:** Understand the history of international organizations and their role in world politics, including international

mediation and negotiations, formal and informal security arrangements, treaty regimes, and the role of international institutions and non-governmental organizations in peacekeeping and humanitarian operations.
   e. **U.S. Security Policy and Strategy:** Understand how U.S. national security policy and strategy are formulated. Understand the roles of nuclear forces in the security policies of the United States and other nuclear powers; U.S. nuclear force acquisition, planning, deterrence policy, and employment concepts from the Second World War to the present; and the role of nuclear weapons in alliance politics and international relations.

3. **Regional Security Studies**
   a. **Identities, Interests, and Politics:** Grasp the most significant political, economic, historical, cultural, and religious drivers that shape national identities and interests within their region of concentration.
   b. **Emerging Security Challenges:** Know the regional sources of political and social instability and become familiar with the roots of ethnic conflict, insurgencies, and terrorism, and their effect on regional and U.S. security.
   c. **Regional Conflicts:** Understand the patterns of violent conflicts, the likely sources and character of regional wars in the present and future, and the historical and prospective impact of such wars on the international system.
   d. **Military Forces and Strategic Posture:** Understand the main factors determining the strategic postures of countries in the region, including strategic culture and goals, threat perceptions, and military force structures.
   e. **U.S. Regional Security Policy:** Understand U.S. foreign policy objectives in a given region and be able to explain U.S. political, economic, and military strategy in the region, including U.S. engagement policy and security assistance programs.
   f. **Economic Factors:** Grasp the importance of underlying economic conditions on regional stability and conflict, as well as the tools of economic statecraft that the United States and international organizations may employ to try to influence these conditions.

Regional Security Studies - Western Hemisphere - Curriculum 683

Program Officer

Jorge Garcia, CDR, USN
Glasgow Hall Room 336

(831) 656-2067, DSN 756-2067
jfgarci1@nps.edu http://www.

Academic Associate

Arturo C. Sotomayor, Ph.D.
Code 38, Glasgow Hall, Room 348

(831) 656-2798, DSN 756-2798
acsotoma@nps.edu Mailto:acsotoma@nps.edu

Brief Overview

Curriculum 683 studies politics and security in the Western Hemisphere, excluding Canada and the United States. Depending upon sponsor requirements, study at NPS may be preceded or followed by language instruction at the Defense Language Institute, co-located on the Monterey Peninsula. In addition, courses, conveying Phase I JPME certification, as well as selected U.S. Marine Corps PME courses, are available to Regional Security Studies students while in residence at NPS.

Entry Date

For thesis students who wish to complete JPME Phase I while in residence, curriculum 683 is a six-quarter (18-month) program. For non-thesis students who wish to complete JPME Phase I in residence, curriculum 683 is a five-quarter (15-month) program. For non-thesis student who do not wish to complete JPME Phase I in residence, curriculum 683 is a four-quarter (12-month) program. In all cases, students may enter in any quarter, with study commencing in January, April, July or October

Degree

Master of Arts in Security Studies (Western Hemisphere)

Subspecialty

Navy P-Codes: 2103P

Typical Subspecialty Jobs

Defense Attaché
Foreign Area Officer
Intelligence Officer
Plans Officer, Staff Planner
Various joint command positions
Service Headquarters - Political / Military officers
Major staff jobs in Combatant Commands and Fleet
　Commands

Curriculum Requirements

Students in curriculum 683 must complete five (5) disciplinary core courses, as follows:

NS3011	Research and Writing in National Security Affairs	
NS3023	Introduction to Comparative Politics	
NS3024	Introduction to International Relations	
	One of the following three:	
NS3000	War in the Modern World	
NS3001	War and its Impact on Post-Conflict Reconstruction	
NS3003	Nationalism and Revolution	
	One of the following three:	
NS3040	Politics of Global Economic Relations	
NS3041	Comparative Economic Systems	
NS3042	Economic Development for Security Building	

In addition, students must complete a minimum of eight (8) curricular core and elective courses in their regional specialization, of which at least three (3) must be at the 4000-level. The courses that satisfy these requirements, and the quarters when they are offered, can be found on the NSA website at http://www.nps.edu/Academics/Schools/SIGS/DegreePro g/NSA/Academics/schedule.html http://www.nps.edu/Academics/Schools/SIGS/DegreePro g/NSA/Academics/schedule.html. Students are also required to take sufficient general electives to maintain a full-time course load (16 hours). The number of general elective slots will vary somewhat depending upon service affiliation and sponsor requirements.

Students who write a thesis must complete NS4080, Thesis Proposal, no later than six months prior to intended graduation. NS4080 does not count as one of the three 4000-level courses required above. Thereafter thesis students may enroll in NS0810, Thesis Research, up to three times; or they may take additional course work in their area of specialization, if they prefer.

Students in curriculum 683 who substitute language training plus a comprehensive examination for the thesis must enroll in NS0811, Preparation for Comprehensive Examination, during their final quarter.

Educational Skill Requirements (ESR)

1. **Basic Graduate Level Skills**
   a. **Conduct Research:** Assemble information from the full range of data sources to understand international political, economic, and military issues.
   b. **Analyze Problems:** Frame issues as research questions; logically combine evidence and theory to analyze and explain international political, economic, and military developments; and

formulate innovative solutions to strategic problems.

c. **Communicate Information:** Clearly summarize large quantities of information and persuasively present positions and courses of action using a broad range of verbal and written communications formats, including short oral arguments, visual briefs, policy memos, position papers, and comprehensive student theses.

2. **General Political Science, International Relations, and Security Studies**

a. **International and Comparative Politics:** Understand international relations theories, including realist, liberal, and cultural paradigms; the conditions and worldviews that shape state interactions in the international system; the history of modern nationalism and the state system; and the roles of domestic politics, non-state actors, and transnational social movements in shaping international politics.

b. **International Economy:** Understand the economic factors that shape the international security environment, including the economic dimensions of national security policy and the ways in which economic policies and interests affect military strategy and force structure.

c. **International and Military History:** Grasp the principal causes of war in the modern era, and understand the political, technological, economic, and other influences that have governed its conduct; understand the social, political, economic, and cultural forces that have contributed to periods of stable peace; and analyze relations between states, including negotiations of peace settlements, military alliances, arms limitation agreements, economic arrangements, and human rights accords.

d. **International Organizations:** Understand the history of international organizations and their role in world politics, including international mediation and negotiations, formal and informal security arrangements, treaty regimes, and the role of international institutions and non-governmental organizations in peacekeeping and humanitarian operations.

e. **U.S. Security Policy and Strategy:** Understand how U.S. national security policy and strategy are formulated. Understand the roles of nuclear forces in the security policies of the United States and other nuclear powers; U.S. nuclear force acquisition, planning, deterrence policy, and employment concepts from the Second World War to the present; and the role of nuclear weapons in alliance politics and international relations.

3. **Regional Security Studies**

a. **Identities, Interests, and Politics:** Grasp the most significant political, economic, historical, cultural, and religious drivers that shape national identities and interests within their region of concentration.

b. **Emerging Security Challenges:** Know the regional sources of political and social instability and become familiar with the roots of ethnic conflict, insurgencies, and terrorism, and their effect on regional and U.S. security.

c. **Regional Conflicts:** Understand the patterns of violent conflicts, the likely sources and character of regional wars in the present and future, and the historical and prospective impact of such wars on the international system.

d. **Military Forces and Strategic Posture:** Understand the main factors determining the strategic postures of countries in the region, including strategic culture and goals, threat perceptions, and military force structures.

e. **U.S. Regional Security Policy:** Understand U.S. foreign policy objectives in a given region and be able to explain U.S. political, economic, and military strategy in the region, including U.S. engagement policy and security assistance programs.

f. **Economic Factors:** Grasp the importance of underlying economic conditions on regional stability and conflict, as well as the tools of economic statecraft that the United States and international organizations may employ to try to influence these conditions.

Regional Security Studies - Europe and Eurasia - Curriculum 684

Program Officer

Jorge Garcia, CDR, USN
Glasgow Hall Room 336

(831) 656-2067, DSN 756-2067
jfgarci1@nps.edu http://www.

Academic Associate

Mikhail Tsypkin, Ph.D.
Code 38, Glasgow Hall, Room 313

(831) 656-2218, DSN 756-2218
mtsypkin@nps.edu

Brief Overview

Curriculum 684 studies politics and security in Europe and Eurasia. Depending upon sponsor requirements, study at NPS may be preceded or followed by language instruction at the Defense Language Institute, co-located on the Monterey Peninsula.

Curriculum 684 distinguishes between Europe and Eurasia based on the designations used in the Army FAO program as follows:

Europe: United Kingdom, Ireland, France, Norway, Netherlands, Belgium, Sweden, Denmark, Luxembourg, Germany, Austria, Switzerland, Italy, Spain, Portugal, Hungary, Bulgaria, Czech Republic, Slovak Republic, Poland, Albania, Croatia, Bosnia-Herzegovina, Serbia Montenegro, Macedonia, Finland, Romania, Greece, Liechtenstein, Malta, Monaco, Andorra, San Marino, Slovenia, and Iceland.

Eurasia: Russia, Belarus, Ukraine, Moldova, Armenia, Georgia, Kazakhstan, Uzbekistan, Kyrgyzstan, Turkmenistan, Tajikistan, Azerbaijan, Estonia, Latvia, and Lithuania.

Separate tracks, with their own sets of requirements, exist for these two regions, as indicated in NSA's on-line schedule of classes.

Entry Date

For thesis students who wish to complete JPME Phase I while in residence, curriculum 684 is a six-quarter (18-month) program. For non-thesis students who will be completing JPME Phase I in residence, curriculum 684 is a five-quarter (15-month) program. For non-thesis student who will not be completing JPME Phase I in residence, curriculum 684 is a four-quarter (12-month) program. In all cases, students may enter in any quarter, with study commencing in January, April, July or October.

Degree

Master of Arts in Security Studies (Europe and Eurasia)

Subspecialty

Navy P-Codes: 2104P

Typical Subspecialty Jobs

Defense Attaché
Foreign Area Officer
Intelligence Officer
Plans Officer, Staff Planner
Various joint command positions
Service Headquarters - Political / Military officers
Major staff jobs in Combatant Commands and Fleet
 Commands

Curriculum Requirements

Students in curriculum 684 must complete five (5) disciplinary core courses, as follows:

NS3011	Research and Writing in National Security Affairs	
NS3023	Introduction to Comparative Politics	
NS3024	Introduction to International Relations	
	One of the following three:	
NS3000	War in the Modern World	
NS3001	War and its Impact on Post-Conflict Reconstruction	
NS3003	Nationalism and Revolution	
	One of the following three:	
NS3040	Politics of Global Economic Relations	
NS3041	Comparative Economic Systems	
NS3042	Economic Development for Security Building	

In addition, students must complete a minimum of eight (8) curricular core and elective courses in their regional specialization, of which at least three (3) must be at the 4000-level. The courses that satisfy these requirements, and the quarters when they are offered, can be found on the NSA website at http://www.nps.edu/Academics/Schools/SIGS/DegreePro g/NSA/Academics/schedule.html http://www.nps.edu/Academics/Schools/SIGS/DegreePro g/NSA/Academics/schedule.html. Students are also required to take sufficient general electives to maintain a full-time course load (16 hours). The number of general elective slots will vary somewhat depending upon service affiliation and sponsor requirements.

Students who write a thesis must complete NS4080, Thesis Proposal, no later than six months prior to intended graduation. NS4080 does not count as one of the three 4000-level courses required above. Thereafter thesis students may enroll in NS0810, Thesis Research, up to three times; or they may take additional course work in their area of specialization, if they prefer.

Students in curriculum 684 who substitute language training plus a comprehensive examination for the thesis must enroll in NS0811, Preparation for Comprehensive Examination, during their final quarter.

Educational Skill Requirements (ESR)

1. **Basic Graduate Level Skills**
   a. **Conduct Research:** Assemble information from the full range of data sources to understand international political, economic, and military issues.
   b. **Analyze Problems:** Frame issues as research questions; logically combine evidence and theory to analyze and explain international political, economic, and military developments; and

formulate innovative solutions to strategic problems.
  c. **Communicate Information:** Clearly summarize large quantities of information and persuasively present positions and courses of action using a broad range of verbal and written communications formats, including short oral arguments, visual briefs, policy memos, position papers, and comprehensive student theses.
2. **General Political Science, International Relations, and Security Studies**
  a. **International and Comparative Politics:** Understand international relations theories, including realist, liberal, and cultural paradigms; the conditions and world views that shape state interactions in the international system; the history of modern nationalism and the state system; and the roles of domestic politics, non-state actors, and transnational social movements in shaping international politics.
  b. **International Economy:** Understand the economic factors that shape the international security environment, including the economic dimensions of national security policy and the ways in which economic policies and interests affect military strategy and force structure.
  c. **International and Military History:** Grasp the principal causes of war in the modern era, and understand the political, technological, economic, and other influences that have governed its conduct; understand the social, political, economic, and cultural forces that have contributed to periods of stable peace; and analyze relations between states, including negotiations of peace settlements, military alliances, arms limitation agreements, economic arrangements, and human rights accords.
  d. **International Organizations:** Understand the history of international organizations and their role in world politics, including international mediation and negotiations, formal and informal security arrangements, treaty regimes, and the role of international institutions and non-governmental organizations in peacekeeping and humanitarian operations.
  e. **U.S. Security Policy and Strategy:** Understand how U.S. national security policy and strategy are formulated. Understand the roles of nuclear forces in the security policies of the United States and other nuclear powers; U.S. nuclear force acquisition, planning, deterrence policy, and employment concepts from the Second World War to the present; and the role of nuclear

weapons in alliance politics and international relations.
3. **Regional Security Studies**
  a. **Identities, Interests, and Politics:** Grasp the most significant political, economic, historical, cultural, and religious drivers that shape national identities and interests within their region of concentration.
  b. **Emerging Security Challenges:** Know the regional sources of political and social instability and become familiar with the roots of ethnic conflict, insurgencies, and terrorism, and their effect on regional and U.S. security.
  c. **Regional Conflicts:** Understand the patterns of violent conflicts, the likely sources and character of regional wars in the present and future, and the historical and prospective impact of such wars on the international system.
  d. **Military Forces and Strategic Posture:** Understand the main factors determining the strategic postures of countries in the region, including strategic culture and goals, threat perceptions, and military force structures.
  e. **U.S. Regional Security Policy:** Understand U.S. foreign policy objectives in a given region and be able to explain U.S. political, economic, and military strategy in the region, including U.S. engagement policy and security assistance programs.
  f. **Economic Factors:** Grasp the importance of underlying economic conditions on regional stability and conflict, as well as the tools of economic statecraft that the United States and international organizations may employ to try to influence these conditions.

Civil-Military Relations - Curriculum 685

Program Officer

Jorge Garcia, CDR, USN
Glasgow Hall Room 336

(831) 656-2067, DSN 756-2067
jfgarci1@nps.edu http://www.

Academic Associate
Arturo Sotomayor, Ph.D.
Code 38, Glasgow Hall, Room 348

(831) 656-2798, DSN 756-2798
acsotoma@nps.edu Mailto:acsotoma@nps.edu

Brief Overview

The Civil-Military Relations curriculum is an interdisciplinary program tailored to the needs of

international officers and civilians. It is open to members of the U.S. armed services as well. The program is designed to meet three related requirements. First, it gives international students the skills needed to resolve the security problems confronting new and emerging democracies. Second, the program offers an in-depth understanding of civil-military relations. Finally, the program prepares students to resolve the civil-military issues raised by participation in U.N. peacekeeping operations, membership in the Partnership for Peace and other alliances, and security cooperation between other nations and the United States.

Entry Date

For students who wish to complete JPME Phase I while in residence, curriculum 685 is a six-quarter (18-month) program. For all other students, curriculum 685 is a five-quarter (15 month) program. International students must enter in Winter Quarter, with study commencing in January. American officers may enter in any quarter.

Degree

Master of Arts in Security Studies (Civil-Military Relations)

Subspecialty

Navy P-Codes: None

Curriculum Requirements

Students in curriculum 685 must complete five (5) disciplinary core courses, as follows:

NS3011	Research and Writing in National Security Affairs
NS3023	Introduction to Comparative Politics
NS3024	Introduction to International Relations

One of the following three:

NS3000	War in the Modern World
NS3001	War and its Impact on Post-Conflict Reconstruction
NS3003	Nationalism and Revolution

One of the following three:

NS3040	Politics of Global Economic Relations
NS3041	Comparative Economic Systems
NS3042	Economic Development for Security Building

In addition, students must complete a minimum of eight (8) curricular core and elective courses, of which at least three (3) must be at the 4000-level. The courses that satisfy these requirements, and the quarters when they are offered, can be found on the NSA website at http://www.nps.edu/Academics/Schools/SIGS/DegreeProg/NSA/Academics/schedule.html http://www.nps.edu/Academics/Schools/SIGS/DegreeProg/NSA/Academics/schedule.html. 685 students have the option of substituting four (4) courses in a single region for

four of the curricular electives that would otherwise be required. At least one of the regional courses must be at the 4000-level.

Students are also required to take sufficient general electives to maintain a full-time course load (16 hours). The number of general elective slots will vary somewhat depending upon service affiliation and sponsor requirements.

Students in curriculum 685 must complete NS4080, Thesis Proposal, no later than six months prior to intended graduation. Thereafter students may enroll in NS0810, Thesis Research, up to three times; or they may take additional course work in their area of specialization, if they prefer.

Educational Skill Requirements (ESR)

1. **Basic Graduate Level Skills**
   a. **Conduct Research:** Assemble information from the full range of data sources to understand international political, economic, and military issues.
   b. **Analyze Problems:** Frame issues as research questions; logically combine evidence and theory to analyze and explain international political, economic, and military developments; and formulate innovative solutions to strategic problems.
   c. **Communicate Information:** Clearly summarize large quantities of information and persuasively present positions and courses of action using a broad range of verbal and written communications formats, including short oral arguments, visual briefs, policy memos, position papers, and comprehensive student theses.

2. **General Political Science, International Relations, and Security Studies**
   a. **International and Comparative Politics:** Understand international relations theories, including realist, liberal, and cultural paradigms; the conditions and world views that shape state interactions in the international system; the history of modern nationalism and the state system; and the roles of domestic politics, non-state actors, and transnational social movements in shaping international politics.
   b. **International Economy:** Understand the economic factors that shape the international security environment, including the economic dimensions of national security policy and the ways in which economic policies and interests affect military strategy and force structure.
   c. **International and Military History:** Grasp the principal causes of war in the modern era, and

understand the political, technological, economic, and other influences that have governed its conduct; understand the social, political, economic, and cultural forces that have contributed to periods of stable peace; and analyze relations between states, including negotiations of peace settlements, military alliances, arms limitation agreements, economic arrangements, and human rights accords.

d. **International Organizations:** Understand the history of international organizations and their role in world politics, including international mediation and negotiations, formal and informal security arrangements, treaty regimes, and the role of international institutions and non-governmental organizations in peacekeeping and humanitarian operations.

e. **U.S. Security Policy and Strategy:** Understand how U.S. national security policy and strategy are formulated. Understand the roles of nuclear forces in the security policies of the United States and other nuclear powers; U.S. nuclear force acquisition, planning, deterrence policy, and employment concepts from the Second World War to the present; and the role of nuclear weapons in alliance politics and international relations.

Stabilization & Reconstruction - Curriculum 686

Program Officer

Jorge Garcia, CDR, USN
Glasgow Hall Room 336

(831) 656-2067, DSN 756-2067
jfgarci1@nps.edu http://www.

Academic Associate

Arturo C. Sotomayor, Ph.D.
Code 38, Glasgow Hall, Room 348

(831) 656-2798, DSN 756-2798
acsotoma@nps.edu Mailto:acsotoma@nps.edu

Brief Overview

The curriculum on Stabilization and Reconstruction is based on a very simple premise. Sustainable economic and political development can go forward only when effective, democratically-controlled institutions can provide security for a nation's people. In nations where U.S. and international forces are providing this security, those forces need to work with civilian development agencies and NGOs to help build indigenous security institutions.

Otherwise, military forces risk creating a climate of dependency, in which continued local reliance on those forces slows their exit and impedes progress towards broader political and economic development.

The purpose of the program is the creation of a security environment within which economic and political development can flourish. By building indigenous capacities to provide security, military forces can "work themselves out of a job" and facilitate their own exit. Moreover, by conducting operations in close cooperation with civilian development agencies and NGOs, forces can facilitate the hand-off to these partners and contribute directly to their development work. In short: the Security Building program is designed to help the United States and its allies win and maintain the peace long after their military forces have returned home.

The program will accomplish its purpose by providing the specialized expertise, problem-solving skills, and management tools required by civilians and military officers (U.S. and international) operating in the post-conflict environment.

Entry Date

For students who wish to complete JPME Phase I while in residence, curriculum 686 is a six-quarter (18-month) program. For all other students, curriculum 686 is a five quarter (15-month) program. Students may enter in any quarter, with study commencing in January, April, July, or October.

Degree

Master of Arts in Security Studies (Stabilization and Reconstruction)

Subspecialty

Navy P-Codes: None.

Curriculum Requirements

Students in curriculum 686 must complete five (5) disciplinary core courses, as follows:

NS3011	Research and Writing in National Security Affairs
NS3023	Introduction to Comparative Politics
NS3024	Introduction to International Relations
	One of the following three:
NS3000	War in the Modern World
NS3001	War and its Impact on Post-Conflict Reconstruction
NS3003	Nationalism and Revolution
	One of the following three:
NS3040	Politics of Global Economic Relations
NS3041	Comparative Economic Systems
NS3042	Economic Development for Security Building

In addition students must to complete a minimum of eight (8) curricular core and elective courses, of which at least three (3) must be at the 4000-level. The courses that satisfy these requirements, and the quarters when they are offered, can be found on the NSA website at http://www.nps.edu/Academics/Schools/SIGS/DegreePro g/NSA/Academics/schedule.html http://www.nps.edu/Academics/Schools/SIGS/DegreePro g/NSA/Academics/schedule.html. 686 students have the option of substituting four (4) courses in a single region for four of the curricular electives that would otherwise be required. At least one of the regional courses must be at the 4000-level.

Students are also required to take sufficient general electives to maintain a full-time course load (16 hours). The number of general elective slots will vary somewhat depending upon service affiliation and sponsor requirements.

Students in curriculum 686 must complete NS4080, Thesis Proposal, no later than six months prior to intended graduation. Thereafter thesis students may enroll in NS0810, Thesis Research, up to three times; or they may take additional course work in their area of specialization, if they prefer.

Educational Skill Requirements (ESR)

1. **Basic Graduate Level Skills**
   a. **Conduct Research:** Assemble information from the full range of data sources to understand international political, economic, and military issues.
   b. **Analyze Problems:** Frame issues as research questions; logically combine evidence and theory to analyze and explain international political, economic, and military developments; and formulate innovative solutions to strategic problems.
   c. **Communicate Information:** Clearly summarize large quantities of information and persuasively present positions and courses of action using a broad range of verbal and written communications formats, including short oral arguments, visual briefs, policy memos, position papers, and comprehensive student theses.

2. **General Political Science, International Relations, and Security Studies**
   a. **International and Comparative Politics:** Understand international relations theories, including realist, liberal, and cultural paradigms; the conditions and world views that shape state interactions in the international system; the history of modern nationalism and the state system; and the roles of domestic politics, non-state actors, and transnational social movements in shaping international politics.
   b. **International Economy:** Understand the economic factors that shape the international security environment, including the economic dimensions of national security policy and the ways in which economic policies and interests affect military strategy and force structure.
   c. **International and Military History:** Grasp the principal causes of war in the modern era, and understand the political, technological, economic, and other influences that have governed its conduct; understand the social, political, economic, and cultural forces that have contributed to periods of stable peace; and analyze relations between states, including negotiations of peace settlements, military alliances, arms limitation agreements, economic arrangements, and human rights accords.
   d. **International Organizations:** Understand the history of international organizations and their role in world politics, including international mediation and negotiations, formal and informal security arrangements, treaty regimes, and the role of international institutions and non-governmental organizations in peacekeeping and humanitarian operations.
   e. **U.S. Security Policy and Strategy:** Understand how U.S. national security policy and strategy are formulated. Understand the roles of nuclear forces in the security policies of the United States and other nuclear powers; U.S. nuclear force acquisition, planning, deterrence policy, and employment concepts from the Second World War to the present; and the role of nuclear weapons in alliance politics and international relations.

3. **Stabilization and Reconstruction**
   a. **Civil-Military Relations:** Understand the core concepts of civil-military relations, particularly as they relate to the establishment of domestic order and the development of democratic politics.
   b. **Operations:** Recognize the military, political, economic, and social contexts that make successful stabilization and reconstruction operations possible.
   c. **Non-Governmental Actors:** Understand the role of non-governmental actors in the development and sustainment of a stable civil society in post-conflict environments.
   d. **Analysis of Post-Conflict Situations:** Know how to analyze problems in post-conflict situations and understand the role of military and non-military

actors in constructing multidisciplinary solutions for stabilization.

e. **Democratic Transitions:** Understand the challenges societies face in the process of making democratic transitions and the role of consensus building strategies for crafting sustainable solutions.

f. **Role and Limits of Force:** Recognize the comparative contributions (and specific limitations) of using national military, U.N. forces, regional forces, and private entities in the process of stabilizing post-conflict societies.

g. **Historical Context:** Students will be familiar with past practices relating to post-conflict stabilization and reconstruction across the world, and understand the relevance and application of those historical practices to conditions today.

h. **Legal Context:** Understand the basic international legal and treaty framework that affects stabilization and reconstruction efforts.

Defense Decision-Making & Planning - Curriculum 687

This curriculum is closed to new admissions. Previous catalog descriptions of this curriculum are found in the Past Edition Archives at this link:

http://www.nps.edu/Academics/Admissions/Registrar/AcademicCatalog

Program Officer

Jorge Garcia, CDR, USN
Glasgow Hall Room 336

(831) 656-2067, DSN 756-2067
jfgarci1@nps.edu http://www.

Strategic Studies - Curriculum 688

Program Officer

Jorge Garcia, CDR, USN
Glasgow Hall Room 336

(831) 656-2067, DSN 756-2067
jfgarci1@nps.edu

Academic Associate

Mikhail Tsypkin, Ph.D.
Code 38, Glasgow Hall, Room 313

(831) 656-2218, DSN 756-2218
mtsypkin@nps.edu

Brief Overview

Strategy is concerned with the use of force to further the ends of policy. The aim of this curriculum is to produce students with a thorough understanding of this relationship, and of the relationship of force to other instruments by which the ends of policy may be pursued. Graduates will possess a comprehensive knowledge of US national security and defense policy and military strategy. They will have the ability to develop and coordinate national and military strategy; to develop concepts and plans to employ military forces at the national and theater levels; to write strategic- and operational-level vision and guidance documents; and to formulate, articulate, and coordinate the employment of all dimensions of military power to support the ends of American national policy.

Strategic Studies is a multi-disciplinary degree program grounded in the fields of history, international relations, comparative politics, and political economy, and requires completion of a Master's thesis as the capstone degree requirement. Satisfactory completion of the four-course Naval War College JPME sequence is required for Navy officers. Students who do not need or desire to complete JPME are expected to develop a coherent four-course elective sequence in its place. The program of study lasts fifteen months, and may be begun in any academic quarter.

Entry Date

Any Quarter

Degree

Master of Arts in Security Studies (Strategic Studies)

Subspecialty

Navy P-Codes: 2301

Curriculum Requirements

Students in curriculum 688 must complete the following:

NS3011   Research and Writing in National Security Affairs
NS3023   Introduction to Comparative Politics
NS3024   Introduction to International Relations
One of the following three:
NS3000   War in the Modern World

NS3001   War and its Impact on Post-Conflict Reconstruction
NS3003   Nationalism and Revolution
One of the following three:
NS3040   Politics of Global Economic Relations

NS3041   Comparative Economic Systems
NS3042   Economic Development for Security Building
Four JPME courses taught by the Naval War College satellite program:
NW3230   Strategy and War
NW3275   Joint and Maritime Operations, Part I

NW3276   Joint and Maritime Operations, Part II
NW3285   National Security Decision-Making
Curricular Courses – Required
NS3030   American National Security Policy
NS3230   Innovation and Adaptation in the Military
NS4990   Seminar in Strategic Studies
NS4255   Maritime Strategy
Three electives from courses approved by the sponsor.
Thesis–Related Courses – Required
NS4080   Thesis Proposal
NS0810   Thesis Research (may be taken up to three times, must be taken once.)

Educational Skill Requirements (ESR)

1. **Basic Graduate Level Skills**
   a. **Conduct Research:** Assemble information from the full range of data sources to understand international political, economic, and military issues.
   b. **Analyze Problems:** Frame issues as research questions; logically combine evidence and theory to analyze and explain international political, economic, and military developments; and formulate innovative solutions to strategic problems.
   c. **Communicate Information:** Clearly summarize large quantities of information and persuasively present positions and courses of action using a broad range of verbal and written communications formats, including short oral arguments, visual briefs, policy memos, position papers, and comprehensive student theses.

2. **General Political Science, International Relations, and Security Studies**
   a. **International and Comparative Politics:** Understand international relations theories, including realist, liberal, and cultural paradigms; the conditions and world views that shape state interactions in the international system; the history of modern nationalism and the state system; and the roles of domestic politics, non-state actors, and transnational social movements in shaping international politics.
   b. **International Economy:** Understand the economic factors that shape the international security environment, including the economic dimensions of national security policy and the ways in which economic policies and interests affect military strategy and force structure.
   c. **International and Military History:** Grasp the principal causes of war in the modern era, and understand the political, technological, economic, and other influences that have governed its conduct; understand the social, political, economic, and cultural forces that have contributed to periods of stable peace; and analyze relations between states, including negotiations of peace settlements, military alliances, arms limitation agreements, economic arrangements, and human rights accords.

3. **US National Security, Defense, and Military Strategy**
   a. **U.S. National Security Policy:** Demonstrate a comprehensive knowledge of US national security policy, military history, and defense, military, and naval strategy.
   b. **International Environment:** Assess the international strategic environment, have knowledge of politico-military affairs, and understand the inner workings of the highest levels of government. Draw policy-relevant conclusions and formulate actionable recommendations.
   c. **Strategic plans and policy:** Demonstrate ability to write strategic-to-operational-level vision and guidance documents calculated to relate the ends of policy to the ways and means of strategic action. Understand the relationship of DIME elements to naval power and joint and maritime strategy. Differentiate and define Service, COCOM, and Naval Component Command roles at the national and theater levels.
   d. **Strategic Theory and Concepts:** Demonstrate ability to evolve concepts and strategy to employ forces at the national and theater levels. Understand how joint and maritime forces may influence the future global security environment. Develop strategic- and theater-level concepts of operations based on higher-level policies and strategies.
   e. **Coalitions and Alliance Politics:** Analyze the principal alliances and international organizations that shape the current security environment, including their role in U.S. national strategy, coalition building, and military missions from peace operations to major wars.
   f. **Regional Security:** Understand the basic security dynamics of at least two major world regions.
   g. **Joint Professional Military Education:** Satisfactory completion of JPME Phase I.

Homeland Security and Defense - Curriculum 691

Program Officer

Jorge Garcia, CDR, USN
Glasgow Hall Room 336

(831) 656-2067, DSN 756-2067

jfgarci1@nps.edu

Academic Associate

Carolyn C. Halladay, Ph.D.
Code 38, Glasgow Hall, Room 352

Brief Overview

Homeland Security and Defense provides military officers with a theoretical and practical understanding of unconventional threats within the framework of the U.S. domestic security environment, and organizational strategies to deal with such threats. It explores the Department of Defense's primary role in deterring and preventing attacks on the territory of the United States and in consequence management should such attacks occur. The strategic interests and objectives of the United States; the roles missions, structures, and effectiveness of U.S. Homeland Security organizations and intelligence organizations, as well as potential threats to U.S. domestic security are examined.

Entry Date

For U.S. Navy students who wish to complete JPME Phase I while in residence, curriculum 691 is a six-quarter (18-month) program. For all other students, curriculum 691 is a five-quarter (15-month) program. In all cases, students may enter in any quarter, with study commencing in January, April, July, or October.

Degree

Master of Arts in Security Studies (Homeland Security and Defense)

Subspecialty

Navy P-Codes: 2600P

Typical Subspecialty Jobs

Intelligence Officer
Plans Officer, Staff Planner
Various Joint Command Positions
Service Headquarters-Homeland Defense/Critical
  Infrastructure Protection
Major Staff Jobs in Combatant Commands and Fleet
  Commands

Academic Certificate Program

NSA offers an Academic Certificate in Homeland Security and Defense to students in other curricula at NPS. The program is designed to provide organizational and strategic dimensions of homeland security and defense, and to facilitate scientific and technical research in the field by providing those engaged in such projects with a useful understanding of the specialized challenges that arise in this relatively new area of public policy. The Certificate may be obtained by successful completion of five curricular core courses required for the MA program as indicated on the schedule published on the NSA website. Successful completion of the program is recorded on a student's transcript.

Curriculum Requirements

Students in curriculum 691 must complete five (5) disciplinary core courses, as follows:

NS3011 Research and Writing in National Security Affairs
NS3023 Introduction to Comparative Politics
NS3024 Introduction to International Relations
  One of the following three:
NS3000 War in the Modern World

NS3001 War and its Impact on Post-Conflict Reconstruction
NS3003 Nationalism and Revolution
  One of the following three:
NS3040 Politics of Global Economic Relations

NS3041 Comparative Economic Systems
NS3042 Economic Development for Security Building

In addition, students must complete a minimum of eight (8) curricular core and elective courses, of which at least three (3) must be at the 4000-level. The courses that satisfy these requirements, and the quarters when they are offered, can be found on the NSA website at http://www.nps.edu/Academics/Schools/SIGS/DegreeProg/NSA/Academics/schedule.html http://www.nps.edu/Academics/Schools/SIGS/DegreeProg/NSA/Academics/schedule.html.

Students are also required to take sufficient general electives to maintain a full-time course load (16 hours). The number of general elective slots will vary somewhat depending upon service affiliation and sponsor requirements.

Students in curriculum 691 must complete NS4080, Thesis Proposal, no later than six months prior to intended graduation. Thereafter students may enroll in NS0810, Thesis Research, up to three times; or they may take additional course work in their area of specialization, if they prefer.

Educational Skill Requirements (ESR)

1. **Basic Graduate Level Skills**
   a. **Conduct Research:** Assemble information from the full range of data sources to understand international political, economic, and military issues.
   b. **Analyze Problems:** Frame issues as research questions; logically combine evidence and theory to analyze and explain international political, economic, and military developments; and

formulate innovative solutions to strategic problems.

c. **Communicate Information:** Clearly summarize large quantities of information and persuasively present positions and courses of action using a broad range of verbal and written communications formats, including short oral arguments, visual briefs, policy memos, position papers, and comprehensive student theses.

2. **General Political Science, International Relations, and Security Studies**

a. **International and Comparative Politics:** Understand international relations theories, including realist, liberal, and cultural paradigms; the conditions and world views that shape state interactions in the international system; the history of modern nationalism and the state system; and the roles of domestic politics, non-state actors, and transnational social movements in shaping international politics.

b. **International Economy:** Understand the economic factors that shape the international security environment, including the economic dimensions of national security policy and the ways in which economic policies and interests affect military strategy and force structure.

c. **International and Military History:** Grasp the principal causes of war in the modern era, and understand the political, technological, economic, and other influences that have governed its conduct; understand the social, political, economic, and cultural forces that have contributed to periods of stable peace; and analyze relations between states, including negotiations of peace settlements, military alliances, arms limitation agreements, economic arrangements, and human rights accords.

d. **International Organizations:** Understand the history of international organizations and their role in world politics, including international mediation and negotiations, formal and informal security arrangements, treaty regimes, and the role of international institutions and non-governmental organizations in peacekeeping and humanitarian operations.

e. **U.S. Security Policy and Strategy:** Understand how U.S. national security policy and strategy are formulated. Understand the roles of nuclear forces in the security policies of the United States and other nuclear powers; U.S. nuclear force acquisition, planning, deterrence policy, and employment concepts from the Second World War to the present; and the role of nuclear

weapons in alliance politics and international relations.

3. **Homeland Security and Defense**

a. **Analytical Skills:** Graduates will be able to logically combine data and theory to analyze and explain political, economic, and military events in the context of the Department of Homeland Security. Students will demonstrate writing, briefing, and computer skills in preparing and presenting their findings.

b. **National Security Issues:** Graduates will be aware of the economic, political, social, and military characteristics of homeland security, homeland defense, and national security issues. These issues include: intelligence gathering and information sharing, posse comitatus, and the interaction of law enforcement with military command

c. **Critical Infrastructure Vulnerability:** Graduates will be familiar with the full range of critical infrastructure sectors within the United States. They will know what their vulnerabilities are, and how to "harden" the critical nodes in each sector. Particular emphasis will be placed on networked infrastructure and the protection of critical nodes.

d. **Threat Analysis:** Graduates will learn about domestic and international terrorism as they pertain to homeland security, as well as plans and capabilities to respond to such threats at the state, local, and federal levels.

e. **Civil-Military Relations:** Graduates will understand the field of civil-military relations as it applies to homeland security within the framework of the U.S. Constitution and the history of American civil-military relations. Students will be able to identify key players in homeland security at the various levels of government within and beyond the DoD, including the Department of Homeland Security, Northern Command, FBI, CIA, etc.

f. **Law Enforcement and the Judicial System:** Graduates will understand the interface between domestic law enforcement, state and local police, emergency response teams, military support of civilians, and investigations by various agencies such as the U.S. Postal Service, etc. Graduates will know the roles and responsibilities of various law enforcement agencies. Finally, graduates will understand how the judicial system interfaces with the military, at the state and local levels.

g. **Intelligence in Homeland Security:** Graduates will understand the role of intelligence in defense of the homeland, including the restraints imposed upon intelligence-gathering within the United States. Graduates will recognize what can be

learned from military intelligence and applied to homeland security. Graduates will understand the complexities of information gathering, analysis, and sharing in the context of homeland security.

Curriculum Sponsor and ESR Approval Authority

Deputy Chief of Naval Operations (Plans, Policy and Operations) (N3/N5)

Center for Homeland Defense and Security - Curriculum 692

Program Manager

Mark Fish
Code 38, Herrmann Hall, Room 021A
(831) 656-1927, DSN 756-1927, FAX (831) 656-2575
mdfish@nps.edu

Academic Associate

Rudy Darken, D.Sc.
(831)656-7588, DSN 756-7588, FAX (831) 656-2575
darken@nps.edu

Website: www.chds.us http://www.chds.us

Executive Director

Ted Lewis, Ph.D.
Code 06, Watkins Hall, Room 370
(831) 656-2830, DSN 756-2830, FAX (831) 656-2575
tlewis@nps.edu

Director

Glen Woodbury
Code 06, Watkins, Hall, Room 372
(831) 656-2356, DSN 756-2356, FAX (831) 656-2619
glwoodbu@nps.edu

Master of Arts Degree

Participants: U.S. students only.
This 18-month program is offered at no cost to eligible senior and fast-track local, state, tribal and federal officials and NORTHCOM-sponsored officers with significant homeland security responsibilities.

Program: Designed to accommodate busy officials, the Master of Arts degree program requires participants to be in residence (at the Naval Postgraduate School in

Monterey, California or at the Office of Personnel Management's Eastern Management Development Center facility in Shepherdstown, West Virginia) two weeks each quarter (for a total of 12 weeks). Participants complete the remainder of their coursework via network-based distance learning methods. The curriculum and research are focused on current policy, strategy and organizational design challenges. Participants complete research papers and a thesis on policy development issues confronting their city, state, or sponsoring organization.
The program graduated its first class in June 2004 (class started in January 2002) and graduates approximately 30 officials three times a year. A military variant of the program, including classified courses, is available through the Department of National Security Affairs.

Requirements for Entry

Applicants eligible for sponsorship must be full-time state, local, tribal or federal DHS officials. All others, including military and NORTHCOM, are eligible to apply but must obtain financial sponsorship from their command. A baccalaureate degree or its equivalent is required. A minimum grade point average of 3.0 or its equivalent is required. A complete application is available online at www.chds.us. http://www.chds.us

Entry Date

This is an 18-month program with entry dates in spring and fall for Monterey cohorts; summer entry for NCR cohorts.

The program requires 12 weeks of in-residence attendance, with the balance of coursework conducted online.

Degree

Master of Arts in Security Studies (Homeland Defense and Security)

Typical Subspecialty Jobs (Executive Level)

Homeland Security
Emergency Management
Public Health
Public Safety (Law, Fire Enforcement)
Public Policy

Subspecialty Code
Navy P-Code: 2600P

Required Course of Study

Quarter 1
NS3180   Introduction to Homeland Security
DA3210   The Unconventional Threat to Homeland
          Security

Quarter 2
IS4010   Technology for Homeland Security
NS4156   Intelligence for Homeland Security:
          Organizational and Policy Challenges
NS2013   Research and Writing for Homeland Security

Quarter 3
CS3660   Critical Infrastructure: Vulnerability Analysis
          & Protection
NS4239   Special Topics in American Government for
          Homeland Security
NS4081   Research Colloquium

Quarter 4
NS4881   Multi-Discipline Approaches to Homeland
          Security
NS3028   Comparative Government for Homeland
          Security

Quarter 5
NS4755   Strategic Thinking and management seminar
NS4133   Psychology of Fear Management and
          Terrorism

Quarter 6
NS4232   Knowledge into Practice: A Homeland
          Security Capstone Course
NS0810   Thesis Lab

Educational Skill Requirements (ESR)

1. **Analytical Skills:** Graduates will be able to logically combine data and theory to analyze and explain political, economic, and military events in the context of the new Department of Homeland Security. Students will demonstrate writing, briefing, and computer skills in preparing and presenting their findings. Each course requires individual students to present a significant project to the entire class.

2. **National Security Issues:** Graduates will be aware of the economic, political, social, and military characteristics of homeland security, homeland defense, and national security issues. These issues include: intelligence gathering and information sharing, posse comitatus, and the interaction of law enforcement with military command

3. **Critical Infrastructure Vulnerability:** Graduates will gain an understanding of how the eight major critical infrastructure sectors within the United States work, what are their vulnerabilities, and how to "harden" the critical nodes in each sector. Particular emphasis will be on the Internet and "networks of all kinds" that contain critical nodes.

4. **Threat Analysis:** Graduates will learn about domestic threats and asymmetric conflict and how they pertain to homeland security, NORCOMM, and state, local, and federal responses. What is the nature of the threat, and who are the terrorists?

5. **Civil-Military Relations:** Graduates will understand the field of civil-military relations as it applies to homeland security and security building within the confines of the U.S. Constitution and civil-military history. Students will be able to identify key players in homeland security at the various levels of government, and understand the dynamics of political institutions in homeland security: office of homeland security, Northern Command, FBI, CIA, etc.

6. **Law Enforcement and the Judicial System:** Graduates will understand the interface between domestic law enforcement, state and local police, emergency response teams, military support of civilians, and investigations by various agencies such as the U.S. Postal Service, etc. Graduates will know the roles and responsibilities of various law enforcement agencies. Finally, graduates will understand how the judicial system interfaces with the military, at the state and local levels.

7. **Intelligence in Homeland Security:** Graduates will understand the role of intelligence in defense of the homeland, and how it is different from military intelligence. Graduates will recognize what can be learned from military intelligence and applied to homeland security. Graduates will understand the complexities of information sharing, gathering, and analysis in the context of homeland security.

8. **Comparative Politics:** Graduates of the program will use the knowledge gained in the Civil-Military Relations, Comparative Governments, and Introduction to Homeland Security courses to make policy for local, state, and federal level programs

9. **Information Technology for Homeland Security:** Computers, the Internet, software for law enforcement, data collection, information sharing, and analysis are key technologies for successful homeland security building. Graduates will become familiar with the tools and techniques of information technology in various sectors ranging from critical infrastructure protection to intelligence gathering and analysis.

Faculty

Robert Bach, Adjunct Professor (2005); Ph.D., Duke, 1978.

Christopher Bellavita, Director, Academic Programs (2003); Ph.D., University of California at Berkeley, 1980.

Richard Bergin, Visiting Assistant Professor (2002); M.S., Marshall School of Business, 1998.

David Brannan, Adjunct Professor (2003); Ph.D., University of St. Andrews, 1999.

Jim Breckenridge, Visiting Professor (2003); Ph.D., University of Houston, 1982.

Erik Dahl, Assistant Professor, (2009); Ph.D., Tufts, 2008

Rudy Darken, Academic Associate, Professor (1996); DSc., Washington state University, 1995.

Lauren Fernandez, Adjunct Professor (2007); DSc, George Washington University, 2007.

Seth Jones, Adjunct Professor (2005); Ph.D., University of Chicago, 2004.

Kathleen Kiernan, Adjunct Professor (2009); Ed.D., Northern Illinois University, 2003.

Ted Lewis, Executive Director, Professor (1993); Ph.D., Washington State University, 1971.

Thomas Mackin, Adjunct Professor (2005); Ph.D., Pennsylvania State University, 1991.

Patrick Miller, Adjunct Professor (2007); M.A., NPS, 2005.

Fathali Moghaddam, Adjunct Professor (2007); Ph.D., University of Surrey, 1979.

Nadav Morag, Adjunct Professor (2005); Ph.D., Tel Aviv University, 2000.

Rodrigo Nieto-Gomez, Assistant Research Professor (2010); Ph.D. University of Paris VIII, 2009.

John Rollins, Adjunct Professor (2007); J.D., American University

Robert Simeral, Senior Intelligence Officer (2002); M.A., NPS, 1979.

Paul Stockton, Visiting Professor, Assistant U.S. Secretary of Defense (2003); Ph.D., Harvard University, 1986.

Paul Smith, Adjunct Professor (2008); B.A., University of Bristol, 1978.

Anders Strindberg, Adjunct Professor (2007); Ph.D., St. Andrews University, 2001.

Lauren Wollman, Managing Director, Academic Programs (2004); Ph.D., University of Southern California, 2000.

Phillip Zimbardo, Visiting Professor; Ph.D., Yale, 1959.

Army National Guard Certificate Program - (INACTIVE)

Participants: U.S. students only.

Program: CHDS has launched a certificate program in Homeland Defense and Security (HD/S) specifically for the National Guard (NG). The new program is designed to help the NG to fulfill its critical roles, responsibilities and tasks in conducting HD/S and Defense Support to Civil Authorities. Additionally, it will provide an avenue to degree completion for NG personnel at all levels, to raise the level of education across the force, to provide leadership education as personnel progress through their careers, and to help them think critically in dealing with the asymmetric threats faced in the Global War on Terror.

Center for Homeland Defense and Security Courses

CS3660 Critical Infrastructure: Vulnerability Analysis and Protection (4-0) Spring
Critical Infrastructure is one of the cornerstones of homeland security. At the completion of the course, students will be able to apply the model-based vulnerability technique to any critical infrastructure within their multi-jurisdictional region, and derive optimal strategies and draft policies for prevention of future terrorist attacks. Prerequisites: NS3180.

DA3210 The Unconventional Threat to HLS (4-0) Spring
The purpose of this course is to provide an introduction to the operational and organizational dynamics of terrorism. It considers those who act as individuals, in small groups or in large organizations. By the end of the course, students should be able to design effective measures for countering and responding to terrorism based on an understanding of its organizational and operational dynamics. Prerequisites: None.

IS4010 Technology for Homeland Security (4-0) Spring, Fall, Winter
Government agencies in today's information age are more dependent than ever on technology and information sharing. This course provides individuals involved in homeland security a broad overview of homeland security technology. This course focuses on technology as a tool to support homeland security personnel regardless of functional specialty. The ultimate objectives are to show students how homeland security professionals can exploit technology and to use it in the most efficient, innovative and productive manner. Prerequisites: None.

NS2013 Policy Analysis and Research Methodology (2-0) Quarterly

This course provides an overview of the steps of the research process and methods used in social-scientific inquiry. Students review various policy research designs, including hypothesis construction and comparative case studies. They also are introduced to literature review and the appropriate use of evidence and warrants. Prerequisite: None.

NS3028 Comparative Government for Homeland Security (4-0) Quarterly

The objectives of the NS3028 course are: (1) to assess important counterterrorism strategies employed by liberal democracies around the world; (2) to distill and extrapolate policy implications from these examples; and (3) to apply these lessons to the organizational and functional challenges faced by homeland security leaders and first responders in the United States. Prerequisites: None.

NS3180 Introduction To Homeland Security (4-0) Winter

This course provides an overview of the essential ideas that constitute the emerging discipline of homeland security. It has two central objectives: to expand the way participants think, analyze and communicate about homeland security and to assess knowledge in critical homeland security knowledge domains. Prerequisites: None.

NS4081 Research Colloquium (2-0) Quarterly

This course provides an overview of the steps of the research process and methods used in social-scientific inquiry. Students review various research methods, including policy options and analysis, modeling, qualitative data analysis, and case study. The primary deliverable of the course is the thesis proposal. Grading: Pass/Fail. Prerequisite: NS2013.

NS4133 The Psychology of Fear Management and Terrorism (4-0) Winter

This course serves as an introduction for homeland security professionals to terrorism as a psychological phenomenon. Government agencies involved in homeland security need to understand the psychological consequences of mass-casualty terrorist attacks and other disasters. This course provides a broad overview of psychological effects of terrorism. Prerequisites: NS3180.

NS4156 Intelligence for Homeland Security: Organizational and Policy Challenges (4-0) Spring

This course examines key questions and issues facing the U.S. intelligence community and its role in homeland security and homeland defense. Students will have the opportunity to fully address policy, organizational and substantive issues regarding homeland intelligence support. Prerequisites: None.

NS4232 Knowledge into Practice: A Homeland Security Capstone Course (3-0) As Required

This course is intended to provide participants the opportunity to expand their ability to enact he knowledge and technical learning acquired in the courses leading up to the capstone. This course will provide students with the motivation and skills to perform their professional roles in new ways, ways that will initiate and sustain change even at the level of the broader institutional context of governance in which they must function. Prerequisites: NS4156, CS3660.

NS4239 Seminar on American Government for Homeland Security (4-0) Spring, Summer, Fall, Winter

The purpose of the Special Topics course is to provide students with an extra focus on 2 or 3 major issues that have current visibility in debates about homeland security. Currently, those topics focus on dilemmas in the evolving relationships between civil and military authority and between government and community. Prerequisites: NS4156, NS3180, SO3210.

NS4755 Strategic Planning and Budgeting for Homeland Security (4-0) Summer

Homeland security requires programs in such disparate areas as counter-terrorism, information security, border security and counter-drug activities. This course will provide students with an analytical framework useful for translating long-term plans into programs and budgets. Prerequisites: NS3180.

NS4881 Multi-Discipline Approaches to Homeland Security (4-0) Summer

Homeland security efforts in the United States constitute a project framed by the rule of law. Constitutional concerns, civil rights issues and the roles if the various disciplines engaged in the effort are driven and impacted by the various local, state, and federal systems of law. This course allows students to explore the homeland security project in relation to the laws that support and constrain it. Prerequisites: None.

CHDS Course Calendar AY12 - AY13

Apr 5, 2012 - Jul 11, 2012	NS3028 and NS4881
Apr 19, 2012 - Jul 11, 2012	NS4755 and NS4133
May 5, 2012 - Aug 1, 2012	NS3180 and DA3210
Jun 9, 2012 - Sep 19, 2012	NS3180 and DA3210
Jun 21, 2012 - Oct 3, 2012	NS3028 and NS4881
Jul 12, 2012 - Sep 20, 2012	NS4232
Aug 2, 2012 - Oct 24, 2012	IS4010, NS4156 and NS2013
Sep 8, 2012 - Nov 28, 2012	NS3180 and DA3210
Sep 20, 2012 - Jan 9, 2013	IS4010, NS4156 and NS2013
Oct 4 - Jan 9, 2013	NS4755 and NS4133
Oct 25, 2012 - Jan 23, 2013	NS4081, CS3660 and NS4239
Nov 29, 2012 - Mar 6, 2013	IS4010, NS4156 and NS2013

Jan 10, 2013 - Mar 28, 2013	NS4232
Jan 10, 2013 - Apr 3, 2013	NS4081, CS3660 and NS4239
Jan 24, 2013 - Apr 17, 2013	NS3028 and NS4881
Mar 7, 2013 - Jun 19, 2013	NS4081, CS3660 and NS4239
Apr 4, 2013 - Jul 10, 2013	NS3028 and NS4881
Apr 18, 2013 - Jul 10, 2013	NS4755 and NS4133
May 4, 2013 - Jul 24, 2013	NS3180 and DA3210
Jun 20, 2013 - Oct 2, 2013	NS3028 and NS4881
Jul 11, 2013 - Sep 26, 2013	NS4232
Jul 11, 2013 - Oct 2, 2013	NS4755 and NS4133
Jul 25, 2013 - Oct 23, 2013	IS4010, NS4156 and NS2013
Sep 9, 2013 - Dec 4, 2013	NS3180 and DA3210
Sep 19, 2013 - Jan 8, 2013	IS4010, NS4156 and NS2013
Oct 3, 2013 - Dec 19, 2013	NS4232
Oct 3, 2013 - Jan 8, 2014	NS4755 and NS4133
Oct 24, 2013 - Jan 22, 2014	NS4081, CS3660 and NS4239

Homeland Security Certificate Program

Participants: U.S. students only.

Program: Program provides "first preventers" in homeland security the knowledge and skills necessary to execute the national homeland security mission. Conducted exclusively online with cutting-edge distance learning technologies, the program is tailored to the needs of each discipline involved in homeland security, especially at the state and local levels. The Certificate Program is being conducted by the Center for Rural Development with support from NPS' Center for Homeland Defense and Security.

Homeland Security Executive Leaders Program

ELP

Participants: U.S. students only.

Program: The Executive Education Seminar is a multi-day program designed to help senior local, state, and federal officials build U.S. capacity to defeat terrorism. Each program offers presentations on selected topics such as: intelligence, critical infrastructure, or public health issues. Participants consider complex issues and case studies and work through problems and scenarios that will enable them to strengthen working relationships across regions, agencies, and local-state-federal jurisdictional lines. This program is designed to bridge the education gap between the 18 month Master's Degree Program and the half-day MET Seminar.

Homeland Security Executive Education Seminars

Participants: U.S. students only.

Program: Executive Education Seminars are intensive, half-day seminars, designed for state governors and their homeland security team. It is also available for major urban area leaders, and focuses exclusively on enhancing the capacity of top government officials to address new homeland security challenges. Topics are discussed in an interactive roundtable format and may include: Local/State/Federal Responsibilities and Coordination, Intelligence Collection, Assessment, and Dissemination and Information Sharing and Critical Infrastructure Protection.

Combating Terrorism – Policy and Strategy - Curriculum 693

Program Officer

Jorge Garcia, CDR, USN
Glasgow Hall Room 336

(831) 656-2067, DSN 756-2067
jfgarci1@nps.edu http://www.

Academic Associate

Arturo C. Sotomayor, Ph.D.
Code 38, Glasgow Hall, Room 348

(831) 656-2798, DSN 756-2798
acsotoma@nps.edu Mailto:acsotoma@nps.edu

Brief Overview

This curriculum provides an understanding of the nature and dynamics of terrorist organizations, and the domestic and international variables involved in the formulation of

counter-terrorist policy. The curriculum allows the students to combine a regional focus with comparative courses that discuss terrorist organizations and operations, the financing of terror, legal and policing developments in counter-terrorism, intelligence, and the military role in homeland defense.

The NSA department is a unique environment in which to pursue this course of studies since its student body is inherently joint and combined, providing students with both a stimulating intellectual environment and an opportunity to establish networks and life-long working relationships with fellow officers from other services and countries.

Entry Date

For students who wish to complete JPME Phase I while in residence, curriculum 693 is a six-quarter (18 month) program. For all other students, curriculum 693 is a five-quarter (15 month) program. Students may enter in any quarter, with study commencing in January, April, July, or October.

Degree

Master of Arts in Security Studies (Combating Terrorism Policy and Strategy)

Subspecialty

Navy P Codes: None

Course Requirements

Students in curriculum 693 must complete five (5) disciplinary core courses, as follows:

NS3011   Research and Writing in National Security Affairs
NS3023   Introduction to Comparative Politics
NS3024   Introduction to International Relations
One of the following three:
NS3000   War in the Modern World

NS3001   War and its Impact on Post-Conflict Reconstruction
NS3003   Nationalism and Revolution
One of the following three:
NS3040   Politics of Global Economic Relations

NS3041   Comparative Economic Systems
NS3042   Economic Development for Security Building

In addition, students must complete a minimum of eight (8) curricular core and elective courses, of which at least three (3) must be at the 4000-level. The courses that satisfy these requirements, and the quarters when they are offered, can be found on the NSA website at http://www.nps.edu/Academics/Schools/SIGS/DegreeProg/NSA/Academics/schedule.html
http://www.nps.edu/Academics/Schools/SIGS/DegreeProg/NSA/Academics/schedule.html.

Students are also required to take sufficient general electives to maintain a full-time course load (16 hours). The number of general elective slots will vary somewhat depending upon service affiliation and sponsor requirements.

Students in curriculum 693 must complete NS4080, Thesis Proposal, no later than six months prior to intended graduation. Thereafter students may enroll in NS0810, Thesis Research, up to three times; or they may take additional course work in their area of specialization, if they prefer.

Educational Skill Requirements (ESR)

1. **Basic Graduate Level Skills:**
   a. **Conduct Research:** Assemble information from the full range of data sources to understand international political, economic, and military issues.
   b. **Analyze Problems:** Frame issues as research questions; logically combine evidence and theory to analyze and explain international political, economic, and military developments; and formulate innovative solutions to strategic problems.
   c. **Communicate Information:** Clearly summarize large quantities of information and persuasively present positions and courses of action using a broad range of verbal and written communications formats, including short oral arguments, visual briefs, policy memos, position papers, and comprehensive student theses.

2. **General Political Science, International Relations, and Security Studies:**
   a. **International and Comparative Politics:** Understand international relations theories, including realist, liberal, and cultural paradigms; the conditions and world views that shape state interactions in the international system; the history of modern nationalism and the state system; and the roles of domestic politics, non-state actors, and transnational social movements in shaping international politics.
   b. **International Economy:** Understand the economic factors that shape the international security environment, including the economic dimensions of national security policy and the ways in which economic policies and interests affect military strategy and force structure.
   c. **International and Military History:** Grasp the principal causes of war in the modern era, and understand the political, technological, economic, and other influences that have governed its conduct; understand the social, political, economic, and cultural forces that have

contributed to periods of stable peace; and analyze relations between states, including negotiations of peace settlements, military alliances, arms limitation agreements, economic arrangements, and human rights accords.

d. **International Organizations:** Understand the history of international organizations and their role in world politics, including international mediation and negotiations, formal and informal security arrangements, treaty regimes, and the role of international institutions and non-governmental organizations in peacekeeping and humanitarian operations.

e. **U.S. Security Policy and Strategy:** Understand how U.S. national security policy and strategy are formulated. Understand the roles of nuclear forces in the security policies of the United States and other nuclear powers; U.S. nuclear force acquisition, planning, deterrence policy, and employment concepts from the Second World War to the present; and the role of nuclear weapons in alliance politics and international relations.

Doctor of Philosophy in Security Studies - Curriculum 694

Program Officer

Jorge Garcia, CDR, USN
Glasgow Hall Room 336

(831) 656-2067, DSN 756-2067
jfgarci1@nps.edu http://www.

Doctoral Committee Chair

Mohammed Hafez, Ph.D.
Code 38, Glasgow Hall, Room 337

(831) 233-0272, DSN 756-2066
mmhafez@nps.edu

Brief Overview

Security Studies is a multidisciplinary field based on the traditional academic disciplines of Political Science, History, and Economics. The doctoral program in Security Studies seeks to equip students with the skills and knowledge required to do work of the highest professional quality in these areas, with emphasis on understanding the challenges and characteristics of modern security and defense policy. Doctoral training is inherently open-ended, being dependent upon completion of a Ph.D. dissertation of significant scope and originality. Successful completion of the program requires one year of in-residence course work beyond the Master's degree, and the completion of a doctoral dissertation of sufficient scope and quality to constitute an original and independent contribution to knowledge. A normal Ph.D. tour is three years, of which the last two are spent conducting research and writing the dissertation. Given the open-ended nature of dissertation research, however, there can be no assurance that the program can be completed in three years.

Requirements for Entry

Admission to the Ph.D. program in Security Studies is available to officers of all the U.S. armed services, civilian federal employees, and to individuals sponsored by selected allied nations. Applicants must possess a Master's Degree in Security Studies or a closely-allied field (Political Science, History, Economics, etc.) by the time doctoral instruction begins.

Admissions decisions are made twice per year. Deadlines are March 15 (for a decision in late March) and September 15 (for a decision in late September). The following materials are required:

· A completed online application, which may be accessed at http://www.nps.edu/Academics/Admissions/ApplyOnline/ApplyNow.html.
· A cover letter specifying research interest and purpose for seeking a doctoral degree, especially in relation to the candidate's previous academic and professional experiences.
· Certified transcripts of prior graduate and undergraduate work. Transcripts of work completed at NPS are not necessary.
· Scores from the Graduate Record Examination, taken within the last five years.
· At least two (2) letters of recommendation, either from former professors or from others in a position to judge the candidate's academic potential.
· Attestation by the student's sponsoring agency or nation that it is committed to provide tuition and salary support during the student's residence at NPS.
· A sample of expository writing (e.g. a paper written for a graduate seminar, a Master's thesis, an article published in an academic or service journal) chosen by the applicant to demonstrate his or her ability to do advanced academic work.
· International applicants who are not currently enrolled at NPS, and whose native language or language of prior instruction is other than English, must submit current results of the Test of English as a Foreign Language (TOEFL) and the Test of Written English.

Domestic applicants should forward the materials just described, to the NPS Director of Admissions. International students should forward their materials to the International Graduate School Programs Office.

Entry Date

Once a student has been admitted, doctoral study may begin in any subsequent quarter during the following twelve months.

Degree

Doctor of Philosophy in Security Studies.

Curriculum Requirements

General Degree Requirements: The NSA doctoral program requires one year of course work beyond the Master's degree. Courses are tailored to develop the candidate's analytical and methodological foundations in two of the following four disciplines: international relations, international political economy, comparative politics, and history. Additionally, elective courses and directed readings assist students in developing their dissertation topic, and prepare them to take required written and oral qualifying examinations.

A student is expected to have completed written and oral qualifying exams, and secured approval of the dissertation proposal by the committee that will supervise its completion, by the end of the fifth quarter in residence.

Degree Candidacy and Dissertation Research: Doctoral students are admitted to candidacy for the Ph.D. following successful completion of written and oral qualifying examinations, and the submission of a satisfactory dissertation proposal. Students admitted to candidacy for the degree are thereafter expected to be engaged full-time in dissertation research and writing. Once a completed dissertation has been submitted the student must defend it before the dissertation committee. A representative of the Academic Council and other interested observers will also be present for the defense.

Curriculum Sponsor and ESR Approval Authority

Deputy Chief of Naval Operations (Plans, Policy and Operations) (N3/5).

Center on Contemporary Conflict (CCC)

Website
www.nps.edu/ccc http://www.nps.edu/ccc

Director
James Clay Moltz, Ph.D.
Code NS, Glasgow Hall, Room 394

(831) 656-1039, DSN 756-1039, FAX (831) 656-2949

jcmoltz@nps.edu

Program Manager
Meghan Rasmussen
Code NS, Glasgow Hall, Room 339

(831) 656-6274, DSN 756-6274, FAX (831) 656-2949

mdrasmus@nps.edu

Overview

The CCC is the premier research wing of the Department of National Security Affairs with over a decade's experience providing research and timely analysis on a variety of topics to leading decision makers in the Department of Defense community.

With faculty specializing in the study of international relations, security policy, and regional studies, the Center has a unique capability to plan, manage, and execute needed government research and development. Our 40 affiliated NSA scholars provide broad and substantial research expertise. To ensure actionable research, the CCC leverages extensive institutional networks within the U.S. Government as well as worldwide partnerships with think tanks, educational institutions, militaries, governments, and alumni.

In addition to executing federally sponsored research, faculty and staff host and organize international seminars, Track II dialogues, and stability exercises that bring critical players together for an open exchange of ideas and formulation of recommendations. The CCC also serves as the program planning and implementation office for the Project on Advanced Systems and Concepts for Countering WMD (PASCC), which is sponsored by the Defense Threat Reduction Agency. In this capacity, the CCC cultivates national and international research partnerships to look well into the future to anticipate and reduce the threat of WMD capabilities.

Point of Contact Information

Academic Programs

Questions about the academic content of NSA degree programs should be addressed to the cognizant Academic Associate or Program Committee Chair, as noted in the curriculum descriptions, above.

Administrative and Service Related Matters

Dora Martinez
Educational Technician
Department of National Security Affairs
Glasgow Hall, Room 379
Naval Postgraduate School
Monterey, CA 93943

(831) 656-2845, DSN 756-2845
dmartinez@nps.edu

Heather Eldridge
Educational Technician
Department of National Security Affairs

Glasgow Hall, Room 338
Naval Postgraduate School
Monterey, CA 93943

(831) 656-2935, DSN 756-2935
hmeldrid@nps.edu

Joint Professional Military Education

Questions about Joint Professional Military Education should be addressed to:

Professor Fred P. Drake
Chairman, Joint Professional Military Education
Naval Postgraduate School
1 University Circle, Halligan Hall, Room 239
Monterey, CA 93943

(831) 656-3003, DSN 756-3003
fpdrake@nps.edu

Admissions

Questions about admission to the Naval Postgraduate School should be addressed to:

Susan Dooley
Director of Admissions
Naval Postgraduate School
1 University Circle, Herrmann Hall, Room 022
Monterey, CA 93943

(831) 656-3093, DSN 756-3093
grad-ed@nps.edu

International Students

International students may also wish to contact the International Graduate Programs Office:

Gary Roser, Col, USMC (Ret.)
Assistant Dean of the School of International Graduate Studies
Naval Postgraduate School
1 University Circle, Herrmann Hall, Room 047D
Monterey, CA 93943

(831) 656-2186, DSN 756-2186, FAX (831) 656-3064
Website: www.nps.edu/Adminsrv/IGPO/index.html

Center for Civil-Military Relations (CCMR)

Website
www.ccmr.org

Director
Richard J. Hoffman
Code CCMR, Glasgow Hall, Room 341B

(831) 656-3171, DSN 756-3171, FAX (831) 656-3351

ccmr@nps.edu

Overview

Established at NPS in 1994, the Center for Civil-Military Relations (CCMR) provides graduate level education to foreign civilian and military participants through resident and nonresident courses. Its programs assist foreign nations in resolving civil-military issues resulting from defense transformation, stability and support operations, combating terrorism, and other security challenges.

Our Approach

CCMR has a long record of meeting the unique civil-military requests and requirements of the security cooperation community and partner countries. The CCMR employs seminars, workshops and courses, encouraging active and applied learning to:
·   Provide high quality, graduate-level educational experience, custom-designed and built to meet the specific objectives and conditions of a recipient country.
·   Teach multiple, international best-practice approaches to achieving the educational objectives of each program.
·   Use world-class civil-military faculty teams with international expertise that bring both academic and practical backgrounds to each program.

Our Programs

Civil-Military Relations

The Civil-Military Relations (CMR) program is tailored to the needs of the recipient country and addresses general or in-depth aspects of civil-military relations, including challenges of democratic consolidation, formulating national defense strategy, civilian control of the military, military professionalism, media-military relations, building linkages between the military and the legislature, intelligence and democracy, and defense transformation.

Peace Operations

The Global Peace Operations Initiative (GPOI) program builds peace support operations (PSO) capability and capacity through education and training worldwide. CCMR Supports the USG GPOI effort across a spectrum of capabilities, ranging from traditional institutional capacity-building to development of education and training programs centered on senior leadership (both civil and military), instructor cadres, and functional area specialists. Central to this base of expertise is the Center's robust history of providing global programs of education and training to friends and allies in every region of the world.

The Leader Development and Education for Sustained Peace (LDESP) program prepares U.S. military leaders and units deploying to Stability Operations, to accomplish

the mission in cooperation with multinational partners, other U.S. Agencies and civil authorities. LDESP provides an educational foundation enabling leadership and units to establish a frame of reference for understanding the complex, ambiguous, and rapidly changing stability operations environment.

International Defense Acquisition

The International Defense Acquisition Resource Management (IDARM) program offers a wide range of defense acquisition resource management courses that address acquisition, project management, logistics, procurement and contracting.

Combating Terrorism

In support of The "Counter Terrorism Fellowship Program" (CTFP), CCMR developed a series of custom-built courses for bilateral, regional, and global audiences. The program provides a comprehensive approach to countering ideological support to terrorism and international homeland defense.

Stabilization and Reconstruction

The Center for Stabilization and Reconstruction Studies (CSRS) is a teaching institute created in September 2004 to educate the full-spectrum of stabilization and reconstruction (S&R) actors, including U.S. and foreign military officers, civilian government officials, and representatives from non-governmental organizations, and international organizations.

Long Term Education Projects

CCMR's unique capacity-building programs provide recipient counties with Department of Defense expertise in the area of defense management. These programs respond to, and facilitate the spread of, democratic defense management norms throughout the world in order to improve legitimacy, effectiveness and efficiency of defense and security institutions.

Program Administration

All courses will be administered in accordance with the applicable laws, policies, and regulations of the U.S. funding provided for course execution. International participation is arranged through the Office of the Secretary of Defense and individual service security cooperation agencies. Overall quota control and programming is exercised by the Naval Education and Training Assistance Field Activity (NETSAFA).

Programs are designed for mid- to senior-grade military officers, civilian officials, legislators, and personnel from non-governmental organizations, both in residence and overseas. All programs provide participants with insights and analytical tools for enhancing civil-military cooperation at all levels.

Course Titles

Mobile Education Teams (MET) Programs

MASL	Description
P179021	MET Civil-Military Cooperation (CIMIC) and Combating Terrorism
P273001	MET Regional Civil-Military Relations
P273011	MET Civil-Military Responses to Terrorism (Regional)
P273013	MET Regional GPOI Peace Support Operations (PSO)
P309041	MET Civil-Military Responses to Terrorism: Consequence Management
P309042	MET Civil-Military Responses to Terrorism: Countering Ideological Support of Terrorism (CIST)
P309043	MET Civil-Military Responses to Terrorism: Intelligence and Combating Terrorism
P309044	MET Civil-Military Responses to Terrorism: Maritime Security
P309045	MET International Defense Transformation
P309064	MET Preparing for Peacekeeping Deployments: Negotiating Effective Support Agreements with International Org
P309065	MET Preparing for Peacekeeping Deployments: Reviewing Inter-Ministerial Peace Keeping Roles & Missions
P309066	MET Preparing for Peacekeeping Deployments: Reviewing MOD and Defense HQ's PK
P309067	MET Preparing for Peacekeeping Deployments: Adopting Task Lists and Standing Operating Procedures
P309068	MET GPOI UN CMCOORD
P309069	MET Civil-Military Responses to Terrorism
P309070	MET Civil-Military Relations
P309073	Civil-Military Relations Pre-Survey
P309077	Enhanced International Peace Keeping Capabilities (EIPC) Peace Support Operations Phase I Pre-Survey
P309078	MET EIPC Peace Support Operations
P309079	MET Enhancing Border Security through National Means and International Cooperation
P309102	MET GPOI Program Design & Development Visit (PDDV)
P309103	MET GPOI Peace Support Operations (PSO)
P309104	MET IDARM Project Management (Managing Complex Defense Projects)
P309116	MET LATAM Strategic Leadership
P309117	MET LATAM National Security Strategy Development Practicum
P309121	MET Enhancing Civil Military Relations (CMR) through Security Sector Reform (SSR)
P309130	IDARM Site Survey
P309131	MET IDARM Principles of Defense Acquisition Management
P309136	MET IDARM Contracting for Pre-Deployment & Deployment Operations

SCHOOL OF INTERNATIONAL GRADUATE STUDIES (SIGS)

P309137	MET Africa Civil-Military Relations for Junior Military Leaders
P309138	MET Africa Disarmament, Demobilization & Reintegration (DDR)
P309139	MET Africa Security Forces and the Electoral Process
P309140	MET Implementing Strategic Planning: Developing Effective Personnel Management Policy
P309148	MET The Media and the Military
P309149	MET Intelligence and Democracy
P309150	MET Building Linkages between the Legislature and the Military
P309151	MET Domestic Support Operations (Military Support to Civilian Authorities)
P309152	MET Civilian Control of the Armed Forces in a Democracy: Methods, Techniques and Applications
P309153	MET Civil-Military Cooperation (CIMIC): Support of Multinational and Interagency Relief and Reconstruction Operations
P309154	MET Civil Affairs (CA)/ Civil-Military Cooperation (CIMIC) Support of Information Operations (IO)
P309156	MET Establishing Democratic Civil-Military Relations and the Rule of Law
P309157	MET Global Peace Ops Init (GPOI)
P309158	MET International Homeland Defense
P309194	MET Africa Local Focus Program on Civil-Military Relations
P309105	MET Africa National Security Planning
P309210	MET IDARM Africa: Strategies for Building and Sustaining Accountability in Defense Resource Management Systems
P309211	MET GPOI Senior Mission Leaders Course (SML)

In Residence Programs

MASL	Description
P159200	Principles of Defense Acquisition Management (IDARM)
P159202	Principles of Defense Procurement and Contracting (IDARM)
P170001	Executive Program in Defense Decision Making
P171400	Civil-Military Relations CONUS Planning
P171404	Intelligence and Democracy
P171406	International Defense Transformation
P179018	Civil-Military Response to Terrorism (Global)
P179022	Maritime Terrorism
P179023	GPOI UN CMCOORD
P179045	Global Peace Operations Initiative (GPOI) United Nations Staff Officers Course
P179046	Global Peace Operations Initiative (GPOI) United Nations Military Observer Training
P179047	Global Peace Operations Initiative (GPOI) United Nations Logistics Officers Course
P179048	Global Peace Operations Initiative (GPOI)

	United Nations Peace Support Operations Instructors' Course
P179069	International Defense Acquisition Negotiations (IDARM)
P179085	GPOI Peace Support Operations Commanders Course (PSOCC)
P181006	Distinguished Visitor Orientation Tour (DVOT)

Center for Stabilization and Reconstruction Studies (CSRS)

Website

www.csrs-nps.org

Program Director

Matthew Vaccaro
Code CCMR, West Wing, Herrmann Hall, Room 413W

(831) 402-0987, FAX (831) 656-1810
mvaccaro@nps.edu

Overview

The Center for Stabilization and Reconstruction Studies (CSRS) is dedicated to building more effective responses to failed or failing states. The Center conducts short-course learning events for practitioners in the broad functional area of stability and reconstruction (S&R). The challenge of stabilization and reconstruction is a central feature of contemporary international relations - and is likely to remain so for some time. These activities are inherently difficult, conducted by multiple actors, and are extremely dynamic. The best learning in stabilization and reconstruction occurs when the curriculum is multi-disciplinary and interactive among a diverse participant mix. The programs of CSRS incorporate practitioners from the complete range of actors that are involved in these activities, including:

· U.S. and foreign military officers;
· U.S. and foreign government civilian officials;
· Civilians from non-governmental organizations; and,
· Representatives of inter-governmental organizations and non-governmental organizations.

Our Programs

Short Courses

CSRS courses are designed based on the educational needs of practitioners. Courses are typically three to five days in length and can be conducted in Monterey or elsewhere. CSRS uses a variety of teaching methods to help practitioners learn, including role-playing scenarios, practical exercises, and facilitated problem-solving. Current topics of instruction fall into five themes: conflict prevention; humanitarian relief; economic recovery and

development; institution building and security sector reform; and cross-community understanding.

Course Schedule

Please consult our website (www.csrs-nps.org) for the most current listing of CSRS courses and application procedures.

Program Administration

CSRS seeks partners and sponsors for specific activities and events. Please let us know if you have an educational requirement related to S&R, or are interested in partnering in some fashion.

International Defense Acquisition Resource Management (IDARM)

Website
www.nps.edu/IDARM/

Program Manager

Dr. Elisabeth Wright
Code CCMR-IDARM, Glasgow Hall, Room 343

(831) 656-2469 or (831) 656-2415, FAX (831) 656-7680
ewright@nps.edu

Overview

Established in 1997, the International Defense Acquisition Resource Management Program (IDARM) is intended to strengthen democratic relationships and international security cooperation through acquisition education, research and professional service.

Education: To develop problem solving and decision-making skills through analysis and critical review.

Research: To conduct studies that support policy making and improve acquisition processes.

Professional Service: To provide leadership and professional expertise in support of international partners.

Our Approach

The primary focus of the program is to strengthen the managerial competencies of the military and civilian leaders responsible for a nation's defense acquisition processes. For many countries, particularly in emerging democracies, acquisition processes are evolving, and the question of developing a structured approach to defense acquisition resource management has not been fully addressed. In other nations, improving the existing defense acquisition process is important to achieving international security goals.

Additionally, the understanding of other nations' resource management processes can lead to increased opportunity for cooperative development programs and the associated reduction in risk and costs. The benefits can also be extended to the relationship of defense acquisition management to multi-national defense agreements, such as NATO.

IDARM Course Offerings

In Residence Courses

Twice yearly, we offer a two-week resident course, Principles of Defense Acquisition Management (MASL P159200). The target audience is international military offers and civilian officials working in any of the professional fields supporting defense acquisition programs. We also offer Principles of Defense Procurement and Contracting (MASL P159202). It will immediately follow the Principles of Acquisition Management Course. The target audience is international military officers and civilian officials working in the policy or operational aspects of tendering and contracting. We offer our third resident course every fall, International Defense Acquisition Negotiations (MASL P179069). This course is designed for U.S. and international military officers and civilian equivalents who directly or indirectly contribute to the development of negotiation positions, conduct analysis of information, or participate in negotiations. Please visit our website for additional course descriptions and scheduled course dates.

Mobile Education Teams (MET)

The IDARM program at NPS offers a wide range of defense acquisition resource management courses to our worldwide customers under the Expanded-IMET program. These courses are delivered via METs with two or more faculty members, depending on the subject matter covered and length of the course, augmented by expert practitioners in the field. The courses are arranged in three general career fields: Defense Acquisition and Program Management, Defense Contract/Procurement Management, and Defense Logistics Management. As is the case with all IDARM programs, the goal is to meet the host country's requirements to the fullest extent possible.

The courses combine both classroom lectures and group exercises supplemented by case studies designed to highlight specific learning objectives involving defense acquisition management decision making. Our education programs are developed by NPS faculty and are tailored to the specific government organizational structures, national acquisition statutes and regulations, and defense acquisition objectives in place in each country we visit.

Each course in the IDARM series is developed using a phased approach, in partnership with the host country's military and civilian leadership and managers, consisting of:

· Phase I - Needs Assessment (in-country) (MASL P309130)

Course development begins with a survey of a nation's needs in a specific resource management area. This phase involves IDARM program team members visiting the host country to meet with those executives and managers responsible for determining defense requirements and qualifications for acquisition program managers and decision makers.

· Phase II - Curriculum Development (in Monterey, CA) (MASL P309132)

The program design phase of the program is conducted at the Naval Postgraduate School (NPS), Monterey, CA. During Phase II, an overview of the proposed curriculum will be presented for the participating country's approval.

· Phase III - Course Delivery (in-country) (MASL P309131)

The graduate education program course is delivered during Phase III. Course duration varies depending on the country's preferences and decisions made during Phase II. The course delivery will improve the host country's ability to utilize their resources with maximum effectiveness, thereby contributing to great stability and self-reliance in the international security environment.

Some of the recommended topics include but are not limited to: Principles of Defense Systems Acquisition Management, Software Acquisition Management, Test and Evaluation Management, Capabilities-Based Requirements, Logistics, Systems Engineering, Supply Chain Management, etc.

Additionally IDARM offers the following METs:

· Project Management (Managing Complex Defense Projects) (MASL P309104)

This eight day course provides project managers and project team members with the tools and techniques necessary to successfully manage complex projects. Emphasis is placed on cost control, schedule management and project scope of work.

· Contracting for Pre-Deployment and Deployment Operations (MASL P309136)

This one week course examines the fundamental concepts and challenges associated with contingency contracting. It is designed to provide course participants with an

understanding of the complexities associated with planning and negotiating contracts in "conflict areas".

· Africa: Strategies for Building and Sustaining Accountability in Defense Resource Management Systems (MASL P309210)

Transparency is a central characteristic of all public resource management and decision making systems. This five day course examines the characteristics of procurement and other decision making systems that are defined by integrity, accountability and transparency.

Program Development

IDARM develops and conducts defense acquisition courses designed to educate both military officers and senior civilian officials in the management principles necessary to support development of a needs-driven acquisition system. Please let us know if you have an education requirement, as we look forward to the opportunity to present an IDARM course in your country and/or welcoming your students to our resident courses. Please visit our website and/or contact the IDARM staff for more information.

SYSTEMS ENGINEERING ANALYSIS CURRICULUM AND PROGRAM

Chair

James Eagle, CAPT, USN (Ret.) (SEA Chair)
Naval Postgraduate School
Code OR, Glasgow Hall, Room 277
1411 Cunningham Road
Monterey, CA 93943-5219

(831) 656-2654, DSN 756-2654, FAX (831) 656-2595
jeagle@nps.edu

Members

Academic Associate

Mark Stevens
Code SE/ST, Bullard Hall, Room 201I

(831) 656-7545, DSN 756-7545
FAX (831) 656-3129
mstevens@nps.edu

Program Officer

Keith Littrell, LCDR, USN
Code OR, Glasgow Hall, Room 283

(831) 656-2358, DSN 756-2358
FAX (831) 656-2595
wklittre@nps.edu

Chair, Department of Systems Engineering

Cliff Whitcomb, Ph.D.
Code SE/Ol, Bullard Hall, Room 201K

(831) 656-3583, DSN 756-3583
FAX (831) 656-3129
cawhitco@nps.edu

Chair, Department of Operations Research

Robert Dell, Ph.D.
Code OR, Glasgow Hall, Room 239A

(831) 656-2654, DSN 756-2654
FAX (831) 656-2595

Overview

The Systems Engineering Analysis (SEA) curriculum and program at NPS provides a unique education bridging the knowledge bases of both Systems Engineering and Operations Analysis. The Chair Professor of SEA, supported by the Academic Associate and Program Officer, manages execution of the program. The Deans of GSEAS and GSOIS jointly exercise overall executive responsibility, with the chairs of the Systems Engineering and Operations Research Departments being jointly responsible for ensuring the quality of the program. The Chair Professor of SEA acts as a liaison point-of-contact for the collaborative efforts between the curriculum sponsor, OPNAV N9I and the SEA curriculum and program at NPS, and collaborates with the two department chairs in professional development, supports team-oriented research and analysis that links technical solutions to tactical problems, enhances understanding of the Navy's Requirements-Setting, Planning, Programming, Budgeting and Execution (PPBE) and acquisition processes, and the manner in which they impact warfighting acquisition programs.

The responsibilities of the faculty team are:
1. To maintain the military relevance and academic excellence of the SEA program;
2. To foster close relationships with the appropriate officers in OPNAV and the Fleet and with a curriculum sponsor, emphasizing the curriculum goal of improving the technical-tactical-operational prowess of the unrestricted line;
3. To draw on the best qualified and most knowledgeable faculty to serve as instructors and curriculum/course advisors;
4. To work through the Academic Associate, to ensure the interdisciplinary nature of the program is maintained, and that the best possible use is made of existing courses and faculty;
5. Working with the Director of MISE, to enhance the availability of suitable student capstone projects, the professionalism of faculty advisors, and the quality of written project reports;
6. To foster the selection and matriculation of well-qualified students who have intellectual and professional promise of being future leaders of the Navy; and,
7. To advise the Chair Professor in the management of SEA courses, administration of SEA students, and supervising the SEA Capstone project.

Degrees Awarded

The Systems Engineering and Operations Research departments jointly award the Master of Science in Systems Engineering Analysis (MS SEA) degree. The SEA curriculum is designed for unrestricted line officers who aspire to command and seek a graduate degree tailored to enhance their value as combat officers. The hallmark of the curriculum is a strong scientific and technical content that offers a balanced blend and breadth

in systems thinking and analysis of current and future military operations.

Candidates normally are expected to have studied mathematics and science in their undergraduate work. Undergraduate engineering study is advantageous, but not required.

The Master of Science degree in Systems Engineering Analysis requires a minimum of 48 quarter-hours of graduate-level work. The candidate must take all courses in an approved study program, which must also satisfy the following requirements: A minimum of 36 quarter-hours of credit in 3000 and 4000 level courses, including a minimum of 12 quarter-hours at the 4000 level.

Participation in a capstone project with a minimum of 12 credits is required for the degree. An acceptable thesis, for a minimum of 12 credits, may be substituted in lieu of a team project. The Academic Associate and the Program Officer must endorse such a request, which will be subject to final approval by the Chair Professor.

A student seeking the Master of Science in Systems Engineering Analysis must also demonstrate knowledge in systems design and integration, systems analysis and application, combat technology, and familiarity with professional military education in strategy and policy. This may be accomplished by completing all courses in an approved study program.

Systems Engineering Analysis Program – Curriculum 308

Program Officer

Keith Littrell, LCDR, USN
Code OR, Glasgow Hall, Room 283

(831) 656-2358, DSN 756-2358
FAX (831) 656-2595
wklittre@nps.edu

Academic Associate

Mark Stevens
Code SE/ST, Bullard Hall, Room 201I

(831) 656-7545, DSN 756-7545
FAX (831) 656-3129
mstevens@nps.edu

This interdisciplinary curriculum provides a foundation in systems thinking, technology, and operations analysis for warfighters. Graduates will be able to understand how to develop and fight new systems of combat systems, and have a more thorough understanding of current combat systems.

Students normally complete group projects in lieu of theses. These "capstone" projects are chosen to allow students to gain a thorough understanding of a critical warfare area and to provide the Navy and other services insights about future systems options to meet emerging needs.

The program is designed as a highly integrated graduate education. Lectures, team projects, and individual research are provided, as well as seminars from visiting experts. The length of this program is eight quarters.

Requirements for Entry

For entry, the officer must have at least a C+ undergraduate grade point average, with at least one calculus course with a C or better and at least one calculus-based physics course with a C or better (APC 334). If an officer is an outstanding performer, but lacks the necessary academic preparation, NPS offers refresher and transition courses before the program starts.

Systems Engineering Analysis Subspecialty

Completion of this curriculum qualifies a naval officer as a Systems Engineering Subspecialist, subspecialty code 6500P.

Entry Dates

The Systems Engineering Analysis curriculum is an eight-quarter curriculum with entry dates in January and July. If it is necessary, due to APC requirements, a 12-week refresher will begin prior to this entry date. If further information is needed, contact the Program Officer or Academic Associate for this curriculum.

Degrees

Master of Science in Systems Engineering Analysis

This degree is proposed for all students completing the 308 curriculum. The System Engineering and Operations Research departments are the approving authority for the degree.

Master of Science in Systems Engineering

To be considered for this degree, a student must meet the degree requirements (including an ABET EAC accredited engineering BS degree or documented equivalent) and complete all the requirements of curriculum 308. The chair of the Department of Systems Engineering is the approving authority for the degree.

Master of Science in Systems Analysis

Selected students may elect to earn a degree in Systems Analysis from the Department of Operations Research. This involves a thesis in lieu of project and an extended analysis sequence. The chair of the Department of Operations Research is the approving authority for the degree.

Typical Course of Study

The first quarter of the SEA curriculum reflects a review of mathematics and physics, from a systems perspective. Subsequent quarters present a balance of courses in systems engineering, operations analysis, technology, joint professional military education, and project work. The students gain additional knowledge and insight through seminars and project related travel.

Quarter 1 (Accelerated)
SE1001 (4-2) Math I for SEA
SE1002 (3-1) Math II for SEA
SE2003 (4-2) Introduction to Mechanical Systems
SE2101 (4-2) Introduction to Electro- Mechanical Systems

Quarter 2
SE3000 (1-0) Systems Engineering Colloquium
SE3100 (3-2) Fundamentals of Systems Engineering
SE3112 (3-2) Combat Systems Engineering I (Sensors)
OS3180 (4-1) Probability and Statistics for Systems Engineers
MN3301 (4-0) Acquisition of Defense Systems

Quarter 3
SI3400 (3-2) Engineering Project Management
OS3211 (4-0) Systems Optimization
SE3000 (1-0) Systems Engineering Colloquium
OS3680 (4-0) Naval Tactical Analysis
NW3230 (4-2) Strategy & Policy

Quarter 4
SE3113 (3-2) Combat Systems Engineering II (Weapons)
SE3302 (3-2) Systems Suitability
SE3000 (1-0) Systems Engineering Colloquium
OS4680 (4-0) Naval Systems Analysis
OS3380 (3-1) Combat Systems Simulation

Quarter 5
SE3303 (3-2) Systems Assessment
SE4112 (3-2) Combat Systems Engineering III
OA4602 (4-0) Joint Campaign Analysis
OA4603 (4-0) Systems Test and Evaluation
SE3000 (1-0) Systems Engineering Colloquium

Quarter 6
NW3275 (4-0) Joint Maritime Operations I (U.S. Navy URL only)
SE4115 (3-2) Combat Systems Integration
Elective
SE3201 (2-4) Engineering Systems Conceptualization
SE3000 (1-0) Systems Engineering Colloquium

Quarter 7
Elective

OA4702 (4-0) Cost Estimation
SE3202 (2-4) Engineering Systems Design
NW3276 (2-2) Joint Maritime Operations II (U.S. Navy URL only)
SE3000 (1-0) Systems Engineering Colloquium

Quarter 8
Elective
SE3203 (2-4) Engineering Systems Implementation & Operation
SI0810 or (0-8) Integrating Project
Elective
NW3285 (4-0) National Security Decision Making

Educational Skill Requirements
Systems Engineering Analysis Curriculum

Broad Objective

This curriculum teaches U.S. Navy Unrestricted Line Officers how the Navy builds and operates large combat systems of systems. The primary objective is to prepare officers to serve afloat and in key operational staff billets by giving them the technological and analytical understanding to fight the fleet today and in the future. The emphasis is on integration of complex warfare systems with compatible tactics. In addition, graduates with experience afloat will be prepared to serve ashore as program managers and in technical/analytical billets on headquarters staffs.

1. **Basics.** Introduction to the mathematics, physics, and computer skills needed to understand the technical aspects of combat, information, and decision systems.

2. **Systems Engineering.** Understand the systems engineering process and how to perform systems engineering studies, to include a knowledge of system design, development, and deployment; technical and cost trade-offs; human-in-the-loop issues and project management. Be able to integrate relevant technological disciplines that bear on weapons, sensor and information systems. Understand responsiveness to realistic military requirements, specifications and cost limitations. Study the linkage between strategic planning, requirements, project organization, and technology.

3. **Operations Analysis.** Learn how to apply advanced management and operations research ideas to defense problems, to include cost-benefit and cost-effectiveness analysis. Understand uncertainty and risk and their impact on military planning, decision making and operations. Become familiar with complexity and the modeling of competitive systems. Gain a basic knowledge of modeling, simulation and gaming. Learn how Operations Research techniques, including experimental design, are applied to operational test and evaluation; planning and analyzing fleet battle experiments; and to military decision making.

4. **Sensor and Weapon Systems.** Gain a solid understanding of the scientific, mathematical and engineering principles behind existing and future military systems. Understand the elements that impact sensor system performance. Understand the principles behind existing and emerging sensor technologies, including radar, sonar, electro-optical sensors, and other sensors. Understand the technologies underlying weapons systems, and the principles that guide successful integration of weapons and sensors with platforms.

5. **Information Systems Technology.** Develop knowledge of information systems technology including computer systems; computer networks and communications systems; software engineering; and data base management. Demonstrate awareness of the capabilities, limitations, design and operation, and vulnerabilities of information systems. Understand the concepts of defensive and offensive Information Warfare.

6. **Independent Study.** Each student must demonstrate the ability to conduct independent and team oriented research and analysis on problems that link technical solutions to tactical problems, and to present the results in writing and oral briefings. A substantive project report or thesis will be required of all students.

7. **Department of Defense Resource Allocation.** Develop a working knowledge of resource allocation within the Department of Defense including the PPBE, JCIDS, and Acquisition processes. It is imperative that students understand key issues regarding the scheduling of budget delivery to, and the related interface with Congress, as well as the critical milestones involved in development of the President's Budget. In addition, a working knowledge of the interfaces between PPBE, JCIDS, and Acquisition is necessary to gain an appreciation for the synergies and disconnects between these two processes - and in particular to understanding the manner in which they impact warfighting acquisition programs.

Joint Professional Military Education

Completion of Joint Professional Military Education (JPME) is required for all USN officers enrolled in the 308 curriculum. Graduates will develop an understanding of warfighting within the context of operational art, to include: national military capabilities and command structure, joint and service doctrine, joint planning and execution, and joint and multinational forces and systems integration at the operational level of war.

Systems Engineering Analysis - Mixed Mode - Curriculum 309

Program Officer

Keith Littrell, LCDR, USN
Code OR, Glasgow Hall, Room 283

(831) 656-2358, DSN 756-2358
wklittre@nps.edu

Academic Associate

Mark Stevens
Code SE/ST, Bullard Hall, Room 201I

(831) 656-7545, DSN 756-7545
FAX (831) 656-3129
mstevens@nps.edu

The Systems Engineering Analysis - Mixed Mode (SEA MM) curriculum and program at NPS provides a unique education consisting of 12 months of distributed education and 12 months of resident education, bridging the knowledge bases of both Systems Engineering and Operations Analysis. The Chair Professor of SEA, supported by the Academic Associate and Program Officer, manages execution of the program. The Deans of GSEAS and GSOIS jointly exercise overall executive responsibility, with the chairs of the Systems Engineering and Operations Research Departments being jointly responsible for ensuring the quality of the program. The Chair Professor of SEA acts as a liaison point-of-contact for the collaborative efforts between the curriculum sponsor, OPNAV N9I, and the SEA curriculum and program at NPS, and collaborates with the two department chairs in professional development; supports team-oriented research and analysis that links technical solutions to tactical problems; and enhances understanding of the Navy's Requirements-Setting, Planning, Programming, Budgeting, and Execution (PPBE) and acquisition processes, and the manner in which they impact warfighting acquisition programs.

The SEA MM curriculum is designed for highly qualified unrestricted line officers who aspire to command and seek a graduate degree tailored to enhance their value as combat officers. The hallmark of the curriculum is a strong scientific and technical content that offers a balanced blend and breadth in systems thinking and analysis of current and future military operations.

Candidates normally are expected to have studied mathematics and science in their undergraduate work. Undergraduate engineering study is advantageous, but not required. The Master of Science degree in Systems Engineering Analysis requires a minimum of 48 quarter-hours of graduate-level work. The candidate must take all courses in an approved study program, which must also satisfy the following requirements: A minimum of 36

quarter-hours of credit in 3000- and 4000-level courses, including a minimum of 12 quarter-hours at the 4000 level.

Participation in a capstone project with a minimum of 12 credits is required for the degree. An acceptable thesis for a minimum of 12 credits, may be substituted in lieu of a team project. The Academic Associate and the Program Officer must endorse such a request, which will be subject to final approval by the Chair Professor.

A student seeking the Master of Science in Systems Engineering Analysis must also demonstrate knowledge in systems design and integration, systems analysis and application, combat technology, and familiarity with professional military education in strategy and policy. This may be accomplished by completing all courses in an approved study program.

Requirements for Entry

For entry, the officer must have at least a C+ undergraduate grade point average, with a calculus sequence taken within the last 5 years with at least a C+ average, and a BS in a technical degree (APC 322).

Systems Engineering Analysis Subspecialty

Completion of this curriculum qualifies a naval officer as a Systems Engineering Subspecialist, subspecialty code 6500P.

Entry Dates

Curriculum convenes in July. If further information is needed, contact the Program Officer or Academic Associate for this curriculum.

Required Courses

*Distributed Learning Courses

Course	Hours	Title
*OS2080	(3-0)	Fundamentals of Naval Analysis
*OS3380	(3-1)	System Simulation
*OS3680	(4-0)	Naval Tactical Analysis
*OS4680	(4-0)	Naval Systems Analysis
*SE3100	(3-2)	Fundamentals of Systems Engineering
*SI3400	(3-2)	Engineering Project Management
*SE3302	(3-2)	Systems Suitability
*SE3303	(3-2)	Systems Assessment
SE2003	(4-2)	Fundamentals of Mechanical Systems
SE2101	(4-2)	Fundamentals of Electromagnetic Systems
SE3112	(3-2)	Combat Systems Engineering I
SE3113	(3-2)	Combat Systems Engineering II
SE4112	(3-2)	Combat Systems Engineering III
TS4000	(3-2)	Combat Systems Integration
OA4602	(4-0)	Joint Campaign Analysis
OA4603	(4-0)	Systems Test and Evaluation
OA4702	(4-0)	Cost Estimation
OS3211	(4-0)	Systems Optimization
MN3301	(4-0)	Acquisition of Defense Systems
NW3285	(4-0)	National Security Decision Making
NW3275	(4-0)	Joint Military Operations I
NW3276	(4-0)	Joint Military Operations II
NW3230	(4-2)	Strategy and Policy
SI4000	(0-2)	Seminar
SE3201/ SE3202/ SE3203	(2-4) each	Engineering Systems Conceptualization/Design/ Implementation
SI0810	(0-8)	Integrating Project

ENERGY ACADEMIC GROUP

Certificate in Defense Energy - Curriculum 234

Chair

Daniel Nussbaum, Ph.D.
Code OR/Glasgow, Room 242
(831) 656-2387, DSN 756-2387
danussba@nps.edu

Program Officer

Walter C. DeGrange, CDR, USN
Code OR, Glasgow Hall, Room 254
(831) 656-3026, DSN 756-3026
FAX (831) 656-2595
wcdegran@nps.edu

Academic Associate

Kevin J. Maher
Code OR/Mk, Glasgow Hall, Room 227
(831) 656-2691, DSN 756-2691
FAX (831) 656-2595
KJMaher@nps.edu

Brief Overview

The Academic Certificate Program in Energy is designed to support the SECNAV's Energy goals, in educating those who are resident at NPS but are not directly detailed into the Energy programs, or those who do not have the opportunity to attend NPS.

Normally, the certificate will consist of either: four graduate courses; or three graduate courses and two consecutive quarters of EN3000, Defense Energy Seminar. A minimum of 12 credit hours is required.

PH3700 is required, but other courses are elective. Students may select from the relevant courses available during the quarter(s) of enrollment. Each student's required course work is developed individually under the direction of the cognizant Academic Associate, to fall within one of three focus areas: Energy (Science & Technology); Energy (Policy & Analysis); or Energy (General) which combines S&T with P&A.

Requirements for Entry

APC requirements will vary with the courses selected. Satisfaction of any course prerequisites.

Entry Dates

Any Quarter

Program Length

12 months

Graduate Certificate Requirements

The academic certificate program must be completed within 3 years of admission to the program. A student must maintain a 3.0 GQPR in the certificate courses to be awarded a certificate.

Required Course

PH3700   4-0   Fundamentals of Energy

Elective Courses

SCIENCE & TECHNOLOGY (S&T)

EC3110	3-2	Electrical Energy for Defense: Present and Emerging Technology
EC3240	3-2	Renewable Energy at Military Bases and for the Warfighter
EN3000	2-0	NPS Defense Energy Speakers Seminar Series
MEXXXX	TBD	Combustion
ME4420	4-0	Advanced Power & Propulsion
MS4410	4-0	Advanced Energy Materials
MS481X	TBD	High Temperature Materials for Energy Production and Conversion
MS48XX	TBD	Electrochemical Energy Conversion and Storage

POLICY & ANALYSIS (P&A)

MN4970	TBD	Energy Economics
OS3007	4-0	Operations Research for Energy Systems Analysts
NS4053	4-0	Energy Policy & Strategy
OA4613	4-0	Energy Logistics in Warfare Operations
GBXXX	TBD	Fundamental Issues in Energy Technology Implementation
SE3700	TBD	Defense Energy Systems
EN3000	2-0	NPS Defense Energy Speakers Seminar Series

EN Courses

EN3000 Defense Energy Seminar (2-0)
Fall/Winter/Spring/Summer
To ensure that students receive the most current and credible information, the Naval Postgraduate School has invited talks from nationally and internationally known speakers. These speakers' seminars will be an important contribution to the student's overall education in energy, and will help the student further develop the breadth required to understand and address the Nation's growing challenges in energy security.

NAVAL WAR COLLEGE PARTNERSHIP & JPME

Chairman

Fred P. Drake
Professor
Halligan Hall Room 239

831-656-3003
DSN 756-3003
fpdrake@nps.edu

Associate Chair

Harold D. Blanton
Professor
Halligan Hall Room 251

831-656-2302
DSN 756-2302
hdblanto@nps.edu

George W. Baer, Professor (1981); Ph.D. Harvard (1965); M.A., B.A. Oxford (1959) Rhodes Scholar; A.B. Stanford (1957).

Harold D. Blanton, Professor (1999); Ph.D., M.A., Florida State University (1999); B.S., Valdosta State University (1991).

J. Warwick Boulton, Associate Professor (2000); M.A. Lehigh University (1970); B.Sc., London School of Economics and Political Science (1969).

Jan S. Breemer, Professor (1999); Ph.D., M.A., University of Southern California (1987,1973); B.A., California State University, Long Beach (1968).

R. Mitchell Brown III, Professor (1999); CDR USN (ret); C&S Naval War College (2002); M.A., Naval Postgraduate School, (1980); MBA Wharton (University of Pennsylvania) (1976); B.S., U.S. Naval Academy (1968).

Jonathan E. Czarnecki, Professor (2001); COL USA, ARNG (ret); Ph.D., M.A., State University of New York at Buffalo (1979, 1976); B.S. Clarkson University (1970).

Fred P. Drake, Professor (1999); CDR USN (ret); M.A., U.S. Naval War College (1996); M.S., Troy State University (1988); B.S., University of Idaho (1979).

Richard B. Grahlman, Professor (1999); CDR USN (ret); M.S., Naval Postgraduate School, B.S., Oregon State University.

Kenneth J. Hagan, Professor (1999); CAPT USNR (ret); Ph.D., Claremont Graduate School (1970); M.A., A.B.,

University of California, Berkeley; Professor Emeritus, U.S. Naval Academy.

Randall J. Hess, Professor (2001); CAPT USN (ret); M.A., Naval War College (1992); M.A., Stanford University (1986); B.S., U.S. Naval Academy.

Michael W. Jones, Professor (2000); LT USNR; Ph.D., Florida State University (2004); M.S., B.A., University of New Orleans (1993).

Casey J. Lucias, Associate Professor (2009); Ph.D., University of Hawaii (2007); M.A., Naval Postgraduate School (2002); B.A., Ashland University (1997).

Michael T. McMaster, Professor (2001); CDR USN (ret); M.S., Naval Postgraduate School (1987); B.B.A., University of New Mexico (1979).

Thomas P. Moore, Professor (2001); COL USAR (ret); Ph.D., Virginia Tech (1986); M.S., Stanford University (1975); B.A., Northeastern University (1974).

Dayne E. Nix, Associate Professor (2009); Ph.D., Salve Regina University (2007); M.A., Naval War College (2004); Th.M., Duke University (1993); M.Div., Denver Seminary (1983); B.A., University of Colorado (1974).

Gary J. Ohls, Professor (2009); Col USMC (ret); Ph.D., Texas Christian University (2008, 2004); M.A., Naval War College (1994); M.B.A., California State University, Long Beach (1977).

David F. Overton, Associate Professor (2007); LtCol USMC (ret); M.S., Naval Postgraduate School (2003); B.S., East Carolina University (1994).

Joyce Sampson, Professor (2001); Ph.D., M.A., Florida State University (2001).

Donald J. Stoker, Professor (1999); Ph.D., Florida State University (1997); M.A., B.A., Valdosta State University.

Karl Walling, Professor (2000); Ph.D., M.A., (1992); B.A., St. John's College (1984).

Professional Military Education (PME) and Joint Professional Military Education (JPME)

The U.S. Naval War College curricula offered at NPS meets all of the requirements for Navy PME (as established by the Chief of Naval Operations) and for JPME (as established by the Chairman, Joint Chiefs of Staff) for Intermediate Level Professional Military

Education. The importance of offering a program that blends graduate-level study with Joint Professional Military Education was recognized by NPS in the early 1990s. Originally called the Joint Education Electives Program (JEEP) when it began in 1993, the program's name was changed to the Program for Joint Education (PJE) to make its name consistent with current military education terminology. In academic year 1999-2000, NPS partnered with the U.S. Naval War College (NWC), Newport, RI to provide NPS students with a tailored program leading to a Naval War College diploma and JPME phase I certification.

It should be recognized that the courses described below are Naval War College courses, which are taught by Naval War College faculty. As such, course content, teaching methodology and program management are the sole responsibility of the Naval War College. The entire sequence of courses including Strategy and Policy, National Security Decision Making and Joint Maritime Operations (parts 1&2), has been reviewed and approved through the Process for Accreditation of Joint Education (PAJE) process conducted by the Joint Chiefs of Staff at the Naval War College's College of Distance Education.

The three-course NWC program provides coverage of all mandatory "learning areas" outlined in CJCS's Officer Professional Military Education Policy (OPMEP), CJCSINST 1800.01 (series). The NWC program, both at NPS and on the College's main campus in Newport, RI, provides instruction in three course areas: *Strategy and War* (S&W), *Theatre Security Decision Making* (TSDM), and *Joint Maritime Operations* (JMO). Effective in September 1999, the S&P curriculum replaced the NPS course *Joint Maritime Strategy* NS-3252, which had been required for all department of the Navy (DoN) students since 1989. Completion of the NWC S&P course is now the mandatory course requirement fulfilling the Secretary of the Navy's maritime strategy requirement which must be met by all DoN students.
Note: Only those students who complete the entire sequence (S&W, TSDM and JMO) will earn JPME phase I certification.

Transcripts of those students who complete all NWC courses (S&W, TSDM and JMO) through any methodology – Fleet Seminar, correspondence, NWC Monterey courses – will be annotated to verify their JPME phase I certification.

All versions of NWC courses are academically rigorous and will require significant effort on the part of each student. The goal is to enable each student to earn both their NPS degree and the NWC diploma (with JPME phase I). It should be recognized, however, that students who cannot complete all of the NWC requirements while in Monterey can enroll in the remaining NWC courses, by Fleet Seminar or other DL course offerings, at their next duty station.

Naval War College Course Descriptions

NW3230 Strategy & War (4–2)

The S&W course is designed to prepare the military officer for the mid-level to advanced stages of a professional career in which he or she may be intimately involved in the interplay between military power and the political process – that is, between strategy, policy, and major operations. The course uses historical examples to demonstrate the military officer's urgent need for a joint and combined warfare perspective on the military profession. That perspective significantly enhances the ability of strategic thinkers and war-fighters to wield the military instrument in support of national goals. In the early stages of an officer's career he or she is trained in tactics. The S&W curriculum, in contrast, is designed to teach officers to think strategically. The course illustrates the relationship between a nation's political interests and goals and the ways military force may be used to achieve them. It focuses on a series of studies that begins with interests, continues through conflict and ends with the final post-war settlement. Academic disciplines of history, political science, military studies, and international relations are woven into a coherent analysis of how wars begin, how they are fought and how they end. The Strategy & War course hones the officer's ability to analyze past operations and apply historical lessons to future joint and combined operations. Three facets of the course develop strategic thought. First and foremost, the course focuses extensively on the strategic analyses that are the cornerstone of strategic thought, particularly the works of Clausewitz and Sun Tzu. Second, the master's work is used to analyze strategic decisions made during several historical conflicts. Collectively these case studies sharpen the student's understanding of the essence of strategy. Clear, objective and imaginative thinking is the framework for the final part of the course where students consider recent wars as well as conflicts that may occur in the future.

NW3275 Joint Maritime Operations (Part 1) (4–0)

The Joint Maritime Operations curriculum develops the ability to translate contemporary national and regional military strategies into naval, joint and multinational operations, with particular emphasis on the operational art and employment of the Sea Services. Thus, it enables officers to make sound operational decisions in both command and staff positions. JMO is an executive development course that emphasizes planning and decision making factors at the joint task force level for operations in the maritime environment. Planning and executing military/maritime operations requires military officers to make increasing use of many disciplines. This differs from the past where application of a single discrete discipline was more often the norm. Officers must have a firm grasp of military strategy, an understanding of joint and combined operations, and a thorough background in the essential elements of the military planning and decision making process to deploy, employ and sustain U.S. military forces efficiently and successfully. Consequently, the JMO course employs a multi-disciplinary approach, providing the student the opportunity to synthesize various ideas that include maritime strategy, joint and service doctrine, military decision-making, operational planning, naval warfare, military warfare, threat assessment, and war gaming techniques. JMO *applies* these ideas to military problems requiring decisions in dynamic situations. The integrating themes of the courses are joint maritime operations, the operational level of war, and military-decision making. Emphasis is placed on the ability to identify the military conditions required to achieve strategic goals, the required sequence of actions, resources and associated costs or risks in that process. NW-3275 is the first of a sequence of two

classes required to complete the JMO curriculum; it must be followed by NW-3276 to earn credit for the course.

NW3276 Joint Maritime Operations (Part 2) (4–0)

This class is the second in a sequence of two classes required to complete the JMO curriculum. PREREQUISITE: NW-3275. (See NW-3275 for info.)

NW3285 Theater Security Decision Making (4–0)

The Naval War College course in Theater Security Decision Making (TSDM) is designed to engage intermediate-level military officers and U.S. Government civilians in a study of the challenging complexities of the contemporary national security environment. While security policy developments since the 1947 National Security Act have emphasized increasingly centralized USG decision making in national security affairs, the evolving Unified Command Plans (UCP) have also enabled de-centralized implementation of those national security decisions. Although the course offers a broad security studies curriculum that encompasses the strategic and theater-strategic levels, particular emphasis is given to understanding decision making challenges and processes at the theater-strategic level of the combatant commands.

TSDM utilizes an active learning methodology through the application of course concepts in the analysis and discussion of complex real-world security issues. Selection of these concepts and materials is predicated on the belief that an individual in a command position or serving in a large, complex national security organization cannot simply rely on discrete disciplines, but rather needs to apply many disciplines relevant to different situations. For this reason, the TSDM course employs a multi-disciplinary approach, drawing on selected concepts from political science, international relations, strategy, leadership, psychology, management, economics, anthropology, and other cognate disciplines. All instruction seeks to utilize the broad academic and professional experience of our students and focuses on making and implementing critical decisions within the command and staff environment.

Marine Corps Professional Military Education at NPS

Marine Corps officers selected to attend NPS through the Marine Corps' Special Education Program (SEP) can participate in Marine Corps PME seminar programs for captains and majors. The Marine Corps' College of Continuing Education (CCE) designs, develops, and delivers both of the Marine Corps' officer distance education programs (DEP): the Expeditionary Warfare School (EWSDEP) and the Command & Staff College (CSCDEP). Interested officers can contact the CCE regional coordinator for NPS through the CCE website: https://www.marinenet.usmc.mil/cce.
USMC PME information is found at www.mcu.usmc.mil/pme/Officer/officerpme.htm

NPS JPME Requirement. All naval officers (Navy and Marine Corps) must take NW-3230 "Strategy and Policy: The American Experience" while attending the Naval Postgraduate School. This requirement is specified in SECNAVINST 1524.2A in 1989. Credit for NW-3230 validates the first unit of Marine Corps Command and

Staff, 8901 "The Theory and Nature of War." As NW-3230 is an NPS JPME requirement, validating NW3230 requires the full completion of the entire Command and Staff 8900 series.

Naval War College C&S option. Marine Corps officers attending NPS may enroll in the Naval War College Command and Staff program in lieu of the Marine Corps Command and Staff DEP. The Naval War College courses needed to complete the Navy C&S requirement while at NPS are: NW3230 (Strategy and Policy-one quarter), NW3275 and NW3276 (Joint Maritime Operations-two consecutive quarters), and NW3285 (National Security Decision Making-one quarter).

Air Force Intermediate Development Education (IDE) at NPS

Air Force officers selected for IDE programs at the NPS are managed by the Air Force Institute of Technology, Civilian Institution Programs (AFIT/CI) office at Wright-Patterson AFB OH. Selected officers complete a master's degree program at NPS in a field of study appropriate to their careers.

NONRESIDENT EDUCATION OPPORTUNITIES (DISTANCE LEARNING)

Nonresident Education Opportunities (Distance Learning)

While courses are available to students in Monterey at its main campus, NPS Distance Learning (DL) enables students to earn certificates or degrees at locations across the nation or around the globe.
· Mission-funded seats are available to eligible active duty naval officers (USN & USMC). Additional course fees may be required.
· All Military and DoD/government civilians are eligible to enroll in NPS Distance Learning programs.
· Select DoD Contractors are also eligible for enrollment in programs related to systems engineering and defense product development.
· Research associated with graduate studies may also include classified work.
· Although program length and costs vary, certificate programs are typically four courses (three to four credit hours each) while Master's degrees typically run 12 to 16 courses.

NPS DL Certificate Programs

Graduate School of Engineering and Applied Sciences

265 – Modeling and Simulation Management

273 – Space Systems

274 – Anti-Submarine Warfare

282 – Systems Engineering

284 – Guidance, Navigation and Control Systems

285 – Fault Tolerant Computing

286 – Reconfigurable Computing

287 – Digital Communications

288 – Cyber Warfare

290 – Signal Processing

291 – Electric Ship Power Systems

292 – EW (Electronic Warfare) Engineer

293 – Journeyman EW Engineer

294 – Senior EW Engineer

295 – Network Engineering

Graduate School of Operational and Information Sciences

262 – Human Systems Integration

270 – Information Systems Security Engineering

271 – Information Systems & Operations

272 – Information Systems Technology

275 – Software Engineering

277 – Knowledge Superiority

281 – Systems Analysis

Graduate School of Business and Public Policy

211 – Advanced Acquisition Program

212 – Acquisition Management DL Program

The Global Public Policy Academic Group

210 – Stability, Security and Development in Complex Operations

NPS DL Master's Programs

Graduate School of Operational and Information Sciences

363 – Systems Analysis

379 – Cost Estimating and Analysis

369 – MS in Software Engineering

376 – MS in Computer Science

357 – Computing Technology

377 – MA in Identity Management and Cyber Security

Graduate School of Engineering and Applied Sciences

311/721 – MS in Systems Engineering

311/721 – MS in Systems Eng. Management

721 – MS in Product Development

592 – MS in Electrical Engineering

592 – MS in Computer Engineering

592 – Master of Engineering (EW, IO, SIGINT, and Cyber focus areas)

570 – Master's of Engineering (ME or AE)

571 – Mechanical/Electrical Engineering for Graduates of Bettis Engineering Reactor School

572 – Mechanical Engineering for Nuclear Trained Officers

316 – MS in Space Systems Operations

535 – MS/Master's in Engineering Acoustics

Graduate School of Business and Public Policy

805/807 – Executive Master of Business Administration (EMBA)

807 – EMBA (Dual Degree with Virginia Tech)

835 – MS in Contract Management

836 – MS in Program Management

More DL programs, modes of delivery, and tuition information can be found at www.nps.edu/DL http://www.nps.edu/DL.

Center for Educational Design, Development, and Distribution (CED3)

CED3 website: www.nps.edu/Academics/DL/

Center for Educational Design, Development, and Distribution (CED3) aspires to become the nation's leading center for educational design, development, and distribution of graduate level educational products and is committed to ongoing excellence in its services.

CED3 uses its expertise in instructional design, media development/production, marketing/communications, student services and administrative services to support resident and non-resident instructional programs. Through collaboration with NPS schools, departments, and faculty, CED3 helps NPS use new and existing technologies to extend graduate level education to the total force.

Five operational teams support two functional areas-Course Development and Course Delivery. These five operational teams are:
·   **Instruction Design**- Supporting effective instruction.
    ·   Contact: ced3idd@nps.edu
·   **Media Development**- Enhancing the educational experience.
    ·   Contact: ced3idd@nps.edu
·   **Marketing and Communications**- Promoting programmatic awareness.
    ·   Contact: ced3MARCOM@nps.edu
·   **Student Support** and **Administrative Services**-Promoting student and stakeholder success.
    ·   Student Support Contact: ced3studcoord@nps.edu
    ·   Bursar and Administrative Services Contact: ced3bursar@nps.edu

Air Force Institute of Technology—Distance Learning

The Air Force Institute of Technology (AFIT), located at Wright-Patterson AFB, Ohio, is the Air Force's graduate school of engineering and management as well as its institution for technical professional continuing education. AFIT is developing distance learning programs for government students who cannot enroll in one of AFIT's resident programs. Detailed information about AFIT's nonresident programs can be found at www.afit.edu/en/dl/

The Naval Postgraduate School maintains a Strategic Alliance with the Air Force Institute of Technology. A memorandum of agreement between the Secretary of the Navy and the Secretary of the Air Force forms this alliance to ensure the two institutions continuously work together to meet the educational needs of the Armed Forces of the United States. NPS and AFIT will continue to reflect the heritage and character of their respective services, meeting Joint and service-unique needs, minimizing unnecessary redundancy, maintaining quality and realizing efficiencies and economies of scale.

NPS generally allows a maximum of 12 graduate-level, quarter-credits to be transferred for purposes of earning a graduate degree. However, an additional 12 quarter-credits may be transferred from the Air Force Institute of Technology (AFIT) in Dayton, Ohio. This is in addition to the normal transfer allowed (12), bringing the total to a maximum of 24 quarter-credits transferable from AFIT to NPS. Permission to transfer a specific course to serve as a substitute for a degree requirement will be determined by the Department Chairman or equivalent person responsible for nominating candidates for degrees at NPS and must be pre-approved in a coherent plan of study for the student. Regardless of transfer credits allowed, all NPS master's degrees still require at least 20 quarter-credits be earned directly from NPS.

ACADEMIC CALENDARS

Summer Quarter AY2013

Reporting Date (**International**)	Sunday	23 Jun 2013
Reporting Date	Monday	1 Jul
Independence Day (Holiday)	Thursday	4 Jul
Instruction Begins	Monday	8 Jul
Labor Day (Holiday)	Monday	2 Sep
Last day of classes	Tuesday	17 Sep
Pre-graduation Awards Ceremony	Tuesday	17 Sep
Final Examinations Begin	Thursday	19 Sep
Final Examinations End	Saturday	21 Sep
Academic Enrichment Week	Monday - Thursday	23 Sep - 26 Sep
Graduation	Friday	27 Sep

Fall Quarter AY2014

Reporting Date (**International**)	Sunday	15 Sept 2013
Reporting Date	Monday	23 Sept
Instruction Begins	Monday	30 Sept
Columbus Day (Holiday)	Monday	14 Oct
Shift Day: Treat as Mon Class Schedule	Tuesday	15 Oct
Veteran's Day (Holiday)	Monday	11 Nov
Thanksgiving Day (Holiday)	Thursday	28 Nov
Pre-graduation Awards Ceremony	Tuesday	10 Dec
Last day of classes	Friday	13 Dec
Final Examination Begin	Tuesday	17 Dec
Final Examinations End	Thursday	19 Dec
Graduation	Friday	20 Dec
Christmas Break	Starts on a Monday	23 Dec - 3 Jan 2014

Winter Quarter AY2014

Reporting Date (**International**)	Thursday	29 Dec 2013
Reporting Date	Monday	30 Dec 2013
New Years (Observed)	Wednesday	1 Jan 2014
Instruction Begins	Monday	6 Jan
Martin Luther King's Birthday (Holiday)	Monday	20 Jan
Shift Day: Treat as Mon Class Schedule	Tuesday	21 Jan
President's Day (Holiday)	Monday	17 Feb
Last day of classes	Tuesday	18 Mar
Pre-graduation Awards Ceremony	Tuesday	18 Mar
Final Examinations Begin	Thursday	20 Mar
Final Examinations End	Saturday	22 Mar
Academic Enrichment Week	Monday - Thursday	24 Mar - 27 Mar
Graduation	Friday	28 Mar

Spring Quarter AY2014

Reporting Date **(International)**	Sunday	16 Mar 2013
Reporting Date	Monday	24 Mar
Instruction Begins	Monday	31 Mar
Memorial Day (Holiday)	Monday	26 May
Pre-graduation Awards Ceremony	Tuesday	10 Jun
Last day of classes	Friday	13 Jun
Final Examinations Begin	Tuesday	17 Jun
Final Examinations End	Thursday	19 Jun
Graduation	Friday	20 Jun
Summer Break	Starts on a Monday	23 Jun - 4 Jul

Summer Quarter AY2014

Reporting Date (**International**)	Sunday	22 Jun 2013
Reporting Date	Monday	30 Jun
Independence Day (Holiday)	Friday	4 Jul
Instruction Begins	Monday	7 Jul
Labor Day (Holiday)	Monday	1 Sep
Last day of classes	Tuesday	16 Sep
Pre-graduation Awards Ceremony	Tuesday	16 Sep
Final Examinations Begin	Thursday	18 Sep
Final Examinations End	Saturday	20 Sep
Academic Enrichment Week	Monday - Thursday	22 Sep - 25 Sep
Graduation	Friday	26 Sep

Fall Quarter AY2015

Reporting Date (**International**)	Sunday	14 Sept 2013
Reporting Date	Monday	22 Sept
Instruction Begins	Monday	29 Sept
Columbus Day (Holiday)	Monday	13 Oct
Shift Day: Treat as Mon Class Schedule	Tuesday	14 Oct
Veteran's Day (Holiday)	Monday	11 Nov
Thanksgiving Day (Holiday)	Thursday	27 Nov
Pre-graduation Awards Ceremony	Tuesday	9 Dec
Last day of classes	Friday	12 Dec
Final Examination Begin	Tuesday	16 Dec
Final Examinations End	Thursday	18 Dec
Graduation	Friday	19 Dec
Christmas Break	Starts on a Monday	22 Dec - 2 Jan 2014

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