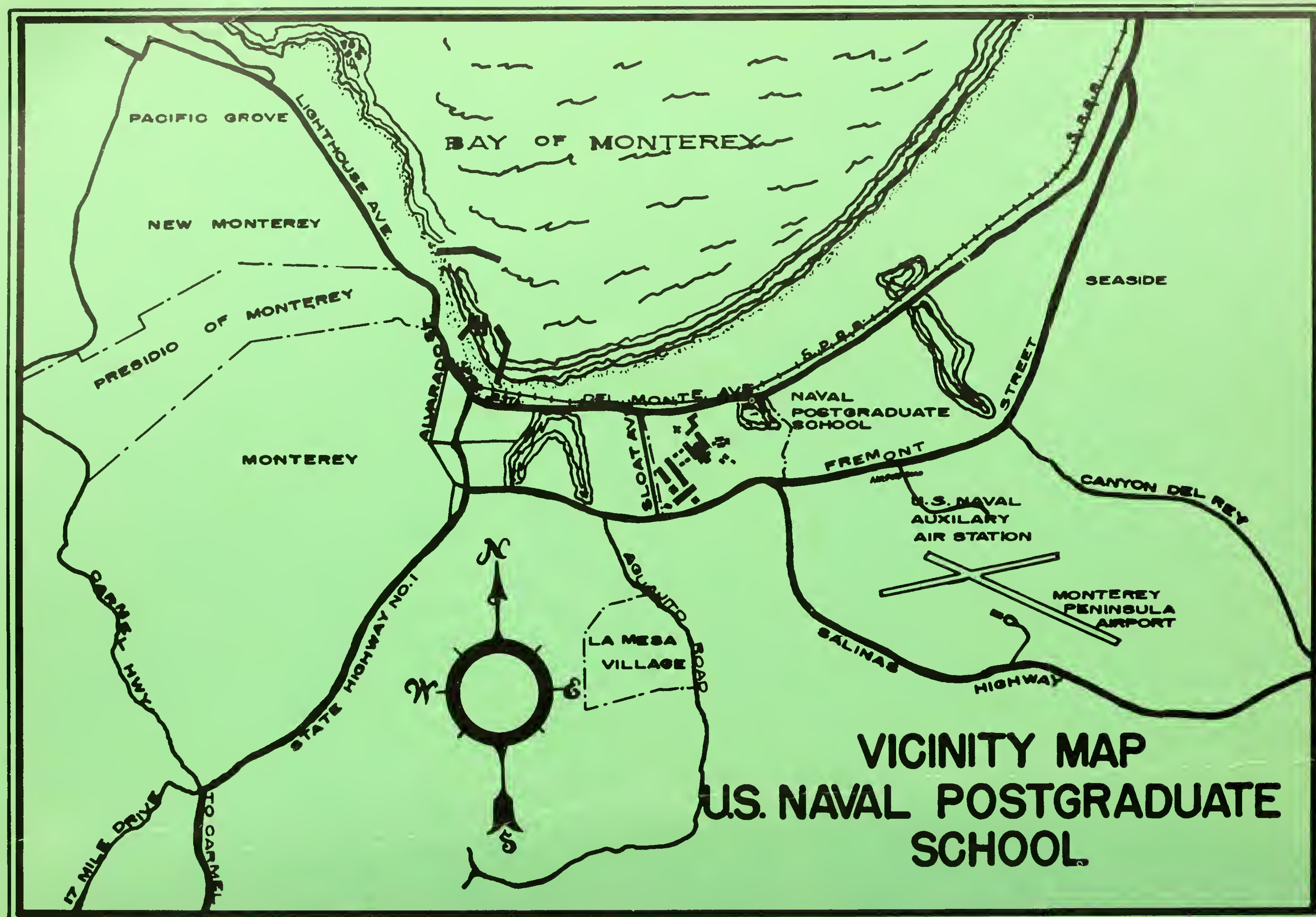
Dean's Office

U. S. NAVAL POSTGRADUATE SCHOOL

Catalogue for Academic Year 1958-1959



VICINITY MAP
U.S. NAVAL POSTGRADUATE SCHOOL

UNITED STATES NAVAL
POSTGRADUATE SCHOOL

CATALOGUE
for the
Academic Year 1958 - 1959

MONTEREY, CALIFORNIA

1 JUNE 1958

12ND P1664 (REV. 5-58)

NAVY-DPPO-12ND-MI

PRINTED BY
TWELFTH NAVAL DISTRICT
PUBLICATIONS AND PRINTING OFFICE

UNITED STATES NAVAL POSTGRADUATE SCHOOL

CALENDAR

Academic Year 1958 - 1959

1958

Engineering School Special Weapons Orientation Presentation	Monday, 16 June
Management School Registration for Summer Course	Thursday, 19 June
Engineering School Completion of Special Weapons Orientation	Friday, 20 June
Management School Classes Begin for Summer Course	Monday, 23 June
Independence Day (Holiday)	Friday, 4 July
Engineering School Registration	Thursday, 31 July
Management School Ends Summer Course	Friday, 1 August
Engineering School First Term Begins	Monday, 4 August
General Line and Naval Science School Ends Third Term	Friday, 8 August
General Line and Naval Science School Registration (Class 1959A)	Monday, 11 August
General Line and Naval Science School Begins First Term (Class 1959A)	Monday, 11 August
Management School Registration (Class 1959A)	Monday, 11 August
Management School Classes Begin (Class 1959A)	Monday, 18 August
Labor Day (Holiday)	Monday, 1 September
Engineering School First Term Ends	Thursday, 9 October
Engineering School Second Term Begins	Tuesday, 14 October
General Line and Naval Science School First Term Ends	Friday, 17 October
General Line and Naval Science School Second Term Begins	Monday, 20 October
General Line and Naval Science School Graduation (Class of 1958B)	Wednesday, 22 October
Veterans Day (Holiday)	Tuesday, 11 November
Thanksgiving Day (Holiday)	Thursday, 27 November
Engineering School and General Line and Naval Science School Second Terms End, Christmas Holiday Begins	Friday, 19 December

1958 ★ CALENDAR ★ 1958

JANUARY							FEBRUARY							MARCH						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
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5	6	7	8	9	10	11	2	3	4	5	6	7	8	2	3	4	5	6	7	8
12	13	14	15	16	17	18	9	10	11	12	13	14	15	9	10	11	12	13	14	15
19	20	21	22	23	24	25	16	17	18	19	20	21	22	16	17	18	19	20	21	22
26	27	28	29	30	31	—	23	24	25	26	27	28	—	23	24	25	26	27	28	29
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APRIL							MAY							JUNE						
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6	7	8	9	10	11	12	4	5	6	7	8	9	10	8	9	10	11	12	13	14
13	14	15	16	17	18	19	11	12	13	14	15	16	17	15	16	17	18	19	20	21
20	21	22	23	24	25	26	18	19	20	21	22	23	24	22	23	24	25	26	27	28
27	28	29	30	—	—	—	25	26	27	28	29	30	31	29	30	—	—	—	—	—
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JULY							AUGUST							SEPTEMBER						
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13	14	15	16	17	18	19	10	11	12	13	14	15	16	14	15	16	17	18	19	20
20	21	22	23	24	25	26	17	18	19	20	21	22	23	21	22	23	24	25	26	27
27	28	29	30	31	—	—	24	25	26	27	28	29	30	28	29	30	—	—	—	—
—	—	—	—	—	—	—	31	—	—	—	—	—	—	—	—	—	—	—	—	—

OCTOBER							NOVEMBER							DECEMBER						
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5	6	7	8	9	10	11	2	3	4	5	6	7	8	7	8	9	10	11	12	13
12	13	14	15	16	17	18	9	10	11	12	13	14	15	14	15	16	17	18	19	20
19	20	21	22	23	24	25	16	17	18	19	20	21	22	21	22	23	24	25	26	27
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—	—	—	—	—	—	—	30	—	—	—	—	—	—	—	—	—	—	—	—	—

1959

Engineering School and General Line and Naval Science School Third Terms Begin	Monday, 5 January
General Line and Naval Science School Registration (Class of 1959A(W))	Monday, 5 January
General Line and Naval Science School Classes Begin (Class of 1959A(W))	Wednesday, 7 January
Management School Graduation (Class of 1959A)	Wednesday, 14 January
Management School Registration (Class of 1959B)	Monday, 19 January
Management School Classes Begin (Class of 1959B)	Monday, 26 January
Washington's Birthday (Holiday)	Monday, 23 February
General Line and Naval Science School Registration (Class of 1959B)	Monday, 9 March
Engineering School and General Line and Naval Science School Third Terms End	Friday, 13 March
Engineering School Special Weapons Orientation Begins	Monday, 16 March
General Line and Naval Science School Fourth Term Begins	Monday, 16 March
Engineering School Special Weapons Orientation Ends	Friday, 20 March
Engineering School Fourth Term Begins	Monday, 23 March
General Line and Naval Science School Fourth Term Ends	Friday, 22 May
General Line and Naval Science School Fifth Term Begins	Monday, 25 May
General Line and Naval Science School Graduation (Class of 1959A and 1959A(W))	Wednesday, 27 May
Engineering School Fourth Term Ends	Friday, 29 May
Engineering School Graduation	Thursday, 4 June
Management School Classes End	Friday, 5 June
Management School Graduation (Class of 1959B)	Wednesday, 10 June
Management School Summer Session Registration	Thursday, 18 June
Management School Summer Session Begins	Monday, 22 June
Engineering School and General Line and Naval Science School Registration (Class of 1960A and 1959B(W))	Monday, 27 July
General Line and Naval Science School Ends Third Term	Friday, 31 July
Management School Summer Session Ends	Friday, 31 July
Engineering School and General Line and Naval Science School Classes Begin	Monday, 3 August
Management School Registration (Class of 1960A)	Monday, 10 August
Management School Classes Begin (Class of 1960A)	Monday, 17 August

1959 ★ CALENDAR ★ 1959

JANUARY							FEBRUARY							MARCH						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
—	—	—	—	1	2	3	—	—	—	—	—	—	—	1	2	3	4	5	6	7
4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	11	12	13	14
11	12	13	14	15	16	17	8	9	10	11	12	13	14	15	16	17	18	19	20	21
18	19	20	21	22	23	24	15	16	17	18	19	20	21	22	23	24	25	26	27	28
25	26	27	28	29	30	31	22	23	24	25	26	27	28	29	30	31	—	—	—	—
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APRIL							MAY							JUNE						
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5	6	7	8	9	10	11	3	4	5	6	7	8	9	7	8	9	10	11	12	13
12	13	14	15	16	17	18	10	11	12	13	14	15	16	14	15	16	17	18	19	20
19	20	21	22	23	24	25	17	18	19	20	21	22	23	21	22	23	24	25	26	27
26	27	28	29	30	—	—	24	25	26	27	28	29	30	28	29	30	—	—	—	—
—	—	—	—	—	—	—	31	—	—	—	—	—	—	—	—	—	—	—	—	—

JULY							AUGUST							SEPTEMBER						
—	—	—	1	2	3	4	—	—	—	—	—	—	1	—	—	1	2	3	4	5
5	6	7	8	9	10	11	2	3	4	5	6	7	8	6	7	8	9	10	11	12
12	13	14	15	16	17	18	9	10	11	12	13	14	15	13	14	15	16	17	18	19
19	20	21	22	23	24	25	16	17	18	19	20	21	22	20	21	22	23	24	25	26
26	27	28	29	30	31	—	23	24	25	26	27	28	29	27	28	29	30	—	—	—
—	—	—	—	—	—	—	30	31	—	—	—	—	—	—	—	—	—	—	—	—

OCTOBER							NOVEMBER							DECEMBER						
—	—	—	—	1	2	3	1	2	3	4	5	6	7	—	—	1	2	3	4	5
4	5	6	7	8	9	10	8	9	10	11	12	13	14	6	7	8	9	10	11	12
11	12	13	14	15	16	17	15	16	17	18	19	20	21	13	14	15	16	17	18	19
18	19	20	21	22	23	24	22	23	24	25	26	27	28	20	21	22	23	24	25	26
25	26	27	28	29	30	31	29	30	—	—	—	—	—	27	28	29	30	31	—	—
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Section III

THE GENERAL LINE AND NAVAL SCIENCE SCHOOL

Section IV

THE MANAGEMENT SCHOOL

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U. S. NAVAL POSTGRADUATE SCHOOL

Superintendent

Elmer Eugene YEOMANS, Rear Admiral, U. S. Navy

B.S., USNA, 1924; M.S., Univ. of California, 1933; National War College, 1948.

Chief of Staff

Paul FOLEY, Jr., Captain, U. S. Navy

B.S., USNA, 1929; U. S. Naval War College, 1953.

Academic Dean

Roy Stanley GLASGOW, B.S., M.S., E.E.

Director, Engineering School

Harold Millar HEMING, Captain, U. S. Navy

B.S., USNA, 1930; U. S. Naval War College, 1953.

Director, General Line and Naval Science School

Albert Peyton COFFIN, Captain, U. S. Navy

B.S., USNA, 1934; U. S. Air War College, 1954.

Prospective Director, General Line and Naval Science School

Robert Park BEEBE, Captain, U. S. Navy

B.S., USNA, 1931; U. S. Naval War College

Director, Management School

John Adrian HACK, Captain, U. S. Navy

B.S., USNA, 1935; B. Mgt. E., Rensselaer Polytechnic Institute, 1950;

U. S. Naval War College, 1957.

Commanding Officer, Administrative Command

Maxim William FIRTH, Captain, U. S. Navy

B.S., USNA, 1931; U. S. Naval War College, 1952.

MISSION

The Secretary of the Navy has defined the mission of the Naval Postgraduate School as follows:

> **"To conduct and direct the instruction of commissioned officers by advanced education, to broaden the professional knowledge of general line officers, and to provide such other indoctrination, technical and professional instruction as may be prescribed to meet the needs of the Naval Service."**

UNITED STATES NAVAL POSTGRADUATE SCHOOL

SECTION I

GENERAL INFORMATION

FUNCTIONS

In carrying out its mission the Postgraduate School performs the following functions: (a) provides advanced engineering education through its own facilities at Monterey, and by supervision of the education of officer students at various civilian institutions throughout the country; (b) provides advanced professional education through the medium of the General Line and Naval Science School; (c) provides graduate management education through the medium of the Management School. Through the performance of these functions the Postgraduate School becomes the agent of the Bureau of Naval Personnel for graduate education.

These functions stem from the mission which in turn has evolved over the years as a result of the recognized need for advanced education. The resulting program is essentially threefold: technical, special and professional. The technical phase is the particular province of the Engineering School which seeks, by graduate instruction, to provide officers with the facility for intelligent technical direction of the Navy's activities in such fields as electronics, ordnance, aerology, aeronautics, naval engineering and communications. This is done through the Engineering School facilities as well as by utilization of civilian institutions known for their leadership in the fields involved. Because of this latter contact, the Engineering School is also charged with the handling of such special programs as civil engineering, naval construction and engineering at civilian institutions.

The General Line and Naval Science School, successor to the General Line School, embraces that portion of the program formerly known as the General Line curriculum, and in addition will include the pilot input of a segment of the so-called five term program. Successful completion of the latter by qualified candidates will lead to a baccalaureate degree (BS). The General Line curriculum is of 9½ months duration and is designed to broaden and enhance the mental outlook and professional knowledge of all career line officers upon the completion of five to seven years commissioned service, thereby preparing them for more responsible duties in the operating forces of the Navy. The curriculum of the five term, or bachelor of science, program will include subjects taught in the 9½ month General Line curriculum.

The Management School offers a five month program including courses in various business subjects and in the general field of management. This School provides Naval officers with graduate level instruction enabling them to be better prepared for their future assignments to management billets. It also has administrative responsibility for related curricula such as business and personnel administration offered at civilian universities.

In addition to the above, the Postgraduate School exercises general supervision over the Naval Intelligence School at Washigton, D. C. Otherwise, the Intelligence School operates independently under a captain of the line who holds the title of director.

ORGANIZATION

The Postgraduate School consists of four main components: the Engineering School, The General Line and Naval Science School, the Management School, and the Administrative Command. Heading the organization is the superintendent, a rear admiral of the line of the Navy. He is assisted by captains of the line as heads of the four components. The Administrative Command is the supporting organization for the schools at Monterey and provides all the usual housekeeping services.

The three schools at Monterey, the Engineering School, the Management School, and the General Line and Naval Science School, each have a military and an academic organization. The civilian faculty of the three schools, headed by the academic dean, provides the academic instruction in fields usually found in a well-rounded technical institution. In addition, officer instructors provide education in the purely naval subjects. Because of their different functions the three schools have different proportions of officer and civilian instructors; the Engineering School teaching staff is preponderantly civilian, whereas the opposite is true in the case of the General Line and Naval Science School. The Management School staff is about equal in proportion of officer and civilian instructors.

STUDENT INFORMATION

Detailed information on the Postgradute School and the Monterey area is provided in a student information brochure given to all newcomers. In general, however, the living facilities approach those detailed by the many travel folders available concerning the Monterey Peninsula.

Of particular interest to the married student is La Mesa Village, a Wherry housing development located within one mile of the school. The 519 units provide an excellent supplement to the general housing available throughout the Peninsula. The general housing facilities are adequately supported by schools, churches, and shopping facilities.

The majority of the rooms of the old Del Monte Hotel are used as a BOQ. Within the same buildings are the usual facilities associated with the BOQ, such as closed and open messes, Navy Exchange, etc.

The Naval Air Facility, Monterey, is located about 2 miles from the school grounds. Its main mission is to provide the flight facilities for the use of aviator students in maintaining their flight proficiency.

FACILITIES

The Naval Postgraduate School is located about one mile east of the city of Monterey. This site is in the process of development aimed at the ultimate provision of modern classroom and laboratory facilities for the Engineering School, the General Line and Naval Science School, and the Management School. When this objective is attained, the spaces now employed for classes and laboratories will revert to their primary purposes as BOQ and other supporting facilities.

During the latter part of 1954 the Engineering School moved into the first group of buildings completed as part of this development plan. These buildings provide proper laboratory space for the first time during the existence of the Engineering School. The following buildings are now in use:

The main Engineering School building, Spanagel Hall, five stories in height, which houses the departments of Electronics, Physics, Metallurgy and Chemistry, and Electrical Engineering. Because of the building's height, the top level supports special equipment for demonstrations in aerology and electronics.

Bullard Hall, the Electrical Engineering Laboratory.

Halligan Hall, the Mechanical Engineering and Aeronautical Engineering Laboratories.

Root Hall, primarily a classroom building, is a long, two-story building that also provides space for the Computer Laboratory and for the departments of Aeronautics, Mechanical Engineering, Aerology and Mathematics and Mechanics. The Management School is also located in Root Hall as is the Reference and Research Library which is occupying about one-third of the building until such time as a separate library building is constructed.

LIBRARY

The Libraries of the U. S. Naval Postgraduate School, which contain various collections of published and unpublished materials for the use of students, faculty and staff of the Engineering School, the General Line and Naval Science School, and the Management School are three in number—the Reference and Research Library, the Christopher Buckley, Jr., Library, and the Textbook Service.

The Reference and Research Library, temporarily located in the east end of Root Hall, is an active collection of some 150,000 books, periodicals and research reports dealing mainly with the curricular subjects in the fields of science, engineering, management and naval studies. Its research and development report collection, including a classified section, provides up-to-date information on research being done, under government-sponsored projects, by universities and by independent researchers. The Reference and Research Library also furnishes microfilm and photostat services and will obtain, on interlibrary loan, any publications which are requested and which are not present in its own collection.

The Christopher Buckley, Jr. Library, located on the first floor of Herrmann Hall is a collection of about 5,000 books relating mainly to naval history or to subjects connected with the sea. It contains among these, many rare or otherwise valuable books, including Sir Walter Raleigh's "Excellent Observations and Notes, Concerning the Royal Navy and Sea-Service," published in 1650; Samuel Pepys' "Memoires Relating to the State of the Royal Navy of England for Ten Years, Determin'd December 1688"; the first edition (1773-1784) of Capt. James Cook's "Voyages," in eight volumes; a number of manuscripts, and many other interesting items. It is a comfortably furnished library in surroundings that are conducive to reading, relaxing, browsing or study. The collection was the result of the generosity and kindness of Mr. Christopher Buckley, resident of Pebble Beach, California, who has been donating books to the School for this Library since 1949, and who has designated it to be the testamentary recipient of his estate.

The Textbook Service contains approximately 90,000 textbooks, reference books and pamphlets in multiple copies, which are issued to students on a term-loan basis and to instructors for an unlimited period. Students are assigned certain specified texts for their courses but may use this Library to obtain related material to use in conjunction with them.

HISTORICAL

The U. S. Naval Postgraduate School had a modest beginning at the Naval Academy at Annapolis in 1909, at which time the first class of ten officers enrolled in a Marine Engineering curriculum. Today, in its location at Monterey, California, approximately 1,000 officer students are enrolled in approximately forty curricula in engineering and related subjects, in the Engineering School and the General Line and Naval Science School. Facilities are being planned and implemented to accommodate a total of 1400 officer students—500 in the Engineering School, 100 in the Management School, and 800 in the General Line and Naval Science School. Since 1909 the growth and development of the U. S. Naval Postgraduate School has been in keeping with its original objective of providing the Navy with officers of advanced technical education capable of administering and directing a modern Navy.

The need for technically trained officers became evident at the turn of the century. The idea of a naval graduate school had its inception in a course of instruction in Marine Engineering which the Bureau of Engineering instituted in 1904. The results of this course were so encouraging that in 1909 the Secretary of the Navy established a School of Marine Engineering at the Naval Academy in Annapolis. In 1912 the School was designated the Postgraduate Department of the U. S. Naval Academy.

The operation of the School was temporarily suspended during World War I, but in 1919 classes were resumed in converted Marine Barracks on the Naval Academy grounds. At this time curricula in Mechanical Engineering and Electrical Engineering were added. With the passing years other curricula —Ordnance Engineering, Radio Engineering, Aerological Engineering and Aeronautical Engineering— were added as the Navy's need for officers with technical knowledge in these fields became evident.

In 1927 the General Line Curriculum was established within the Postgraduate School to provide courses of instruction to acquaint junior line officers returning from sea duty with modern developments taking place in the Navy. The courses dealt with naval and military subjects for the most part. The General Line Curriculum remained as an integral part of the Postgraduate Department until the declaration of the emergency prior to the outbreak of World War II, at which time it was discontinued because of the need for officers in the growing fleet.

The enrollment in the Postgraduate School increased rapidly in the war years both in the several engineering curricula and in the communications curriculum which was added to meet the need for trained communication officers in the naval establishment. The School outgrew its quarters necessitating the building of an annex to house the additional classrooms and laboratories required, but even with this addition, the space requirements of the expanded school were not met.

The post-war program called for yet further expansion and the re-establishment of the General Line Curriculum with a greatly increased enrollment. In 1946 the General Line School was established at Newport, Rhode Island, as an outlying element of the Postgraduate School and continued until dis-established in 1952; in 1948 an additional General Line School was established at Monterey, California. The objective of the General Line School program—that of providing an integrated course in naval science to broaden the professional knowledge of unrestricted line officers of the Regular Navy—continued in effect as it had since the inception of this program. From 1946 until 1955 a curriculum varying in length from six months to one year provided such a course for Reserve and ex-Temporary officers who had transferred to Regular status. Since 1955, the curriculum has been nine and one-half months in duration and is intended for other Reguar officers at the end of five to seven years of commissioned service.

The physical growth of the School and its increase in scope and importance were recognized in Congressional action which resulted in legislation during the years 1945 to 1951 emphasizing the academic level of the School, and providing for continued growth in a new location with modern buildings and equipment. This legislation authorized the School to confer Bachelors, Masters, and Doctors degrees in engineering and related subjects; created the position of academic dean to insure continuity in academic policy, established the School as a separate naval activity to be known as the United States Naval Postgraduate School; authorized the establishment of the School at Monterey, California; and provided funds to initiate the construction of buildings to house modern laboratories and classrooms at that location.

In December 1948 a survey was conducted by Region IV Committee on Engineering Schools of the Engineering Council for Professional Development (ECPD). As a result of this survey which was a detailed and thorough investigation of the curricula, faculty and facilities of the School, the Naval Postgraduate School was informed on 29 October 1949 by the ECPD that the Curricula in Aeronautical Engineering, Electrical Engineering (including option in Electronics) and Mechanical Engineering were accredited. In 1955 the School was accredited by the Western College Association and in the same year the ECPD reaccredited the curricula it had approved in 1949 and, in addition, accredited that in Ordnance Engineering (Special Physics).

On 22 December 1951, by order of the Secretary of the Navy, the United States Naval Postgraduate School was officially disestablished at Annapolis, Maryland, and established at Monterey, California. This completed the transfer of the School from the

East to the West Coast, which had begun in 1948 when the Aerology Department and Curricular office were moved to the new location. Concurrently with this relocation, the U. S. Naval School (General Line) at Monterey was disestablished as a separate military command and its functions and facilities were assumed by the U. S. Naval Postgraduate School. At the same time, there was established the U. S. Naval Administrative Command, U. S. Naval Postgraduate School, Monterey, to provide logistic support, including supply, public works, medical and dental functions, for the Naval Postgraduate School and its components.

In Mid-1957 a series of discussions were commenced between representatives of the Bureau of Naval Personnel and the Postgraduate School looking to the possibility of establishing a bachelor of science curriculum at the General Line School. It was conceived that this curriculum would fit into the Navy's five-term college program commencing in August 1958 with semi-annual pilot inputs, and ultimately, as the faculty and facilities expanded, the entire program would be carried out at Monterey. This curriculum was planned to include subjects taught in the General Line curriculum as well as a number of new courses adequate to support a degree of bachelor of science, no major designated. The discussions resulted in a feasibility study by the staff of the Postgraduate School, and in October 1957 the Chief of Naval Personnel approved the concept of a composite Five Term/General Line School Program to be implemented with the August 1958 input. The pilot phase of this program will require that selected candidates possess advance credits in specific areas in order to compensate for courses not yet established. Transition to the ultimate program of complete course offerings will depend upon the availability of funds required for expansion of faculty and physical facilities. In the interim, each semi-annual student input will include 50 students to be enrolled in the composite program, with the remainder enrolled in the 9½ month General Line Curriculum as heretofore. The Chief of Naval Personnel further specified that the title "General Line School" be changed to "General Line and Naval Science School", effective 1 July 1958.

In June 1956, by direction of the Chief of Naval Personnel, a Management School was established as an additional component of the Postgraduate School. The mission of the school is to provide an educational program for officers in the application of sound scientific management practice to the complex organizational structure and operations of the Navy with a view toward increasing efficiency and economy of operation. The first class included only Supply and Civil Engineering Corps officers and emphasis was placed on general management theory, financial management, and inventory management. In August 1957 this school was expanded to include input from both Line and Staff Corps officers. The curriculum now includes various areas of industrial management and additional material in the basic areas.

The U. S. Naval Postgraduate School, Monterey, now comprises the Engineering School under a director, the General Line and Naval Science School under a director, the Management School under a director, and the Administrative Command under a commanding officer. In command of the Naval Postgraduate School and all of its components is a line officer of flag rank in the Regular Navy with the title of superintendent.

Herrmann Hall, the Administration Building.
This building contains offices of the Superintendent, Academic Dean and Administrative Command, as well as the Bachelor Officers' Quarters and certain logistic facilities.

The Naval Postgraduate School is located on 293 acres extending to Monterey Bay. The new Engineering School buildings are in the foreground.

Aerial view of a portion of the U. S. Naval Postgraduate School campus. In the background is the city of Monterey.

THE CHAPEL

SECTION II

THE ENGINEERING SCHOOL

DIRECTOR

Harold Millar HEMING, Captain, U. S. Navy
B. S., USNA, 1930;
Graduate, USNPS, 1939, Marine Engineering;
U. S. Naval War College, 1950

Assistant Director

Harry Edson TOWNSEND, Captain, U. S. Navy
B. S., USNA, 1932;
USNPS, 1939, Naval Engineering;
U. S. Naval War College

Administrative Officer

James Louis MAY
Commander, U. S. Navy
B. S., USNA, 1939

Allotment and Budget Control Officer

Jackson Madison RIGHTMYER
Commander, U. S. Navy

NAVAL STAFF

AEROLOGY CURRICULA

Charles Ellis TILDEN

Commander, U. S. Navy
Officer-in-Charge
M.S., USNPS, 1951

Leo C. CLARKE

Commander, U. S. Naval Reserve
Assistant Officer in Charge

Sylvester James HALMINSKI

Commander, U. S. Naval Reserve
Instructor in Aerology
B.S., Loyola Univ. of Los Angeles, 1941
USNPS, 1943, Aerological Engineering

Milton Bruce MORELAND

Lieutenant Commander, U. S. Navy
Instructor in Aerology
B.S., Colorado State College, 1942;
M.S., USNPS, 1952

Fredrick Gustave OLSON

Lieutenant Commander, U. S. Navy
Instructor in Aerology
A.B., Univ. of Washington, 1943
UCLA, 1944, Meteorology

Robert Alvie MOORE

Lieutenant Commander, U. S. Navy
Instructor in Aerology
B.S., USNPS, 1953

John Francis MATEJCECK

Lieutenant Commander, U. S. Navy
Instructor in Aerology
B.S., USNPS, 1954

John Arthur JEPSON

Lieutenant, U. S. Navy
Instructor in Aerology
B.S., USNA, 1949; B.S., USNPS, 1954;
M.S., USNPS, 1957

Sanford Lee CHILDERS

Chief Aerographer, U. S. Navy
Instructor in Aerology

AERONAUTICAL CURRICULA

Robert Leavenworth MASTIN

Commander, U. S. Navy
Officer in Charge
B.S., USNA, 1939; Ae.E., California Institute of Technology, 1947

Donald LeRoy IRGENS

Commander, U. S. Navy
Assistant Officer in Charge
B.S., North Dakota Agricultural College, 1940;
M.S., Univ. of Minnesota, 1949

Paul MILLER, Jr.

Commander, U. S. Navy
Instructor in Aeronautics
B.S., USNA, 1943
Test Pilot Training, NATC, Patuxent River, Md., 1951

ENGINEERING ELECTRONICS AND COMMUNICATIONS ENGINEERING CURRICULA

Louis Piollet SPEAR

Captain, U. S. Navy
Officer in Charge
B.S., USNA, 1939; M.S., USNPS, 1947

Charles Alexander DARRAH

Commander, U. S. Navy
Assistant Officer in Charge for Comm. Engrg
USNPS, 1944, Applied Communications
A.B., Vanderbilt Univ., 1949

John Victor PETERS

Lieutenant Commander, U. S. Navy
Asst. Officer in Charge for Engrg Electronics
B.S., USNA, 1944; USNPS, 1952;
M.S., USNPS, 1953

Eugene Latimer REID

Lieutenant, U. S. Navy
Instructor in Communications
B.S., Georgia Institute of Tech., 1950;
USNPS, 1955, Command Communications

Forrest John GODFREY

Lieutenant, U. S. Navy
Electronics Laboratory Officer

NAVAL ENGINEERING CURRICULA

William Rolston CRUTCHER

Captain, U. S. Navy
Officer-in-Charge
B.S., USNA 1934; U. S. Naval War College, 1950

Wilbur M. M. FOWDEN, Jr.

Commander, U. S. Navy
Assistant Officer-in-Charge
B.S., Polytechnic College of Engineering, 1942;
M.M.E., Rensselaer Polytechnic Institute, 1948

ORDNANCE ENGINEERING CURRICULA

Robert Ernest ODENING

Captain, U. S. Navy
Officer in Charge
B.S., USNA, 1936; M.S., Cornell Univ., 1944;
M.S., California Institute of Technology, 1951.

Harold Lee GRAHAM, Jr.

Commander, U. S. Navy
Assistant Officer-in-Charge and Instructor in Ordnance Engineering
B.S., USNA, 1941; USNPS, 1946;
Cornell Univ., 1948

Thomas Dominic PFUNDSTEIN

Lieutenant, U. S. Navy
Instructor in Mine Warfare
B.S., USNPS, 1955

CIVILIAN FACULTY

DEPARTMENT OF AEROLOGY

William Dwight DUTHIE

Professor of Aerology; Chairman (1945)
A.B., Univ. of Washington, 1935; M.S., 1937;
Ph.D. Princeton Univ., 1940.

George Joseph HALTINER

Professor of Aerology (1946)
B.S., College of St. Thomas, 1940; Ph. M., Univ. of Wisconsin, 1942; Ph.D. 1948.

Glenn Harold JUNG

Associate Professor of Aerology and Oceanography (1958)
S.B., Massachusetts Institute of Technology, 1949;
S.M., 1952;
Ph.D., Texas Agricultural and Mechanical College, 1955.

Frank Lionel MARTIN

Professor of Aerology (1947)
A.B., Univ. of British Columbia, 1936; A.M., 1938;
Ph.D., Univ. of Chicago, 1941.

(The year of joining the Postgraduate School faculty is indicated in parenthesis.)

Robert Joseph RENARD

Assistant Professor of Aerology (1952)
M.S., Univ. of Chicago, 1952.

Charles Luther TAYLOR

Assistant Professor of Aerology, (1954)
B.S., Pennsylvania State Univ., 1942; M. S., 1947.

Warren Charles THOMPSON

Associate Professor of Aerology and Oceanography (1953)
A.B., Univ. of California at Los Angeles, 1943; M.S., Scripps Institution of Oceanography, 1948; Ph.D., Texas A. & M. College, 1953.

Jacob Bertram WICKHAM

Associate Professor of Aerology and Oceanography (1951)
B.S., Univ. of California, 1947; M.S., Scripps Institution of Oceanography, 1949.

DEPARTMENT OF AERONAUTICS

Wendell Marois COATES

Professor of Aeronautics; Chairman (1931)
A.B., Williams College, 1919; M.S., Univ. of Michigan, 1923; D.Sc., 1929.

Richard William BELL

Professor of Aeronautics (1951)
A.B., Oberlin College, 1939; Ae.E., California Institute of Technology, 1941.
(On leave of absence).

Theodore Henry GAWAIN

Professor of Aeronautics (1951)
B.S., Univ. of Pennsylvania, 1940; D.Sc., Massachusetts Institute of Technology, 1944.

Ulrich HAUPT

Associate Professor of Aeronautics (1954)
Dipl. Ing., Institute of Technology, Darmstadt, 1934.

Richard Moore HEAD

Professor of Aeronautics (1949)
B.S., California Institute of Technology, 1942; M.S., 1943; Ae.E., 1943; Ph.D., 1949.

George Judson HIGGINS

Professor of Aeronautics (1942)
B.S., Univ. of Michigan, 1923; Ae.E., 1934.

Charles Horace KAHR, Jr.

Professor of Aeronautics (1947)
B.S., Univ. of Michigan, 1944; M.S., 1945.

Henry Lebrecht KOHLER

Professor of Aeronautics (1943)
B.S., Univ. of Illinois, 1929; M.S., Yale Univ., 1930; M.E., 1931.

Michael Hans VAVRA

Professor of Aeronautics (1947)
Dipl. Ing., Swiss Federal Institute of Technology, 1934.

DEPARTMENT OF ELECTRICAL ENGINEERING

Charles Van Orden TERWILLIGER

Professor of Electrical Engineering
Chairman (1925)
B.E., Union College, 1916; M.S., 1919; M.S., Harvard Univ., 1922; D.Eng., Johns Hopkins Univ., 1938.

John Miller BOULDRY

Associate Professor of Electrical Engineering (1946)
B.S., Northeastern Univ., 1941;
M. S., Brown Univ., 1956.

Edward Markham GARDNER

Professor of Electrical Engineering (1948)
B.S., Univ. of London, 1923; M. S., California Institute of Technology, 1938.

Raymond Kenneth HOUSTON

Professor of Electrical Engineering (1946)
B.S., Worcester Polytechnic Institute, 1938; M.S., 1939.

Herbert LeRoy MYERS

Asst. Prof. of Electrical Engineering (1951)
B.S., Univ. of Southern California, 1951.

Charles Benjamin OLER

Professor of Electrical Engineering (1946)
B.S., Univ. of Pennsylvania, 1927; M. S., 1930; D.Eng., Johns Hopkins Univ., 1950.

Orval Harold POLK

Professor of Electrical Engineering (1946)
B.S., Univ. of Colorado, 1927; M.S., Univ. of Arizona, 1933; E.E., Univ. of Colorado, 1940.

Charles Harry ROTHAUGE

Professor of Electrical Engineering (1949)
B.E., Johns Hopkins Univ., 1940; D.Eng., 1949.

William Conley SMITH

Professor of Electrical Engineering (1946)
B.S., Ohio Univ., 1935; M.S., 1939.

William Alfred STEIN

Associate Professor of Electrical Engineering (1951)
B.S., Washington Univ., 1943; M.S., 1947; D.Sc. 1951.

George Julius THALER

Professor of Electrical Engineering (1951)
B.E., Johns Hopkins Univ., 1940; D.Eng., 1947.

Allen Edgar VIVELL

Professor of Electrical Engineering (1945)
B.E., Johns Hopkins Univ., 1927; D.Eng., 1937.

Richard Carvel Hensen WHEELER

Professor of Electrical Engineering (1929)
B.E., Johns Hopkins Univ., 1923; D.Eng., Rensselaer Polytechnic Institute, 1926.

DEPARTMENT OF ELECTRONICS

George Robert GIET

Professor of Electronics; Chairman (1925)
A.B., Columbia Univ., 1921; E.E., 1923.

William Malcolm BAUER

Professor of Electronics (1946)
B.S., Northwestern Univ., 1927; E.E., 1928; M.S., Harvard Univ., 1929; D.Sc., 1940.

Stephen BREIDA, Jr.

Asst. Professor of Electronics (1958)
B.S.E.E., Drexel Inst. of Tech., 1952; M.S.E.E., Purdue, Univ., 1954.

Jesse Gerald CHANEY

Professor of Electronics (1946)
A.B., Southwestern Univ., 1924; A.M., Univ. of Texas, 1930.

Paul Eugene COOPER

Professor of Electronics (1946)
B.S., Univ. of Texas, 1937; M.S., 1939.

Mitchell Lavette COTTON

Assistant Professor of Electronics (1953)
B.S., California Institute of Technology, 1948; M.S., Washington Univ., 1952; E.E., Univ. of California, 1954.

David Boysen HOISINGTON

Prof. of Electrical Engineering (1947)
B.S., Massachusetts Inst. of Tech., 1940; M.S., Univ. of Pennsylvania, 1941.

Clarence Frederick KLAMM, Jr.

Associate Professor of Electronics (1951)
B.S., Washington Univ., 1943; M.S., 1948.

Carl Ernest MENNEKEN

Professor of Electronics (1942)
B.S., Univ. of Florida, 1932; M.S., Univ. of Michigan, 1936.

Robert Lee MILLER

Professor of Electronics (1946)
B.Ed., Illinois State Normal Univ., 1936; M.S., Univ. of Illinois, 1942.

Raymond Patrick MURRAY

Assoc. Prof. of Electrical Engineering (1947)
B.S., Kansas State College, 1937; M.S., Brown Univ., 1953.

William Everett NORRIS

Assoc. Prof. of Electrical Engineering (1951)
B.S., Univ. of California, 1941; M.S., 1950.

Marvin Paul PASTEL

Assistant Professor of Electronics (1955)
B.S., Principia College, 1947; M.S., Washington Univ., 1948.

Abraham SHEINGOLD

Professor of Electronics (1946)
B.S., College of the City of New York, 1936; M.S., 1937.

Donald Alan STENTZ

Associate Professor of Electronics (1949)
B.S., Duke Univ., 1949; M.S., USNPS, 1958.

John Benjamin TURNER, Jr.

Assistant Professor of Electronics (1955)
B.S., Univ. of Arkansas, 1941; M.S., Univ. of California, 1948.

Carl Paul WIEDOW

Associate Professor of Electronics (1956)
A.B., Occidental College, 1933; M.S., Univ. of Southern California, 1935; M.S. (Physics), California Institute of Technology, 1945; M.S., (E.E.), California Institute of Technology, 1946; Ph.D., Oregon State College, 1956.

DEPARTMENT OF MATHEMATICS AND MECHANICS

Warren Randolph CHURCH

Professor of Mathematics and Mechanics; Chairman (1938)
A.B., Amherst, 1926; A.M., Univ. of Pennsylvania, 1930; Ph.D., Yale Univ., 1935.

Ralph Eugene ROOT

Professor Emeritus of Mathematics (1914)
B.S., Morningside College, 1905; A.M., Univ. of Iowa, 1909; Ph.D., Univ. of Chicago, 1911.

Charles Henry Rawlins, Jr.

Professor Emeritus of Mathematics and Mechanics (1922)
Ph.B., Dickinson College, 1910; A.M., 1913; Ph.D., Johns Hopkins Univ., 1916.

Horace Crookham AYRES

Associate Professor of Mathematics and Mechanics (1958)
B.S., Univ. of Washington, 1931; M.S., Univ. of Washington, 1931; Ph.D., Univ. of California, 1936.

Willard Evan BLEICK

Professor of Mathematics and Mechanics (1946)
M.E., Stevens Institute of Technology, 1929; Ph.D., Johns Hopkins Univ., 1933.

Richard Crowley CAMPBELL

Associate Professor of Mathematics and Mechanics (1948)
B.S., Muhlenberg College, 1940; A.M., Univ. of Pennsylvania, 1942.

Craig COMSTOCK

Instructor in Mathematics (1958)
B.E.P., Cornell Univ., 1956.

Frank David FAULKNER

Associate Professor of Mathematics and Mechanics (1950)
B.S., Kansas State Teachers College, 1940; M.S., Kansas State College, 1942.

Joseph GIARRATANA

Professor of Mathematics and Mechanics (1946)
B.S., Univ. of Montana, 1928; Ph.D., New York Univ., 1936.

Donald GUTHRIE, Jr.

Assistant Professor of Mathematics (1958)
B.S., Stanford Univ., 1954;
M.A., Columbia Univ., 1955;
Ph.D., Stanford Univ., 1958.

Walter JENNINGS

Associate Professor of Mathematics and Mechanics (1947)
A.B., Ohio State Univ., 1932; B.S., 1934; A.M., 1934.

Brooks Javins LOCKHART

Professor of Mathematics and Mechanics (1948)
A.B., Marshall College, 1937; M.S., West Virginia Univ., 1940; Ph.D., Univ. of Illinois, 1943.

Kenneth Robert LUCAS

Assistant Professor of Mathematics (1958)
B.S., Washburn Univ., 1949;
Ph.D., Univ. of Kansas, 1957.

Craig A. MAGWIRE

Associate Professor of Mathematics and Mechanics (1955)
B.A., Nebraska State Teachers College, 1943; M.S., Univ. of Michigan, 1947; Ph.D., Stanford Univ., 1953.

Hugo Murua MARTINEZ

Associate Professor; Supervisor of Computation Laboratory (1955)
B.A., Univ. of California, 1952.

Aladuke Boyd MEWBORN

Professor of Mathematics and Mechanics (1946)
B.S., Univ. of Arizona, 1927; M.S., 1933; Ph.D., California Institute of Technology, 1940.

William Edmund MILNE

Visiting Professor of Mathematics and Mechanics (1957)
A.B., Whitman College, 1912; A.M., Harvard Univ., 1913; Ph.D., Harvard Univ., 1915; D.Sc., Whitman College, 1942.

Thomas Edmond OBERBECK

Professor of Mathematics and Mechanics (1951)
A.B., Washington Univ., 1938; A.M., Univ. of Nebraska, 1940; Ph.D., California Institute of Technology, 1948.

John Philip PIERCE

Associate Professor of Mathematics and Mechanics (1948)
B.S., Worcester Polytechnic Institute, 1931; M.E.E., Polytechnic Institute of Brooklyn, 1937.

Francis McConnell PULLIAM

Professor of Mathematics and Mechanics (1949)
A.B., Univ. of Illinois, 1937; A.M., 1938; Ph.D., 1947.

Franklin Fryer SHEEHAN

Associate Professor of Mathematics (1958)
B.S., Stanford Univ., 1947.

Elmo Joseph STEWART

Associate Professor of Mathematics and Mechanics (1955)
B.S., Univ. of Utah, 1937; M.S., 1939; Ph.D. Rice Institute, 1953.

Charles Chapman TORRANCE

Professor of Mathematics and Mechanics (1946)
M.E., Cornell Univ., 1922; A.M., 1927; Ph.D., 1931.

William Lloyd WAINWRIGHT

Associate Professor of Mathematics and Mechanics (1958)
B.S., Purdue Univ., 1951; M.S., 1955; Ph.D., Univ. of Michigan, 1958.

Kenneth Ted WALLENIUS

Instructor in Mathematics and Mechanics (1958)
A.B., Univ. of Southern California, 1954; A.M., 1955.

DEPARTMENT OF MECHANICAL ENGINEERING

Robert Eugene NEWTON

Professor of Mechanical Engineering; Chairman (1951)
B.S., Washington Univ., 1938; M.S., 1939; Ph.D., Univ. of Michigan, 1951.

Dennis KAVANAUGH

Professor Emeritus of Mechanical Engineering (1926)
B.S., Lehigh Univ., 1914.

Paul James KIEFER

Professor Emeritus of Mechanical Engineering (1920)
A.B., Wittenberg College, 1908; B.S., Case Institute of Technology, 1911; M.E., 1939; D.Sc., (Hon.) Wittenberg College, 1953.

John Edison BROCK

Professor of Mechanical Engineering (1954)
B.S., Purdue Univ., 1938; M.S., 1941; Ph.D., Univ. of Minnesota, 1950.

Ernest Kenneth GATCOMBE

Professor of Mechanical Engineering (1946)
B.S., Univ. of Maine, 1931; M.S., Purdue Univ., 1939; Ph.D., Cornell Univ., 1944.

Charles Pinto HOWARD

Assistant Professor of Mechanical Engineering (1954)
B.S., Texas Agricultural and Mechanical College, 1949; M.S., 1951.

Cecil Dudley Gregg KING

Assistant Professor of Mechanical Engineering (1952)
B.E., Yale Univ., 1943; M.S., Univ. of California, 1952.

Roy Walters PROWELL

Professor of Mechanical Engineering (1946)
B.S., Lehigh Univ., 1936; M.S., Univ. of Pittsburgh, 1943.

Paul Francis PUCCI

Assistant Professor of Mechanical Engineering (1956)
B.S., Purdue Univ., 1949; M.S., 1950; Ph.D., Stanford Univ., 1955.

Harold Marshall WRIGHT

Professor of Mechanical Engineering (1945)
B.S., North Carolina State College, 1930; M.M.E., Rensselaer Polytechnic Institute, 1931.

DEPARTMENT OF METALLURGY AND CHEMISTRY

Frederick Leo COONAN

Professor of Metallurgy and Chemistry; Chairman (1931)
A.B., Holy Cross College, 1922; M.S., 1924; D.Sc., Massachusetts Institute of Technology, 1931.

Newton Weber BUERGER

Professor of Metallurgy (1942)
B.S., Massachusetts Institute of Technology, 1933; M.S., 1934; Ph.D., 1937.

John Robert CLARK

Professor of Metallurgy (1947)
B.S., Union College, 1935; D.Sc., Massachusetts Institute of Technology, 1942.

Alfred GOLDBERG

Assistant Professor of Metallurgy (1953)
B.Eng., McGill Univ., 1946; M.S., Carnegie Institute of Technology, 1947; Ph.D., Univ. of California, 1955.

William Wisner HAWES

Associate Professor of Metallurgy and Chemistry (1952)
B.S., Purdue Univ., 1924; M.S., Brown Univ., 1927; Ph.D., 1930.

Carl Adolph HERING

Professor of Chemical Engineering (1946)
B.S., Oregon State College, 1941; M.S., Cornell Univ., 1944.

Gilbert Ford KINNEY

Professor of Chemical Engineering (1942)
A.B., Arkansas College, 1928; M.S., Univ. of Tennessee, 1930; Ph.D., New York Univ., 1935.

George Daniel MARSHALL, Jr.

Professor of Metallurgy (1946)
B.S., Yale Univ., 1930; M.S., 1932.

George Harold McFARLIN

Professor of Chemistry (1948)
A.B., Indiana Univ., 1925; A.M., 1926.

Richard Alan REINHARDT

Associate Professor of Chemistry (1954)
B.S., Univ. of California, 1943; Ph.D., 1947.

Melvin Ferguson REYNOLDS

Professor of Chemistry (1946)
B.S., Franklin and Marshall College, 1932; M.S., New York Univ., 1935; Ph.D., 1937.

James Edward SINCLAIR

Associate Professor of Chemistry (1949)
B.S., Johns Hopkins Univ., 1945; M.S., USNPS, 1956.

James Woodrow WILSON

Associate Professor of Chemical Engineering (1949)
A.B., Stephen F. Austin State Teachers College, 1935; B. S., Univ. of Texas, 1939; M.S., Texas Agricultural and Mechanical College, 1941.

DEPARTMENT OF PHYSICS

Austin Rogers FREY

Professor of Physics; Chairman (1946)
B.S., Harvard Univ., 1920; M.S., 1924; Ph.D., 1929.

Alfred William COOPER

Assistant Professor of Physics (1957)
B.A. (Mod), Univ. of Dublin, 1955.

John Niessink COOPER

Professor of Physics (1956)
A.B., Kalamazoo College, 1935; Ph.D., Cornell Univ., 1940.

Eugene Casson CRITTENDEN, Jr.

Professor of Physics (1953)
A.B., Cornell Univ., 1934; Ph.D., 1938.

William Peyton CUNNINGHAM

Professor of Physics (1946)
B.S., Yale Univ., 1928; Ph.D., 1932.

Sydney Hobart KALMBACH

Associate Professor of Physics (1947)
B.S., Marquette Univ., 1934; M.S., 1937.

Lawrence Edward KINSLER

Professor of Physics (1946)
B.S., California Institute of Technology, 1931; Ph.D., 1934.

Herman MEDWIN

Associate Professor of Physics (1955)
B.S., Worcester Polytechnic Institute, 1941; M.S., Univ. of California at Los Angeles, 1948; Ph.D., Univ. of California at Los Angeles, 1953.

Edmund Alexander MILNE

Assistant Professor of Physics (1954)
B.A., Oregon State College, 1949; M.S., California Institute of Technology, 1950; Ph.D., 1953.

Norman Lee OLESON

Professor of Physics (1948)
B.S., Univ. of Michigan, 1935; M.S., 1937; Ph.D., 1940.

John Dewitt RIGGIN

Professor of Physics (1948)
B.S., Univ. of Mississippi, 1934; M.S., 1936.

Oscar Bryan WILSON, Jr.

Associate Professor of Physics (1957)
B.S., Univ. of Texas, 1944; M.A., Univ. of California at Los Angeles, 1948, Ph.D., 1951.

LIBRARY

George Ridgely LUCKETT

Professor; Director of Libraries (1950)
B.S., Johns Hopkins Univ., 1949; M.S., Catholic Univ., 1951.

Morris HOFFMAN

Associate Professor; Associate Librarian (1952)
B.S., Univ. of Minnesota, 1947; A.M., 1949.

Janusz Ignacy KODREBSKI

Head Catalog Librarian (1956)
Secondary education, Torun, Poland, 1927
Diploma National War College, Warsaw, 1938
M.S., Univ. of Southern California, 1955.

Georgia Plummer LYKE

Reference Librarian (1952)
A.A., Hartnell Junior College, 1940.

Daveda B. PARK

Cataloger (1955)
A.B., Univ. of California, 1938.

Marjorie I. THORPE

Technical Reports Librarian (1952)
A.B., Univ. of California at Los Angeles, 1942; B.S., Univ. of Southern California, 1943.

Robert Moran TIERNEY

Acquisitions Librarian (1957)
A.B., Columbia Univ., 1937.

Mabel C. VAN VORHIS

Technical Reports Cataloger (1955)
A.B., Univ. of California, 1926.

FUNCTIONS

The Engineering School is responsible for the accomplishment of that part of the mission of the Postgraduate School that provides for "advanced education . . . and technical instruction . . . as may be prescribed to meet the needs of the service." It performs these functions through its own facilities at Monterey and by cooperation with the various civilian educational institutions throughout the country.

The variety of advanced education required by the Navy ranges from the basically technical, such as engineering electronics, through advanced study of pure science to law and religion. To cover this wide field several methods of education are used. In some cases the curriculum is conducted entirely at the Engineering School; in others, a civilian institution is employed; and in still others, both means are used.

ORGANIZATION

The Engineering School is organized under its director to carry out its functions along two basic lines; i.e., naval administration and academic instruction. The former provides the professional supervision of all the curricula and the latter provides the technical instruction and educational advice.

Under the director, the naval administration is provided by five curricular offices staffed by captains or commanders of the Navy experienced in their respective fields. The titles of these various "officers in charge" are:

(a) Aerology

(b) Aeronautical Engineering

(c) Engineering Electronics and Communications Engineering

(d) Naval Engineering

(e) Ordnance Engineering

These officers provide the naval administration of the students undertaking curricula under their cognizance as well as the supervision of the curricula to insure that the needs of the service are met. They also supervise curricula in allied fields.

The educational side of the Engineering School is provided almost entirely by the civilian faculty. This group is organized along the lines of most civilian graduate institutions. There are eight academic departments, each headed by a chairman, as follows:

Aerology

Aeronautics

Electrical Engineering

Electronics

Mathematics and Mechanics

Mechanical Engineering

Metallurgy and Chemistry

Physics

In addition to providing the actual technical instruction the academic departments provide educational advice to the curricular officers both directly as a department and through the assignment of an associate for a particular curricula. The academic associate assists the officer in charge in devising the curriculum and directing the students assigned in pursuing it.

The curricula offices also provide instruction in specifically naval subjects where an officer's experience is the most valuable background for the education to be imparted. Thus the naval staff and civilian faculty together provide a broad course of instruction.

ACADEMIC RECORDS

The course designation and marking system in use by the Engineering School is designed to facilitate the evaluation of both the curricula and the students for degree purposes. The regulations for degrees as set forth in later paragraphs require a certain quality point rating to be obtained by the students in courses of a clearly graduate nature.

Courses are assigned designators consisting of a two-letter abbreviation of the subject (Ma for Mathematics, Co for Communications), a three-digit course number, and a letter (A, B, C, or L) in parentheses, such as Ma-101(C) and Ph-643(A). The letters in parentheses are a measure of the graduate standing of the course as follows:

(A) Full graduate course;

(B) Partial graduate course;

(C) Undergraduate course;

(L) Lecture course—no academic credit.

Course listings include the hours assigned, the hours of recitation first and laboratory second, separated by a dash; e.g., CH-412(C) 3-2. This means three hours of lecture and two hours of laboratory work per week. For credit purposes laboratory hours are assigned half weight, hence the example above has a credit hour value of 4 term hours. This corresponds to 2.67 semester hours, since each term hour is the equivalent of two-thirds semester hour.

Marks are assigned each student in accordance with the following shedule:

Performance	Grade	Quality Point Number
Excellent	A	3.0
Good	B	2.0
Fair	C	1.0
Barely passing	D	.0
Failure	X	—1.0

When the value of the course in credit hours is multiplied by the quality point number, corresponding to the grade assigned, the total quality points for that course is obtained. When this is totaled for all courses taken and divided by the total credit hours, a numerical evaluation of the various grades is obtained which is called the quality point rating or more simply, QPR. A student realizing a QPR of 2.0 has made a B average for all the courses he has undertaken.

REGULATIONS GOVERNING THE AWARD OF DEGREES

In accordance with Public Law 303 of the 79th Congress, with the Regulations prescribed by the Secretary of the Navy, and with accreditation by the Engineers' Council for Professional Development, the superintendent is authorized to confer the degree of Bachelor of Science in the Mechanical Engineering, the Electrical Engineering, the Engineering Electronics and the Aeronautical Engineering curricula. The recipients of such degrees must be found qualified by the Academic Council in accordance with certain academic standards.

The superintendent is further authorized to confer Masters and Doctors degrees in engineering or related fields, upon the recommendation by the faculty, based upon satisfactory completion of a program of advanced study approved by the Academic Council.

The following paragraphs set forth the requirements for the degrees:

(1) Requirements for the Bachelor of Science Degree:

(a) The Bachelor's degree in engineering or other scientific fields may be awarded for successful completion of a curriculum which serves the needs of the Navy and has the approval of the Academic Council as meriting a degree. Such a curriculum shall conform to current practice in accredited engineering institutions and shall contain a well-defined major, with appropriate cognate minors.

(b) Admission with suitable advanced standing and a minimum of two academic years of residence at the Naval Postgraduate School are normally required. With the approval of the Academic Council, this residence requirement may be reduced to not less than one academic year in the case of particular students who have had sufficient prior preparation at other institutions.

(c) To be eligible for the degree, the student must attain a minimum average quality point rating of 1.0 in all courses of his curriculum. In very exceptional cases, small deficiencies from this figure may be waived at the discretion of the Academic Council.

(d) With due regard for the above requirements, the Academic Council will decide whether or not to recommend the candidate to the Superintendent of the Naval Postgraduate School for the award of the Bachelor's degree.

(2) Requirements for the Master of Science Degree:

(a) The Master's degree in engineering and related fields is awarded for the successful completion of a curriculum which complements the basic scientific education of a student and which has been approved by the Academic Council as meriting a degree, provided the student exhibits superior scholarship, attains scientific proficiency, and meets additional requirements as stated in the following paragraphs.

(b) Since curricula serving the needs of the Navy ordinarily contain undergraduate as well as graduate courses, a minimum of two academic years of residence at the Naval Postgraduate School is normally required. With the approval of the Academic Council, the time of residence may be reduced in the case of particular students who have successfully pursued graduate study at other educational institutions. In no case will the degree be granted for less than one academic year of residence at the Naval Postgraduate School.

(c) A curriculum leading to a Master's degree shall comprise not less than 48 term hours (32 semester hours) of work that is clearly of graduate level, and shall contain a well-supported major, together with cognate minors. At least six of the term hours shall be in advanced mathematics. The proposed program shall be submitted to the cognizant department chairman for review and approval. If the program is satisfactory to the department chairman, it shall be forwarded by him to the Academic Council for final action.

(d) To become a candidate for the Master's degree the student shall have completed at least three quarters of the graduate credit courses of his curriculum with a quality point rating in them of not less than 1.75 as defined in the section on scholarship.

(e) To be eligible for the Master's degree, the student must attain a minimum average quality point rating of 2.0 in all graduate credit courses; 1.5 in all of his other courses. In special cases, under very extenuating circumstances, small deficiencies from the figures noted in paragraphs (d) and (e) may be waived at the discretion of the Academic Council.

(f) A reasonable proportion of the graduate work leading to the Master's degree shall be composed of research and a thesis reporting the results obtained. The thesis topic is selected by the student in conjunction with a faculty advisor, and is subject to the approval of the cognizant department chairman. The research must indicate ability to perform independent work; the thesis grades entered by the faculty advisor are assigned on this basis. In addition, the completed thesis must indicate an ability to report on the work in a scholarly fashion. The thesis in final form is submitted via the faculty advisor to the cognizant department chairman for review and evaluation. Upon final approval of the thesis the student shall be certified as eligible for examination.

(g) If the thesis is accepted, the candidate for the degree shall take a final oral examination, the duration of which will be approximately one hour. An additional comprehensive written examination may be required at the discretion of the cognizant department chairman. Not more than one half of the oral examination shall be devoted to questions directly related to the candidate's thesis topic; the remainder to the candidate's major and related areas of study.

(h) With due regard for the above requirements, the Academic Council will decide whether or not to recommend the candidate to the superintendent of the Naval Postgraduate School for the award of the Master's degree.

(3) Requirements for the Doctor's Degree:

(a) The Doctor's degree in engineering and related fields is awarded as a result of very meritorious and scholarly achievement in a particular field of study which has been approved by the Academic Council as within the purview of the Naval Postgraduate School. A candidate must exhibit faithful and scholarly application to all prescribed courses of study, achieve a high level of scientific advancement and establish his ability for independent investigation, research, and analysis. He shall further meet the requirements described in the following paragraphs.

(b) Any program leading to the Doctor's degree shall require the equivalent of at least three academic years of study beyond the undergraduate level, and shall meet the needs of the Navy for advanced study in the particular area of investigation. At least one academic year of the doctorate work shall be spent at the Naval Postgraduate School.

(c) A student seeking to become a candidate for the doctorate shall hold a Bachelor's degree from a college or university, based on a curriculum that included the prerequisites for full graduate status in the department of his major study, or he shall have pursued successfully an equivalent course of study. The student shall submit his previous record to the Academic Council, via the Academic Dean, for final determination of the adequacy of his preparation.

(d) Upon favorable action by the Academic Council, the student will be notified that he may request the chairman of the department of his major subject to form a Doctorate Committee. This chairman will specify one or more minor subjects and, with the chairmen of the corresponding departments, will nominate a Doctorate Committee consisting of five or more members, at least three of whom are under different departments. The chairman of the department of the major subject will submit to the Academic Council for its approval the choice of minor fields and the names of the faculty members nominated for the Doctorate Committee.

(e) After a sufficient period of study in his major and minor fields, the student shall submit to qualifying examinations, including tests of his reading knowledge of foreign languages. The selection of these languages depends on the field of study. The minimum is a reading knowledge of German and a second language to be suggested by his Doctorate Committee and approved by the Academic Council. The language examinations will be conducted by a committee especially appointed by the Academic Council. The other qualifying examinations will cover material previously studied in his major and minor fields; they will be written and oral and will be conducted by the Doctorate Committee. The members of the Academic Council or their delegates may be present at the oral examinations. The Doctorate Committee will report the results of the qualifying examinations to the Academic Council for consideration and, upon approval, the student becomes a candidate for the Doctorate. The qualifying examinations are not given, ordinarily, before the completion of the first year of residence at the Naval Postgraduate School; they must be passed successfully at least two years before the degree is granted.

(f) Upon successful qualification as a candidate, the student will be given a further program of study by the Doctorate Committee. This program must be approved by the Academic Council.

(g) The distinct requirement of the doctorate is the successful completion of an original, significant, and scholarly investigation in the candidate's major area of study. The results of the investigation, in the form of a publishable dissertation, must be submitted to the Academic Council at least two months before the time at which it is hoped the degree will be granted. The Academic Council will select two or more referees, who will make individual written reports on the dissertation. Lastly, the Academic Council will vote upon the acceptance of the dissertation.

(h) After the approval of the dissertation, and not later than two weeks prior to the award of the degree, the candidate will be subject to written and oral examination in his major and minor subjects. Written examinations will be conducted by the department having cognizance of the particular subject. The occasion and scope of each examination will be arranged by the Doctorate Committee, after consultation with the departments concerned and the members of the Academic Council. The Doctorate Committee will notify the Academic Council of the time of the oral examination and will invite their attendance, or that of their delegates. The Committee will also invite the attendance of such other interested persons as it may deem desirable. In this oral examination, approximately on half of the allotted time will be devoted to the major subject and one half to the minor subjects. The Doctorate Committee will submit the results of all examinations to the Academic Council for their approval.

(i) With due regard for all of the above requirements, the Academic Council will decide whether to recommend the candidate to the Superintendent of the Naval Postgraduate School for the award of the doctorate.

(j) It is not to be expected that the course requirements for the doctorate can be met while pursuing one of the three-year curricula shown in this catalogue unless the student has previously had suitable graduate work and signifies his desire to become a candidate within three months of the beginning of his curriculum.

LABORATORY FACILITIES AND EQUIPMENT OF THE ENGINEERING SCHOOL

Extensive laboratory experimentation is carried on at the Engineering School in connection with the instructional and research programs of the various departments. The experimental facilities have been greatly improved and expanded in recent years, and further improvement is planned for the future.

The Physics laboratories are equipped to carry on experimental and research work in acoustics, atomic physics, electricity, nuclear physics, geometrical and physical optics, bio-physics, and solid state physics.

The laboratory facilities include a two-million volt Van de Graaff electrostatic accelerator, a Collins liquid helium cryostat, a large grating spectrograph, an infrared spectrophotometer, a medium size anechoic (echo-free) chamber, a small reverberation chamber, and a multiple-unit acoustics laboratory for student experimentation in airborne acoustics.

The work in the acoustics laboratory is particularly directed toward underwater sound applications, and a large proportion of the laboratory space is devoted to sonar equipment, test tanks, and instrumentation for investigations in underwater sound.

The Aeronautical laboratories contain facilities for experimentation and research in aerodynamics, structural and stress analysis, aerothermodynamics and propulsion problems.

Facilities for the study of subsonic technical aerodynamics are centered about 32″ x 45″ subsonic wind tunnel having a speed range extending from approximately 10 to 185 knots. The Structural Test Laboratory contains a testing machine of 200,000 pounds capacity, used in structural and stress analysis of aircraft components. The facilities of the Compressibility Laboratory include a transonic wind tunnel having a 4″ x 16″ test section and operating in the Mach number range from 0.4 to 1.4, and a supersonic wind tunnel having a 4″ x 4″ test section and operating in the Mach number range from 1.4 to 4. Instruments associated with these wind tunnels include a 9″ Mach-Zehnder interferometer and a 9″ and two 5″ Schlieren systems for flow observations. The Propulsion Laboratory contains a single test block and facilities for measurement of thrust, fuel flow, temperature, pressures and other parameters of engine operation. Present engine equipment consist of a 9½″ Westinghouse Turbo-Jet and three pulse jet engines. A small flame tube, especially equipped for the study of flame propagation, is also available.

For studies of flows in turbo machines the laboratory contains the Mark I Compressor Test Rig, instrumented for conventional performance measurements, and for special problems of three-dimensional flows about the stationary vanes and the turning rotor blades. By changing the angular position of the stationary vanes, a large number of design configurations can be investigated. Further, a small Boeing turboprop engine with variable pitch propeller is available for the determination of performance data and investigations of transient control behavior. Under development is a 300 hp Cascade Test Rig for measurements of pressure distributions, and boundary layer investigations on blades of turbo-machines.

The **Chemical** laboratories of the Department of Metallurgy and Chemistry are will equipped for instructional purposes at both the undergraduate and graduate level in chemistry and chemical engineering. These laboratories include a radiochemistry ("hot") laboratory with Geiger and scintillation counters and special apparatus for handling and testing radioactive materials; a well-equipped fuel and lubricant laboratory; a plastics laboratory and shop where plastics are synthesized, molded in compression or injection presses, and their mechanical, physical and chemical properties determined; an explosives laboratory with impact tester, ballistics mortar, chronograph and other apparatus for evaluating explosives. Space is also available for faculty and student research projects.

The **Metallurgy** laboratories are completely equipped with the standard mechanical testing machines and heat-treating furnaces. The latest type of microscopes and metallographs are available for metallographic examination. Facilities for the study of crystal structures include X-ray diffraction units, powder cameras and heating cameras, Weissenberg X-ray goniometers and a recording photo densitometer. Metal fabricating and melting equipment include a swaging machine, rolling mill, induction and vacuum melting furnaces, a die-casting machine and a welding laboratory. Studies of the effect of high and low temperatures on metals are made in a laboratory equipped with creep testing apparatus and facilities for obtaining low temperatures.

In the **Electrical Engineering** laboratories, facilities are provided for instruction and research in servomechanisms, electronics, electrical machinery and circuits. The laboratories are equipped with many duplicate sets of equipment for performing all standard experiments. Additional items of special equipment include a five-unit harmonic set, a high-voltage set, a Schering Bridge, an analog computer, BTA motors, wave analyzers, sound meters, special servo analyzers, oscillographs, industrial analyzers, Brush recorders, dynamometers, synchroscopes, amplidynes and rototrols.

The Electrical Engineering laboratories are housed in a specially designed two-story building (132′ x 132′) adjacent to the main engineering building. The ground floor houses the machinery and high voltage laboratories, and the second floor is devoted to electronics, control, servomechanisms and measurements. Both floors are provided with switchboards able to distribute a wide range of DC, AC 60-cycle or 400-cycle power to any location. The ground floor has a completely equipped darkroom and the upper floor an excellent standards laboratory, and twelve small research rooms.

The **Mechanical Engineering** laboratories provide facilities for instruction and research in elastic-body mechanics and dynamics, in hydromechanics and in heat-power and related fields. Noteworthy equipment in the heat-power laboratories include a forced-circulation boiler, 3500 psi and 1000°F; a gas or oil-fired boiler, 250 psi, and 8000 lb./hr., fully automatic controls; a 150-HP Boeing turbo-prop gas turbine installation, dynamometer loaded; a two-dimensional supersonic air nozzle with schlieren equipment for analysis of shock-wise flows; a vapor-compression still and a solo-shell dual-effect evaporator. Facilities of the elastic-body mechanics and dynamics laboratories include a universal fatigue tester, for testing in tension, compression, bending or torsion, a Chapman polariscope for stress determination by photo-elastic method; vibration inducer units and associated equipment for inducing vibrations in mechanical systems with controlled amplitudes and frequencies from 20 to 20,000 cycles per second; Gisholt and Olsen dynamic balancing machines; and a linear accelerometer and calibrator unit.

The **Electronics** laboratories are well equipped for carrying on a comprehensive program of experimental work in the various branches of the field. Facilities are available for investigating the operational characteristics of radio and electronic circuits at frequencies ranging from d-c to the microwave region. For precision measurements and accurate calibration of instruments, standard frequency sources and standardizing equipment are available.

To illustrate modern communications practices, representative systems are available covering a wide range of operating frequencies, power outputs and methods of modulation. These include systems for transmitting manual and automatic telegraphy, voice and video signals. Additional systems include electronics countermeasures equipment, radio aids to navigation and a broad selection of Navy radar systems.

Improved facilities are now provided for the study of telemetering systems, computing systems, modern radar systems, antenna radiation characteristics, microwave phenomena, and transistors as well as for advanced work in circuit measurements. Additional space is also available for conducting individual research and project work.

The equipment of the **Mathematics and Mechanics** Department includes comprehensive computation facilities for use in the instruction and research program of the School. In addition to a general purpose automatically sequenced digital computer, the computing equipment now available includes an electronic analogue computer and digital differential analyzer both of which are used to find the solutions of differential equations; a specially modified accounting machine used in finite difference computations; a variety of planimeter type instruments including a large precision moment integrator, a Stieltjes integrator and a harmonic analyzer. The digital computer is capable of magnetic storing of more than 1,000 numbers or instructions on a drum rotating at 40 r.p.s. and 200,000 numbers or instructions on two magnetic tape units. It is used in the solution of thesis and other research problems as well as for instruction.

The laboratory facilities in **Aerology** include all instruments in present-day use for measuring the current physical and dynamic state of the atmosphere, as well as teletype and facsimile communications equipment for the rapid reception and dissemination of weather data in coded and analyzed form for the entire northern hemisphere.

The instruments for gathering weather data include rawinsonde equipment, which provides a continuous recording of temperature, pressure, humidity and wind directions and velocities at designated levels above the surface; radiosonde equipment whereby pressure, temperature and humidity information is transmitted to ground via radio signals from heights that may extend above 100,000 feet; a wiresonde that measure air temperature and humidity conditions in the lower strata of the atmosphere, an inversion meter designed for remote recordings of free air temperature at designated heights in the boundary layer; a bathythermograph for recording sea temperature gradients; a weather configurated aircraft equipped as a flying classroom; and a shore wave recorder for measuring wave heights and periods.

TABLE I

CURRICULA GIVEN WHOLLY OR IN PART BY THE ENGINEERING SCHOOL

Curriculum	Group Desig.	Length	Cognizant Curricula Office	Academic Associate
Advanced Science				
Chemistry	RC	3 yrs.	Engineering Electronics	Prof. Coonan
Hydrodynamics	RH	3 yrs.	Engineering Electronics	Prof. Howard
Mathematics (Applied)	RM	3 yrs.	Engineering Electronics	Prof. Church
Metallurgy	RMT	3 yrs.	Engineering Electronics	Prof. Coonan
Physics (General)	RP	3 yrs.	Engineering Electronics	Prof. Frey
Physics (Nuclear)	RX	3 yrs.	Engineering Electronics	Prof. Frey
Aerology				
Basic Aerology	M	1 yr.	Aerology	Prof. Duthie
General Aerology	MA	2 yrs.	Aerology	Prof. Duthie
Advanced Aerology	MM	2 yrs.	Aerology	Prof. Duthie
Aeronautical Engineering				
General	A	2, 3 yrs.	Aeronautical Engineering	Prof. Coates
Avionics	AV	2, 3 yrs.	Aeronautical Engineering	Profs. Thaler, Klamm
Engineering Electronics and Communications Engineering				
Communications Engineering	CE	2 yrs.	Engineering Electronics	Prof. Stentz
Engineering Electronics (General)	E	2 yrs.	Engineering Electronics	Prof. Klamm
Engineering Electronics (System Design)	EA	3 yrs.	Engineering Electronics	Prof. Klamm
Engineering Electronics (Acoustics)	EW	3 yrs.	Engineering Electronics	Prof. Kinsler
Mine Warfare	RW	2 yrs.	Ordnance Engineering	Prof. Kinsler
Naval Engineering				
Electrical Engineering	NLA	3 yrs.	Naval Engineering	Prof. Polk
Engineering Materials	NM	3 yrs.	Naval Engineering	Prof. Coonan
Mechanical Engineering	NH, NHA	2, 3 yrs.	Naval Engineering	Prof. Wright
Mechanical Engineering (Fuels and Lubricants)	NC	3 yrs.	Naval Engineering	Prof. Coonan
Mechanical Engineering (Gas Turbines)	NJ	3 yrs.	Naval Engineering	Profs. Wright, Vavra
Nuclear Power	NN	2 yrs.	Naval Engineering	Prof. C. D. G. King
Nuclear Engineering (Effects)	RZ	2 yrs.	Ordnance Engineering	Prof. Frey
Operations Analysis	RO	2 yrs.	Ordnance Engineering	Prof. Cunningham
Ordnance Engineering				
Explosives and Propellants	OP	2 yrs.	Ordnance Engineering	Prof. Kinney
Fire Control	OF	3 yrs.	Ordnance Engineering	Prof. Bleick
General and Industrial	O	2 yrs.	Ordnance Engineering	Prof. Bleick
Guided Missiles	OG	2½ yrs.	Ordnance Engineering	Prof. Faulkner
Special Physics	OX	3 yrs.	Ordnance Engineering	Prof. Frey
Underwater Ordnance	OU	2 yrs.	Ordnance Engineering	Prof. Kinsler
Special Mathematics	S	2, 3 yrs.	Engineering Electronics	Prof. W. R. Church

TABLE II

CURRICULA CONDUCTED ENTIRELY AT OTHER INSTITUTIONS

Curriculum	Group Desig.	Length	Institution	Cognizant Curr. Officer	Liaison Official
Civil Engineering, Advanced					
Electrical Engineering		1 yr.		Naval Engineering	
Mechanical Engineering		1 yr.		Naval Engineering	
Sanitary Engineering	ZGM	1 yr.	Michigan	Naval Engineering	C.O., NROTC Unit
Soil Mechanics & Foundations	ZGR	1 yr.	RPI	Naval Engineering	C.O., NROTC Unit
Structures	ZGI	1 yr.	Illinois	Naval Engineering	C.O., NROTC Unit
Waterfront Facilities	ZGP	1 yr.	Princeton	Naval Engineering	C.O., NROTC Unit
Civil Engineering, Qualification	ZGQ	17 mos.	RPI	Engineering Electronics	C.O., NROTC Unit
Hydrographic Engineering	ZV	1 yr.	Ohio State	Aerology	C.O., NROTC Unit
Judge Advocate Officers Advanced Course	ZHV	9 mos.	Univ. of Virginia	Engineering Electronics	C.O., NROTC Unit
Metallurgical Engineering	ZNM	9 mos.	Carnegie Inst.of Tech.	Naval Engineering	Assoc. Prof. J. W. Ludewig
Naval Architecture	ZNA	9 mos.	Univ. of California	Naval Engineering	C.O., NROTC Unit
Naval Construction and Marine Engineering	ZNB	3 yrs.	Webb Inst.	Naval Engineering	Capt. R. A. Hinners USN (Ret.)
Naval Construction and Engineering	ZNB	3 yrs.	MIT	Naval Engineering	C.O., NavAdminUnit
Naval Intelligence	ZI	9 mos.	U. S. Naval Intel. Scol Wash. D.C.	Staff Secretary	Director, U.S. Naval Intelligence School
Nuclear Engineering (Advanced)	ZNE	15 mos.	MIT	Naval Engineering	C.O., NavAdminUnit
Oceanography	ZO	1 yr.	Univ of Washington	Aerology	C.O., NROTC Unit
Personnel Administration and Training	ZP	1 yr.	Stanford	Engineering Electronics	C.O., NROTC Unit
Petroleum Administration and Management (Gas, Oil and Water Rights)	ZHS	1 yr.	SMU	Engineering Electronics	Senior Student
Petroleum Engineering	ZL	2 yrs.	Pittsburgh	Naval Engineering	Prof. H. G. Botset
Religion	ZU	1 yr.	Various	Engineering Electronics	Various
Social Science	ZST	2 yrs.	Tufts Univ. or Stanford Univ.	Engineering Electronics	C.O., NROTC Unit

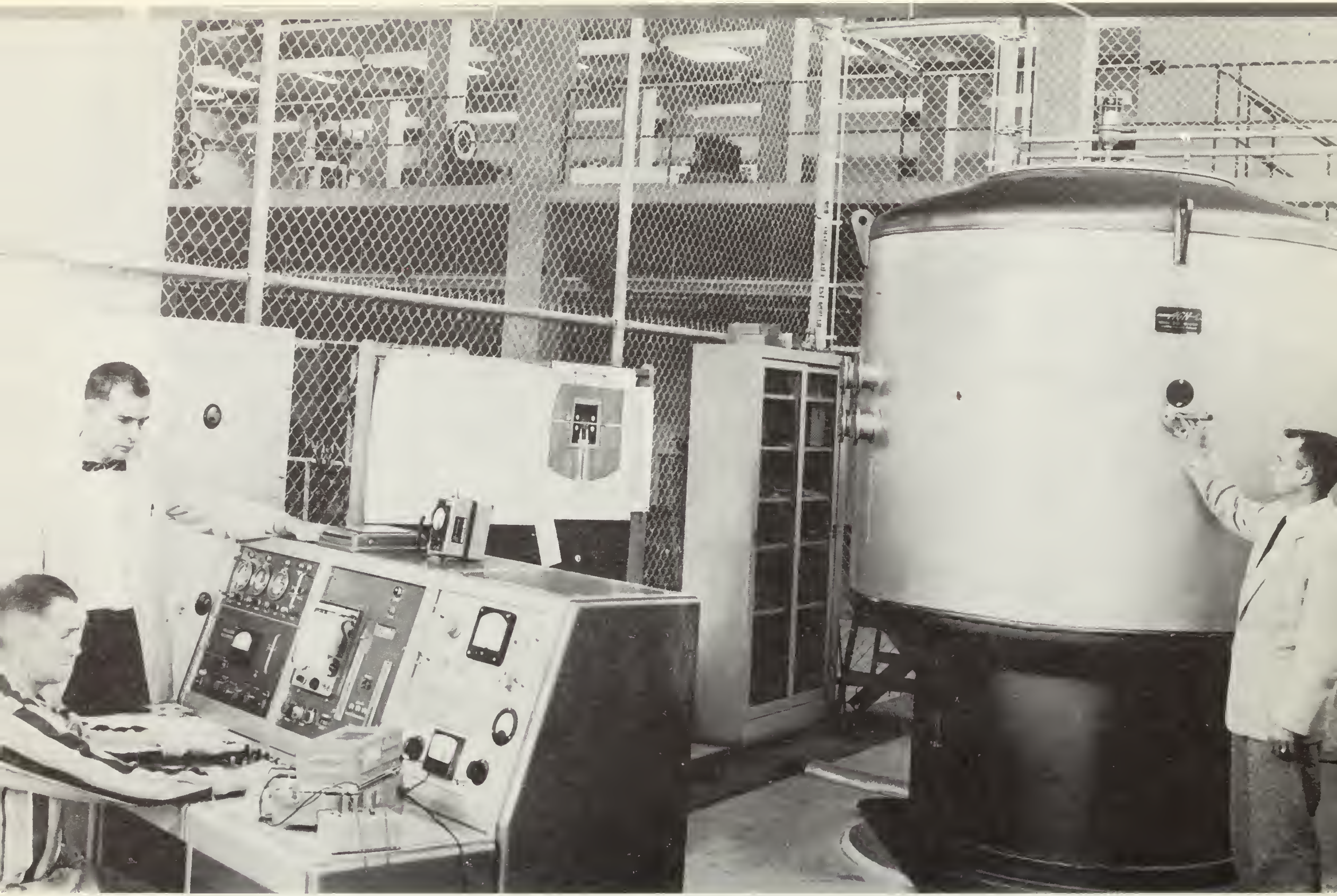
Note: An outline of each curriculum listed above is given on page 57 et seq.

The Engineering School. King Hall, the auditorium, is seen in the foreground.

Many visiting flag officers, themselves graduates of technical postgraduate curricula, enjoy renewing their acquaintance with members of the faculty under whom they studied.

Taking measurements of sound in the Anechoic Chamber.

The electronic digital computer.



Experimental Nuclear Reactor

THE ENGINEERING SCHOOL

ENGINEERING SCHOOL CURRICULA

EXPLANATORY NOTES

Descriptive name of course is followed by two numbers, separated by a hyphen. The first number signifies classroom hours; the second, laboratory hours.

THE ACADEMIC LEVEL OF A COURSE IS INDICATED BY A LETTER IN PARENTHESIS AFTER THE COURSE NUMBER AS FOLLOWS:

(A) Full graduate course

(B) Partial graduate course

(C) Undergraduate course

(L) Lecture course—no academic credit

One term credit-hour is given for each hour of lecture or recitation, and half of this amount for each hour of laboratory work. A term credit-hour is equivalent to two thirds of the conventional college semester credit hour because the Engineering School term is of ten-weeks duration in contrast to the usual college semester of 15 or 16 weeks.

ADVANCED SCIENCE CURRICULA

Chemistry (Group Designator RC)

Hydrodynamics (Group Designator RH)

Metallurgy (Group Designator RMT)

General Physics (Group Designator RP)

Nuclear Physics (Group Designator RX)

Applied Mathematics (Group Designator RM)

OBJECTIVE

To prepare selected officer personnel to deal with the problems of fundamental and applied research in the fields of general physics, nuclear physics, hydrodynamics, chemistry, metallurgy, and applied mathematics.

CURRICULA

Officers nominated for the Advanced Science Curricula are selected from among the first-year students enrolled in the Engineering School of the U. S. Naval Postgraduate School who apply for these curricula. Applicants are carefully screened and only those having a very good academic background and who appear to have an excellent chance of succeeding in their chosen field are nominated.

Officers in the Advanced Science Curricula complete the first year of their curriculum in the Engineering School at the U. S. Naval Postgraduate School. The second and third years are spent at a civilian university. These officers may spend the summer prior to entering the civilian universities on duty at the Office of Naval Research, Washington, D. C., familiarizing themselves with the work of the Office of Naval Research in the basic natural sciences, and preparing themselves for graduate school language requirements.

The curriculum at the civilian university for each officer is arranged from courses selected to suit the needs of the Navy, to develop the capabilities of the individual student and to meet the ultimate objective of his specialty.

The Advanced Science Curricula normally lead to the Master of Science degree for those officers meeting the requirements of the civilian universities for that degree and may, in exceptional cases for especially qualified officers, lead to a Doctor's degree.

BASIC AEROLOGY

(GROUP DESIGNATOR M)

OBJECTIVE

To prepare officers to become qualified for limited aerological duties.

FIRST YEAR (M1)

FIRST TERM

Ma-162(C)	Introduction to Calculus	5-0
Ph-190(C)	Survey of Physics	3-0
Mr-200(C)	Introduction to Meteorology	3-0
Mr-211(C)	Weather Codes, Maps, and Elementary Weather-Map Analysis	2-12
Mr-400(C)	Introduction to Meteorological Instruments	2-0
		15-12

SECOND TERM

Ma-163(C)	Calculus and Vector Analysis	4-0
Mr-212(C)	Surface and Upper-Air Analysis	4-12
Mr-402(C)	Introduction to Meteorological Thermodynamics	3-2
Mr-500(C)	Introduction to Climatology of the Oceans and Atmosphere	3-0
		14-14

THIRD TERM

Mr-110(C)	Aerological Aspects of ABC Warfare	1-1
Mr-213(C)	Upper-Air and Surface Prognosis	3-12
Mr-311(B)	Introduction to Dynamic Meteorology	5-0
Mr-403(C)	Introduction to Micrometeorology	3-0
		12-13

FOURTH TERM

Mr-205(C)	Forecasting Weather Elements and Operational Routines	4-0
Mr-217(B)	Advanced Weather Analysis and Forecasting	0-20
Mr-220(B)	Selected Topics in Applied Meteorology	4-0
Mr-610(C)	Sea and Swell Forecasting	2-2
		10-22

GENERAL AEROLOGY

(GROUP DESIGNATOR MA)

OBJECTIVE

To prepare officers to become qualified aerologists, with a working knowledge of Oceanography as applied to naval operations.

FIRST YEAR (MA1)

FIRST TERM

Ma-161(C)	Algebra, Trigonometry, and Analytic Geometry	5-0
Mr-200(C)	Introduction to Meteorology	3-0
Oc-110(C)	Introduction to Oceanography	3-0
Ph-190(C)	Survey of Physics I	3-0
		14-0

SECOND TERM

Ma-162(C)	Introduction to Calculus	5-0
Mr-201(C)	Weather Codes and Elementary Weather-Map Analysis	3-9
Mr-410(C)	Meteorological Instruments	2-2
Ph-191(C)	Survey of Physics II	3-0
		13-11

THIRD TERM

Ma-163(C)	Calculus and Vector Analysis	4-0
Mr-202(C)	Weather-Map Analysis	2-9
Mr-402(C)	Introduction to Meteorological Thermodynamics	3-2
Oc-210(B)	Physical Oceanography	3-0
		12-11

FOURTH TERM

Ma-381(C)	Elementary Probability and Statistics	4-2
Mr-203(C)	Upper-air Analysis and Prognosis	2-9
Mr-301(B)	Elementary Dynamic Meteorology I	4-0
Oc-620(B)	Oceanography Factors in Underwater Sound I	3-0
		13-11

During intersessional period students are instructed in the aerological aspects of ABC warfare and visit naval and civilian installations.

SECOND YEAR (MA2)

FIRST TERM

Mr-204(C)	Weather Analysis and Forecasting	2-9
Mr-228(B)	Southern Hemisphere and Tropical Meteorology	2-0
Mr-302(B)	Elementary Dynamic Meteorology II	4-0
Mr-521(B)	Synoptic Climatology	3-2
		11-11

SECOND TERM

Mr-403(B)	Introduction to Micrometeorology	4-0
Mr-611(B)	Ocean Waves and Wave Forecasting	3-6
Mr-612(B)	Polar Ice and Sea-Ice Forecasting	3-4
Oc-621(B)	Oceanographic Factors in Underwater Sound II	1-2
		11-12

THIRD TERM

Mr-215(B)	Advanced Weather Analysis and Forecasting	2-9
Mr-220(B)	Selected Topics in Applied Meteorology	4-0
Mr-415(B)	Radar Propagation in the Atmosphere	2-0
	Research Problem	0-6
		8-15

FOURTH TERM

Mr-216(B)	Advanced Weather Analysis and Forecasting	3-0
Mr-217(B)	Advanced Weather Analysis and Forecasting	0-16
Mr-810(A)	Seminar in Meteorology and Oceanography	2-0
Oc-213(B)	Shallow-Water Oceanography	3-0
		8-16

This curriculum affords an opportunity to qualify for the degree of Bachelor of Science in Aerology.

ADVANCED AEROLOGY

(GROUP DESIGNATOR MM)

OBJECTIVE

To prepare officers to become qualified aerologists with a working knowledge of Oceanography as applied to naval operations and to enable them, through advanced study, to conduct independent research.

FIRST YEAR (MM1)

FIRST TERM

Ma-131(C)	Topics in Engineering Mathematics	5-2
Mr-200(C)	Introduction to Meteorology	3-0
Oc-110(C)	Introduction to Oceanography	3-0
Ph-196(C)	Review of General Physics	5-0
		16-2

SECOND TERM

Ma-132(B)	Vector Analysis and Differential Equations	5-0
Mr-201(C)	Weather Codes and Elementary Weather-Map Analysis	3-9
Mr-410(C)	Meteorological Instruments	2-2
Mr-413(B)	Thermodynamics of Meteorology	3-2
		13-13

THIRD TERM

Ma-133(A)	Differential Equations and Vector Mechanics	5-0
Mr-202(C)	Weather-Map Analysis	2-9
Mr-321(A)	Dynamic Meteorology I	3-0
Mr-412(A)	Physical Meteorology	3-0
Oc-210(B)	Physical Oceanography	3-0
		16-9

FOURTH TERM

Ma-125(B)	Numerical Methods of Digital Computers	2-2
Ma-330(C)	Introduction to Statistics	2-0
Mr-203(C)	Upper-Air Analysis and Prognosis	2-9
Mr-228(B)	Southern Hemisphere and Tropical Meteorology	2-0
Mr-322(A)	Dynamic Meteorology II	3-0
Oc-620(B)	Oceanographic Factors in Underwater Sound I	3-0
		14-11

During intersessional period students are instructed in the aerological aspects of ABC warfare and visit naval and civilian installations.

SECOND YEAR (MM2)

FIRST TERM

Ma-331(A)	Statistics	4-2
Mr-204(C)	Weather Analysis and Forecasting	2-9
Mr-229(B)	Selected Topics in Meteorology	2-0
Mr-323(A)	Dynamic Meteorology III (Turbulence and Diffusion)	3-0
Mr-521(B)	Synoptic Climatology	3-2
		14-13

SECOND TERM

Ma-421(A)	Digital and Analog Computation	3-2
Mr-415(B)	Radar Propagation in the Atmosphere	2-0
Mr-611(B)	Ocean Waves and Wave Forecasting	3-6
Mr-612(B)	Polar Ice and Sea-Ice Forecasting	3-4
Oc-621(B)	Oceanographic Factors in Underwater Sound II	1-2
		12-14

THIRD TERM

Mr-215(B)	Advanced Weather Analysis and Forecasting	2-9
Mr-422(A)	The Upper Atmosphere	5-0
Oc-213(B)	Shallow-Water Oceanography	3-0
Thesis I		2-6
		12-15

FOURTH TERM

Mr-216(B)	Advanced Weather Analysis and Forecasting	3-0
Mr-217(B)	Advanced Weather Analysis and Forecasting	0-16
Mr-810(A)	Seminar in Meteorology and Oceanography	2-0
Thesis II		0-8
		5-24

This curriculum affords an opportunity to qualify for the degree of Master of Science in Aerology.

AERONAUTICAL ENGINEERING CURRICULA

AERONAUTICAL ENGINEERING

OBJECTIVE

To provide officers with advanced aeronautical engineering knowledge to meet the technical requirements of the Navy in this field. Specifically, these curricula are designed to cover the fundamental and advanced theories of mathematics, mechanics, metallurgy, structural analysis, aerodynamics, dynamics, aircraft propulsion, electricity and electronics as they concern the particular curriculum.

SUMMARY

The Aeronautical Engineering curricula this year are in a transition period. Classes entering in the summer of 1958 and subsequent thereto will study in only two areas: Aeronautical Engineering (General) and Aeronautical Engineering (Avionics). Each of these areas of study includes both a two year and a three year curriculum.

All students will, however, be enrolled in a common first year of instruction. Upon completion of this first year a two-way split will be made: first, into two and three year curricula groups; second, into the General and Avionics curricula. Although the number of students selected in each case must be in accordance with quotas established by the Chief of Naval Personnel, individual preference as to length of course and field of study is given primary consideration.

Both two year curricula are given entirely at Monterey and normally lead to the degree of Bachelor of Science, Aeronautical Engineering, except for those qualified to study at a higher level. The third year of the three-year curricula is in most cases at a civilian university. Satisfactory completion of these curricula leads to the opportunity to qualify for advanced graduate degrees with a wide range of thesis subjects. The selection of a university for third year work is based upon educational capability, the interest of the student in a suitable aeronautical engineering sub-field for thesis work, and the availability of universities for this purpose.

Students who entered Monterey prior to the summer of 1958 are studying under an older system of curricula arrangement and will finish under programs in effect at the time of their entrance.

AERONAUTICAL ENGINEERING

COMMON FIRST YEAR OF STUDY

FIRST YEAR (A1)

FIRST TERM

Ae-100(C)	Basic Aerodynamics	3-2
Ae-200(C)	Rigid Body Statics	3-2
Ma-151(C)	Differential Equations	5-0
Ma-120(C)	Vector Algebra and Geometry	3-1
Mc-101(C)	Engineering Mechanics	2-2
		16-7

SECOND TERM

Ae-121(C)	Technical Aerodynamics	3-4
Ae-211(C)	Strength of Materials	4-2
Ma-152(B)	Infinite Series	3-0
Ma-158(B)	Topics for Automatic Control	4-0
Mc-102(C)	Engineering Mechanics II	2-2
		16-8
Ae-001(L)	Aeronautical Lecture	0-1

THIRD TERM

Ae-131(C)	Technical Aerodynamics Performance I	4-2
Ae-212(C)	Stress Analysis I	4-2
Ae-409(C)	Aeronautical Thermodynamics	4-2
Ma-125(B)	Numerical Methods for Digital Computers	2-2
EE-281(C)	Basic Electrical Phenomena	3-0
		17-8
LP-101(L)	Lecture Program	0-1

FOURTH TERM

Ae-141(A)	Dynamics I	3-2
Ae-213(B)	Stress Analysis II	4-2
Ae-410(B)	Aeronautical Thermodynamics II	3-2
Ma-153(B)	Vector Analysis	3-0
EE-282(B)	Basic Circuit Analysis	3-2
		16-8
LP-102(L)	Lecture Program	0-1

AERONAUTICAL ENGINEERING, GENERAL

TWO AND THREE YEAR CURRICULA

SECOND YEAR (A2)

FIRST TERM

Ae-142(A)	Aircraft Dynamics I	3-4
Ae-501(A)	Hydro-Aero Mechanics I	4-0
Ch-121(B)	General and Petroleum Chemistry	4-2
Mt-201(C)	Introductory Physical Metallurgy	3-2
Elective		2-0
		16-8

SECOND TERM

Ae-214(A)	Stress Analysis III	3-0
Ae-221(A)	Structures Performance	3-2
Ae-411(B)	Aircraft Engines	4-2
Ae-502(A)	Hydro-Aero Mechanics II	4-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
		17-6
Ae-001(L)	Aeronautical Lecture	0-1

THIRD TERM

Ae-311(C)	Airplane Design I	2-4
Ae-421(B)	Aircraft Propulsion	3-2
Ae-503(A)	Compressibility I	4-0
EE-752(C)	Electronics	3-2
Elective		3-0
		15-8
LP-101(L)	Lecture Program I	0-1

FOURTH TERM

Ae-312(A)	Airplane Design II	1-4
Ae-431(A)	Aerothermodynamics of Turbomachines	3-2
Ae-504(A)	Compressibility II	3-2
EE-652(B)	Transients and Servomechanisms	3-2
Elective		3-0
		13-10
LP-102(L)	Lecture Program II	0-1

NOTES:

1. Electives from the following group:

Ae-151(B)	Flight Testing and Evaluation I	2-0
Ae-215(A)	Advanced Stress Analysis	4-0
Mt-301(A)	High Temperature Materials	3-0
CE-541(A)	Reaction Motors	2-2
Ch-581(A)	Chemistry of Special Fuels	2-2

2. Options available to provide prerequisites for different institutions, to accommodate a variety of thesis areas, or to utilize efficiently laboratory facilities at Monterey:

Term	Option	Drop	Take	
2	Flight Performance	Ae-214(A)	Ae-153(B) Flight Testing and Evaluation III	2-0
			Ae-163(B) Flight Testing and Evaluation Lab III	0-4
3	Flight Performance	Ae-503(A)	Ae-152(B) Flight Testing and Evaluation II	2-0
			Ae-162(B) Flight Testing and Evaluation Lab II	0-4
	Nuclear Propulsion	Ae-503(A)	Ph-660(B) Atomic Physics	4-3
		EE-752(C)	Mt-301(A) High Temperature Materials	3-0
			CE-541(A) Reaction Motors	2-2
	Materials	Ae-503(A)	Ph-610(B) Survey of Atomic and Nuclear Physics	3-0
		EE-752(C)	Mt-104(C) Production Metallurgy	4-0
			CE-541(A) Reaction Motors	2-2
4	Flight Performance	Ae-431(A)	Ae-151(B) Flight Testing and Evaluation I	2-0
		AE-504(A)	Ae-161(B) Flight Testing and Evalution Lab I	0-4
			Ae-508(A) Compressibility	3-2
	Nuclear Propulsion	AE-504(A)	Ae-508(A) Compressibility	3-2
		EE-652(B)	Ph-642(B) Nuclear Physics	4-0
			Ch-561(A) Physical Chemistry	3-2
	Materials	Ae-504(A)	Ae-508(A) Compressibility	3-2
		EE-652(B)	Ch-221(C) Qualitative Analysis	3-2
			Ch-411(C) Physical Chemistry	3-2

AERONAUTICAL ENGINEERING (AVIONICS)

TWO AND THREE YEAR CURRICULA

SECOND YEAR (AV2)

FIRST TERM

Ae-142(A) Dynamics II	3-4
Ae-501(A) Hydro-Aero Mechanics I	4-0
Elective	4-2
Elective	4-2
	15-8

SECOND TERM

Ae-221(A) Structure Performance	3-2
Ae-411(B) Aircraft Engines	4-2
Ae-502(A) Hydro-Aero Mechanics II	4-0
Elective	3-2
Elective	3-2
	17-8
Ae-001(L) Aeronautical Lecture	0-1

THIRD TERM

Ae-316(C) Airplane Design	2-4
Ae-421(B) Aircraft Propulsion	3-2
Elective	3-2
Elective	3-0
Elective	3-0
	14-8
LP-101(L) Lecture Program	0-1

FOURTH TERM

Ae-508(A) Compressibility	3-2
Elective	3-3
Elective	3-2
Elective	3-0
Elective	3-0
	15-7
LP-102(L) Lecture Program	0-1

NOTES:

1. Ae courses show minimum strength for B.S. degree.

2. Electives are chosen from either option group to provide prerequisites for different institutions, to accommodate different thesis areas, or, for the 2-year curriculum, to establish a satisfactory terminus.

Term	OPTION GROUP 1 (Weapons Systems)		OPTION GROUP 2 (Electronics Minor)	
1	EE-283(B) Advanced Circuit Analysis	3-4	Es-261(C) Electron Tubes and Circuits I	3-2
	EE-464(C) Special Machinery	3-4	Es-228(C) Transistors, Transducers	3-2
			Es-129(B) Communication Theory	4-0
2	EE-771(B) Electronics	3-2	Es-262(C) Electron Tubes and Circuits II	3-2
	EE-284(A) Electric Control Circuits	3-2	Es-727(B) Antennas and Feed Systems	3-3
			Es-326(B) Transmitters and Receivers	4-2
3	EE-672(A) Servomechanisms	3-2	Es-421(B) Pulse Techniques	2-3
	EE-772(B) Electronics	3-2	Es-327(B) Electronic Systems	3-3
4	EE-745(A) Electronic Control and Measurement	3-3	Es-422(B) Radar Systems I	3-3
	EE-673(A) Nonlinear Servomechanisms	3-2	Es-433(B) Radar Data Processing and Computer-Controlled Systems	3-3
	Mc-403(A) Kinematics of Guidance	3-0		

3. The Avionics curriculum, offering a three-year course with a major in engineering electronics, will not be offered until 1960 when the present electronics curriculum is phased out. This curriculum will present the opportunity to qualify for an M.S. in Engineering Electronics. It will include the first year of study common to all students entering the Aeronautical Engineering group.

THREE-YEAR CURRICULUM

ELECTRONICS MAJOR

THIRD YEAR (AV3)

See Note 3 page 30.

AERONAUTICAL ENGINEERING

THREE-YEAR CURRICULA

THIRD YEAR

With the exception of the old course Aeronautical Engineering (Electrical) which is now phasing out, all third year work is presently done away from Monterey. Universities currently used and the fields in which they provide the strongest competence for advanced study are as follows:

California Institute of Technology, Pasadena, Cal.	Aerodynamics Structures Jet Propulsion
Massachusetts Institute of Technology, Boston, Mass.	Avionics Airborne Weapons Systems Propulsion
University of Michigan, Ann Arbor, Mich.	Aerodynamics Avionics Propulsion Structures
University of Minnesota, Minneapolis, Minn.	Aerodynamics Propulsion Structures
Princeton University, Princeton, N.J.	Aerodynamics
Stevens Institute of Technology, Hoboken, N.J.	Aero-hydrodynamics
Iowa State College, Ames, Iowa	Nuclear Propulsion
College of Aeronautics, Cranfield, England	Aerodynamics Aircraft Design Propulsion Aircraft Economics and Production Aircraft Electronics

ENGINEERING ELECTRONICS AND COMMUNICATIONS ENGINEERING CURRICULA

COMMUNICATIONS ENGINEERING

(GROUP DESIGNATOR CE)

OBJECTIVE

To prepare unrestricted line officers for important assignments in operations and naval communications afloat and ashore.

FIRST YEAR (CE1)

FIRST TERM

Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-121(C)	Introduction to Engineering Math	3-1
Es-111(C)	Fundamentals of Electric Circuits and Circuit Elements I	4-4
Ph-240(C)	Optics and Spectra	3-3
Co-141(C)	Public Speaking	0-2
		13-11

SECOND TERM

Ma-122(B)	Differential Equations and Vector Calculus	5-0
Es-112(C)	Fundamentals of Electric Circuits and Circuit Elements II	4-3
Es-212(C)	Electron Tube Circuits I	4-3
Ph-620(B)	Atomic Physics	3-0
		16-6

THIRD TERM

Ma-123(A)	Orthogonal Functions and Partial Differential Equations	5-0
Es-113(C)	Circuit Analysis and Measurements I	3-3
Es-213(C)	Electron Tube Circuits II	4-3
Es-116(C)	Transient Circuit Theory	4-2
		16-8

FOURTH TERM

Es-628(C)	Introduction to Electromagnetics	4-0
Es-114(C)	Circuit Analysis and Measurements II	3-3
Es-214(C)	Electron Tube Circuits III	4-3
Es-222(B)	Transistor Electronics	3-3
		14-9

During the intersessional period an extended trip will be made to naval communication facilities to obtain practical experience in various phases of the Naval Communications System.

SECOND YEAR (CE2)

FIRST TERM

Es-381(C)	Systems I	3-3
Es-287(C)	Electron Tubes and Circuits (UHF, Pulse)	3-2
EE-656(B)	Control Machines and Servomechanisms	3-4
Ma-320(C)	Introduction to Statistics and Operations Analysis	4-0
Co-261(C)	Administration and Management	3-0
		16-9

SECOND TERM

Es-382(B)	Systems II	3-3
Es-128(B)	Communication Theory	4-0
Es-787(B)	Antennas and Propagation	3-2
Co-201(C)	Communication Principles and Procedures I	3-1
Co-221(C)	Communications Planning I	2-0
Co-231(C)	Naval Warfare Tactics and Procedures I	2-0
		17-6

THIRD TERM

Es-125(B)	Computers and Data Processors	3-3
Co-202(C)	Communication Principles and Procedures II	3-2
Co-222(C)	Communications Planning II	3-2
Co-232(C)	Naval Warfare Tactics and Procedures II	4-3
		13-10

FOURTH TERM

Es-383(B)	Systems III	3-0
Co-223(C)	Communications Planning III	3-2
Co-233(C)	Naval Warfare Tactics and Procedures III	4-3
Co-211(C)	Cryptographic Methods and Procedures	3-2
		13-7

This curriculum affords an opportunity to qualify for a degree of Bachelor of Science in Communication Engineering.

ENGINEERING ELECTRONICS

BASIC OBJECTIVE

To educate officers in the basic sciences and technical fields related to electronics in order to better equip them to handle electronics problems ashore and afloat. The basic curriculum consists of two years of study at the Naval Postgraduate School. Two advanced curricula are available, within quota limitations to qualified volunteers. One specializes in underwater acoustics and the other in systems design and both consist of three years of study at the Postgraduate School in Monterey. Satisfactory completion of the General curriculum normally leads to the B.S. degree in Engineering Electronics and the three year curricula afford an opportunity to qualify for an M. S. degree.

TWO-YEAR CURRICULUM (GENERAL)

(GROUP DESIGNATOR E)

OBJECTIVE

To further the aims of the basic objective by giving officer students a fundamental course in engineering electronics in order that intelligent understanding of the fields of electronics may be obtained.

FIRST YEAR (E1)

FIRST TERM

Es-111(C)	Fundamentals of Electric Circuits and Circuit Elements I	4-4
Ph-240(C)	Optics and Spectra	3-3
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-121(C)	Introduction to Engineering Mathematics	3-1
		13-9

SECOND TERM

Ma-122(B)	Differential Equations and Vector Calculus	5-0
Es-112(C)	Fundamentals of Electric Circuits and Circuit Elements II	4-3
Es-212(C)	Electron Tube Circuits I	4-3
Ph-620(B)	Atomic Physics	3-0
		16-6

THIRD TERM

Es-113(C)	Circuit Analysis and Measurements I	3-3
Es-213(C)	Electron Tube Circuits II	4-3
Ma-123(A)	Orthogonal Functions and Partial Differential Equations	5-0
Ph-730(A)	Physics of the Solid State	3-3
LP-101(L)	NPS Lecture Program I	0-1
		15-10

FOURTH TERM

Es-615(C)	Introduction to Electromagnetics	4-0
Es-114(C)	Circuit Analysis and Measurements II	3-3
Es-214(C)	Electron Tube Circuits III	4-3
Es-116(C)	Transient Circuit Theory	4-2
LP-102(L)	NPS Lecture Program II	0-1
		15-9

Intersessional period: "Elements of Management and Industrial Engineering" course, MN-101, and a course in the "Art of Presentation" at U. S. Naval Postgraduate School, Monterey.

SECOND YEAR (E2)

FIRST TERM

Es-124(C)	Radio Frequency Measurements	2-3
Es-222(B)	Transistor Electronics	3-3
Es-626(C)	Guided Waves and Resonators	2-0
EE-463(C)	Special Machinery	3-2
Es-326(B)	Transmitters and Receivers	4-2
Es-821(C)	Systems Lectures I	0-1
		14-11

SECOND TERM

Es-727(B)	Antennas and Feed Systems	3-3
EE-670(A)	Servomechanisms	3-3
Es-227(B)	Ultra-high-frequency Techniques	3-2
Es-123(B)	Pulse Techniques	3-3
Es-822(C)	Systems Lectures II	0-1
		12-12

THIRD TERM

Es-129(B)	Communication Theory	4-0
Es-422(B)	Radar Systems I	3-3
Es-125(B)	Computers and Data Processors	3-3
Es-327(B)	Electronic Systems	3-3
Ph-421(B)	Fundamental Acoustics	3-0
LP-101(L)	NPS Lecture Program I	0-1
		16-10

FOURTH TERM

Es-423(B)	Radar Systems II	3-6
Es-323(B)	Missile Guidance Systems	3-0
Ph-428(A)	Underwater Acoustics and Sonar Systems	3-3
Es-823(B)	Systems Seminar	3-0
ME-247(C)	Nuclear Power Plant Survey	1-0
		13-9

Upon completion of curriculum visits will be made to various naval and civilian industrial installations prior to detachment.

THREE-YEAR CURRICULUM (SYSTEMS DESIGN)

(GROUP DESIGNATOR EA)

OBJECTIVE

To further the aims of the basic objective with further study in the basic sciences and special emphasis on systems design.

FIRST YEAR (EA1)

The first, second and third terms are the same as those given to the two-year curriculum (General).

FOURTH TERM

Es-114(C)	Circuit Analysis and Measurements II	3-3
Es-214(C)	Electron Tube Circuits III	4-3
Ma-124(B)	Complex Variable	3-0
Ma-125(B)	Numerical Methods for Digital Computers	2-2
Ph-113(A)	Dynamics	4-0
LP-102(L)	NPS Lecture Program II	0-1
		16-9

Intersessional period: "Elements of Management and Industrial Engineering" course, MN-101, and a course in the "Art of Presentation" at U. S. Naval Postgraduate School, Monterey.

SECOND YEAR (EA2)

FIRST TERM

Ph-431(B)	Fundamental Acoustics	4-0
Es-621(C)	Electromagnetics I	4-0
Es-225(B)	Electron Tubes	3-3
Es-126(C)	R.F. Measurements and Microwave Techniques	2-6
		13-9

SECOND TERM

Ma-321(B)	Probability and Statistics	4-2
Es-622(B)	Electromagnetics II	5-0
Es-221(A)	Transistor Electronics	3-3
Es-121(B)	Advanced Circuit Theory I	4-2
		16-7

THIRD TERM

Ph-432(A)	Underwater Acoustics and Sonar Systems	4-3
Es-127(B)	Pulse and Digital Techniques	3-3
Es-623(A)	Electromagnetics III	4-0
Es-122(A)	Advanced Circuit Theory II	4-2
LP-101(L)	NPS Lecture Program I	0-1
		15-9

FOURTH TERM

Es-321(B)	Communications Systems I	3-3
Es-226(A)	Microwave Tubes and Techniques	3-3
Es-726(B)	Antennas, Transmission Lines	3-3
Es-128(A)	Information Theory I	3-0
LP-102(L)	NPS Lecture Program II	0-1
		12-10

During the intersessional period visits will be made to various naval and civilian industrial installations.

THIRD YEAR (EA3)

FIRST TERM

Es-431(B)	Radar Systems Engineering I	3-3
Es-136(A)	Information Networks	3-2
EE-463(C)	Special Machinery	3-2
Es-139(A)	Information Theory II	3-0
Es-332(B)	Communications Systems II	2-3
		14-10

SECOND TERM

Es-432(B)	Radar Systems Engineering II	3-6
EE-670(A)	Introduction to Servomechanisms	3-3
	Thesis	2-0
Es-333(B)	Communications Systems III	3-3
		11-12

THIRD TERM

This term is spent in an industrial electronics laboratory. During this period the student works as a junior engineer on a selected project which may form part of or be related to his thesis.

FOURTH TERM

Es-836(A)	Project Seminar	0-2
Oa-121(A)	Survey of Operations Analysis	4-2
	Thesis	4-0
Es-334(B)	Communications Systems IV	2-3
Es-335(B)	Electronic Systems	3-3
Me-247(C)	Nuclear Power Plant Survey	1-0
		14-10

THREE-YEAR CURRICULUM (ACOUSTICS)

GROUP DESIGNATOR (EW)

OBJECTIVE

To further the aims of the basic objective with special emphasis on underwater acoustics and sonar.

First Year and Second Year are same as Systems Design Curriculum.

THIRD YEAR (EW3)

FIRST TERM

Es-431(B)	Radar Systems Engineering I	3-3
EE-463(C)	Special Machinery	3-2
Es-139(A)	Information Theory II	3-0
Ph-461(A)	Transducer Theory and Design	3-3
Oc-110(C)	Introduction to Oceanography	3-0
		15-8

SECOND TERM

Es-432(B)	Radar Systems Engineering II	3-6
Es-537(B)	Sonar Systems Engineering Design and Developments	3-3
EE-670(A)	Introduction to Servomechanisms	3-3
Ph-480(A)	Acoustics Seminar	2-0
		11-12

THIRD TERM

This term is spent in an industrial electronics laboratory. During this period the student works as a junior engineer on a selected project which may form part of or be related to his thesis.

FOURTH TERM

Es-836(A)	Project Seminar	0-2
Oa-121(A)	Survey of Operations Analysis	4-2
Ph-433(A)	Propagation of Waves in Fluids	2-0
Ph-442(A)	Shock Waves in Fluids	3-0
Ph-471(A)	Acoustics Research	0-3
	Thesis	4-0
Me-247(C)	Nuclear Power Plant Survey	1-0
		14-7

NAVAL ENGINEERING CURRICULA

ELECTRICAL ENGINEERING

(GROUP DESIGNATOR NLA)

OBJECTIVE

To prepare officers in advanced electrical engineering for technical and administrative duties connected with naval machinery and engineering plants.

FIRST YEAR

FIRST YEAR (NLA1)

FIRST TERM

Ch-121(B)	General and Petroleum Chemistry	4-2
EE-171(C)	Electrical Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-111(C)	Introduction to Engineering Mathemetics	3-1
ME-510(C)	Statics	2-2
		14-10

SECOND TERM

EE-271(C)	Alternating-Current Circuits	3-2
Ma-112(B)	Differential Equations and Infinite Series	5-0
ME-502(C)	Dynamics	2-2
ME-500(C)	Strength of Materials	3-0
Mt-201(C)	Introductory Physical Metallurgy	3-2
		16-6

THIRD TERM

EE-272(B)	Alternating-Current Circuits	2-2
EE-273(C)	Electrical Measurement I	2-3
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
ME-503(A)	Advanced Dynamics	2-2
Mt-208(C)	Physical and Production Metallurgy	4-2
LP-101(L)	NPS Lecture Program I	0-1
		13-10

FOURTH TERM

EE-371(C)	Direct-Current Machinery	3-2
Ma-114(A)	Functions of a Complex Variable and Vector Analysis	3-0
ME-111(C)	Engineering Thermodynamics	4-2
ME-601(C)	Materials Testing Laboratory	0-2
Mt-301(A)	High Temperature Materials	3-0
LP-102(L)	NPS Lecture Program II	0-1
		13-7

Intersessional period: "Elements of Management and Industrial Engineering" course, MN-101, and a course in the "Art of Presentation" at U. S. Naval Postgraduate School, Monterey.

SECOND YEAR (NLA2)

FIRST TERM

EE-274(B)	Electrical Measurement II	2-3
EE-471(C)	Alternating-Current Machinery	3-4
Ma-115(A)	Differential Equations for Automatic Control	3-0
ME-122(C)	Engineering Thermodynamics	3-2
Ma-125(B)	Numerical Methods for Digital Computers	2-2
		13-11

SECOND TERM

EE-472(C)	Alternating-Current Machinery	3-4
EE-971(A)	Seminar	1-0
ME-421(C)	Hydromechanics	3-2
Ma-421(A)	Digital and Analog Computation	3-2
Ph-610(C)	Survey of Atomic and Nuclear Physics	3-0
		13-8

THIRD TERM

EE-571(B)	Transmission Lines and Filters	3-4
EE-771(B)	Electronics	3-2
EE-971(A)	Seminar	1-0
EE-671(A)	Transients	3-4
Ph-361(A)	Electromagnetism	3-0
LP-101(L)	NPS Lecture Program I	0-1
		13-11

FOURTH TERM

EE-670(A)	Servomechanisms	3-3
EE-971(A)	Seminar	1-0
EE-772(B)	Electronics	3-2
ME-310(B)	Heat Transfer (or elective)	4-2
Ph-362(A)	Electromagnetic Waves	3-0
LP-102(L)	NPS Lecture Program II	0-1
		14-8

Intersessional period: A four- or five-week field trip will be arranged in the electrical manufacturing industry.

THIRD YEAR (NLA3)

FIRST TERM

EE-745(A)	Electronic Control and Measurement	3-3
EE-871(A)	Electrical Machine Design	4-0
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
	Thesis	0-6
		9-11

SECOND TERM

EE-872(A)	Electric Machine Design	4-0
EE-971(A)	Seminar	1-0
ME-221(C)	Marine Power Plant Equipment	3-2
	Thesis	0-12
		8-14

THIRD TERM

EE-873(A)	Electrical Machine Design	4-0
EE-971(A)	Seminar	1-0
ME-222(C)	Marine Power Plant Equipment	3-4
LP-101(L)	NPS Lecture Program I	0-1
	Thesis	0-12
		8-17

FOURTH TERM

EE-874(A)	Electrical Machine Design	4-0
EE-971(A)	Seminar	1-0
ME-223(B)	Marine Power Plant Analysis	2-4
ME-240(B)	Nuclear Power Plants	4-0
LP-102(L)	NPS Lecture Program II	0-1
	Thesis	0-8
		11-13

This curriculum affords the opportunity to qualify for the degree of Master of Science in Electrical Engineering.

ENGINEERING MATERIALS

(GROUP DESIGNATOR NM)

OBJECTIVE

To educate officers in the engineering sciences and the principles involved in the treatment, properties, applications, and limitations of various engineering materials.

FIRST YEAR (NM1)

FIRST TERM

Ch-121(B)	General and Petroleum Chemistry	4-2
Ma-111(C)	Introduction to Engineering Mathematics	3-1
ME-501(C)	Statics	2-2
EE-171(C)	Electrical Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
		14-10

SECOND TERM

EE-251(C)	Alternating-Current Circuits	3-4
Ma-112(B)	Differential Equations and Infinite Series	5-0
Mt-201(C)	Introductory Physical Metallurgy	3-2
ME-502(C)	Dynamics	2-2
		13-8

THIRD TERM

EE-351(C)	Direct-Current Machinery	2-2
Mt-208(C)	Physical and Production Metallurgy	4-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Ch-221(C)	Qualitative Analysis	3-2
CE-521(A)	Plastics	3-2
LP-101(L)	NPS Lecture Program I	0-1
		15-9

FOURTH TERM

EE-453(C)	Alternating-Current Mach.	3-4
Ma-114(A)	Functions of a Complex Variable and Vector Analysis	3-0
Ch-231(C)	Quantitative Analysis	2-4
ME-511(C)	Strength of Materials	5-0
LP-102(L)	NPS Lecture Program II	0-1
		13-9

Intersessional period: "Elements of Management and Industrial Engineering" course, MN-101, and a course in the "Art of Presentation" at U. S. Naval Postgraduate School, Monterey.

SECOND TERM (NM2)

FIRST TERM

Cr-311(B)	Crystallography and Mineralogy	3-2
ME-522(B)	Strength of Materials	4-0
ME-611(C)	Mechanical Properties of Engineering Materials	2-2
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
		11-6

SECOND TERM

Ph-240(C)	Optics and Radiation from Atomic Systems	3-3
Mt-301(A)	High Temperature Materials	3-0
CE-611(C)	Thermodynamics	3-2
CE-701(C)	Chemical Engineering Calculations	3-2
Ph-610(C)	Survey of Atomic and Nuclear Physics	3-0
		15-7

THIRD TERM

Ch-411(C)	Physical Chemistry	3-2
CE-721(B)	Unit Operations	3-2
Ch-311(C)	Organic Chemistry	3-2
ME-622(B)	Experimental Stress Analysis	2-2
LP-101(L)	NPS Lecture Program I	0-1
		11-9

FOURTH TERM

Ch-412(C)	Physical Chemistry	3-2
CE-112(A)	Fuels, Combustion, and High Energy Fuels	3-2
ME-240(B)	Nuclear Power Plants	4-0
Ch-312(C)	Organic Chemistry	3-2
Mt-204(A)	Non-Ferrous Metallography	3-3
LP-102(L)	NPS Lecture Program II	0-1
		16-10

Intersessional period: A field trip will be arranged in industry during this period.

ENGINEERING MATERIALS

THIRD YEAR (NM3)

FIRST TERM

CE-722(A)	Unit Operations	3-2
Mt-302(A)	Alloy Steels	3-3
Ch-323(A)	The Chemistry of High Polymers	3-0
Mt-305(B)	Corrosion, Corrosion Protection	3-0
		12-5

SECOND TERM

Mt-306(B)	Engineering Measurements	3-3
Mt-402(B)	Nuclear Reactor Materials—Effects of Radiation	3-0
Mt-205(A)	Adv Physical Metallurgy	3-4
Oc-140(C)	General Oceanography and Marine Biology	3-0
	Thesis	0-3
		12-10

THIRD TERM

Ch-582(A)	Toxicology	3-0
CE-553(A)	Nuclear Chemical Technology	4-3
Mt-800(A)	Metallurgy Seminar	3-0
	Thesis	0-10
LP-101(L)	NPS Lecture Program I	0-1
		10-14

FOURTH TERM

Ch-800(A)	Chemistry Seminar	3-0
Ma-301(B)	Statistics	3-2
Mt-206(A)	Adv Physical Metallurgy	3-4
	Thesis	0-6
LP-102(L)	NPS Lecture Program II	0-1
		9-13

This curriculum affords the opportunity to qualify for the degree, Master of Science.

MECHANICAL ENGINEERING

(GROUP DESIGNATOR NH)

OBJECTIVE

To prepare officers in advanced mechanical engineering, for technical and administrative duties ashore and afloat, involving research, development, design, and inspection of naval machinery and engineering plants.

BASIC CURRICULUM (TWO YEARS)

Designed to supply broad coverage in a variety of subjects which are essential to an understanding of modern naval engineering.

FIRST YEAR (NH1)

FIRST TERM

Ch-121(B)	General and Petroleum Chemistry	4-2
EE-171(C)	Electrical Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
ME-501(C)	Statics	2-2
		14-10

SECOND TERM

EE-251(C)	Alternating-Current Circuits	3-4
Ma-112(B)	Differential Equations and Infinite Series	5-0
ME-502(C)	Dynamics	2-2
Mt-201(C)	Introductory Physical Metallurgy	3-2
		13-8

THIRD TERM

Ch-561(A)	Physical Chemistry	3-2
EE-351(C)	Direct-Current Machinery	2-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
ME-503(A)	Advanced Dynamics	2-2
Mt-208(C)	Physical and Production Metallurgy	4-2
LP-101(L)	NPS Lecture Program I	0-1
		14-9

FOURTH TERM

EE-453(C)	Alternating-Current Machinery	3-4
Ma-114(A)	Functions of a Complex Variable and Vector Analysis	3-0
ME-111(C)	Engineering Thermodynamics	4-2
ME-511(C)	Strength of Materials	5-0
LP-102(L)	NPS Lecture Program II	0-1
		15-7

Intersessional period: "Elements of Management and Industrial Engineering" course, MN-101, and a course in the "Art of Presentation" at U. S. Naval Postgraduate School, Monterey.

SECOND YEAR (NH2)

FIRST TERM

ME-122(C)	Engineering Thermodynamics	3-2
ME-421(C)	Hydromechanics	3-2
ME-522(B)	Strength of Materials	4-0
ME-611(C)	Mechanical Properties of Engineering Materials	2-2
Mt-203(C)	Physical Metallurgy (Special Topics)	2-2
		14-8

SECOND TERM

ME-221(C)	Marine Power Plant Equipment	3-2
ME-422(B)	Hydromechanics	2-2
Ph-610(C)	Survey of Atomic and Nuclear Physics	3-0
ME-711(B)	Mechanics of Machinery	4-2
Mt-301(A)	High Temperature Materials	3-0
		15-6

THIRD TERM

EE-751(C)	Electronics	3-4
LP-101(L)	NPS Lecture Program I	0-1
ME-222(C)	Marine Power Plant Equipment	3-4
ME-712(A)	Dynamics of Machinery	3-2
ME-622(B)	Experimental Stress Analysis	2-2
		11-13

FOURTH TERM

CE-521(A)	Plastics	3-2
LP-102(L)	NPS Lecture Program II	0-1
ME-223(B)	Marine Power Plant Analysis	2-4
ME-240(B)	Nuclear Power Plants	4-0
ME-820(C)	Machine Design	2-4
		11-11

This curriculum affords the opportunity to qualify for the degree of Bachelor of Science in Mechanical Engineering.

MECHANICAL ENGINEERING

ADVANCED CURRICULUM (THREE YEARS)

Designed for students, chosen from the NH Group at the end of the first year, whose performance and records qualify them for advanced study.

FIRST YEAR

Same as first year (NH1)

Intersessional period: "Elements of Management and Industrial Engineering" Course, MN-101, and a course in the "Art of Presentation" at U. S. Naval Postgraduate School, Monterey.

SECOND YEAR (NHA2)

FIRST TERM

Ma-115(A)	Differential Equations for Automatic Control	3-0
ME-112(B)	Engineering Thermodynamics	4-2
ME-512(A)	Strength of Materials	5-0
ME-611(C)	Mechanical Properties of Engineering Materials	2-2
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
		16-6

SECOND TERM

EE-711(C)	Electronics	3-2
ME-211(C)	Marine Power Plant Equipment	3-2
ME-411(C)	Hydromechanics	3-2
ME-711(B)	Mechanics of Machinery	4-2
		13-8

THIRD TERM

ME-212(C)	Marine Power Plant Equipment	3-4
ME-412(A)	Hydromechanics	4-2
Ma-125(B)	Numerical Methods for Digital Computers	2-2
ME-712(A)	Dynamics of Machinery	3-2
LP-101(L)	NPS Lecture Program I	0-1
		12-11

FOURTH TERM

Ma-421(A)	Digital and Analog Computation	3-2
ME-310(B)	Heat Transfer	4-2
Mt-302(A)	Alloy Steels	3-3
ME-513(A)	Theory of Elasticity	3-0
LP-102(L)	NPS Lecture Program II	0-1
		13-8

Intersessional period: A four- or five-week field trip will be arranged to industrial or research activities.

THIRD YEAR (NHA3)

FIRST TERM

EE-651(B)	Transients and Servomechanisms	3-4
ME-215(A)	Marine Power Plant Analysis and Design	2-4
ME-612(A)	Experimental Stress Analysis	3-2
ME-811(C)	Machine Design	3-2
		11-12

SECOND TERM

ME-216(A)	Marine Power Plant Analysis and Design	2-4
ME-812(B)	Machine Design	3-4
Mt-301(A)	High Temperature Materials	3-0
	Thesis	0-2
		8-10

THIRD TERM

Ph-610(C)	Survey of Atomic and Nuclear Physics	3-0
LP-101(L)	NPS Lecture Program I	0-1
	Thesis	0-16
		3-17

FOURTH TERM

CE-521(A)	Plastics	3-2
ME-240(B)	Nuclear Power Plants	4-0
Mt-204(A)	Non-Ferrous Metallography	3-3
LP-102(L)	NPS Lecture Program II	0-1
	Thesis	0-6
		10-12

This curriculum affords the opportunity to qualify for the degree of Master of Science in Mechanical Engineering.

MECHANICAL ENGINEERING (FUELS AND LUBRICANTS) CURRICULUM

(GROUP DESIGNATOR NC)

OBJECTIVE

To educate officers in the thorough understanding of the relationship between designed equipment performance and fuels and lubricants, and in the chemistry, properties and inspection of fuels and lubricants.

FIRST YEAR (NC1)

FIRST TERM

Ch-121(B) General and Petroleum Chemistry	4-2
MA-100(C) Vector Algebra and Geometry	2-1
Ma-111(C) Introduction to Engineering Mathematics	3-1
ME-501(C) Statics	2-2
Ge-101(C) Physical Geology	3-2
	14-8

SECOND TERM

Ch-221(C) Qualitative Analysis	3-2
Mt-201(C) Introductory Physical Metallurgy	3-2
Ma-112(B) Differential Equations and Infinite Series	5-0
ME-502(C) Dynamics	2-2
Ch-701(C) Chemical Engineering Calculations	3-2
	16-8

THIRD TERM

Ch-231(C) Quantitative Analysis	2-4
Ch-311(C) Organic Chemistry	3-2
Ch-411(C) Physical Chemistry	3-2
Ma-113(B) Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Mt-208(C) Ferrous Physical Metallurgy	4-2
LP-101(L) NPS Lecture Program I	0-1
	15-11

FOURTH TERM

Ch-312(C) Organic Chemistry	3-2
Ch-412(C) Physical Chemistry	3-2
Ma-114(B) Functions of a Complex Variable and Vector Analysis	3-0
Me-511(C) Strength of Materials	5-0
Me-111(C) Engineering Thermodynamics	4-2
LP-102(L) NPS Lecture Program II	0-1
	18-7

Intersessional period: "Elements of Management and Industrial Engineering" Course, MN-101, and a course in the "Art of Presentation" at U. S. Naval Postgraduate School, Monterey.

SECOND YEAR (NC2) AT PENNSYLVANIA STATE UNIVERSITY

FALL SEMESTER

Ch E 402—Chemical Engineering	4
ME 31—Heat Power Engineering I	3
Fuel Tech. 201—Introduction to Fuel Technology	2
ME 409—Gas Turbines	3
Physics 454—Atomic and Nuclear Physics	3
	15

SPRING SEMESTER

Ch E 403—Chemical Engineering	4
ME 32—Heat Power Engineering II	3
Fuel Tech. 408—Combustion Technology	3
ME 413—Internal Combustion Engines	3
ME 410—Power Plants	3
	16

Intersessional period: Field trip.

THIRD YEAR (NC3) AT PENNSYLVANIA STATE UNIVERSITY

FALL SEMESTER

Ch E 422—Motor Fuels	2
ME 453—Bearing Design and Lubrication	3
ME 510—Mixture Preparation and Combustion In Internal Combustion Engines	3
Fuel Tech. 406—Gaseous Combustion	3
ME 504—Advanced Engineering Thermodynamics	3
Fuel Tech. 511—Fuel Technology Seminar (audit)	0
	14

SPRING SEMESTER

ME 553—Friction and Lubrication	3
ME 41—Heat Power Engineering III	3
Min. Ec. 486—Petroleum and Natural Gas Economics	3
ME 600—Thesis	6
ME 506—Mechanical Engineering Seminar	1
	16

This curriculum affords the opportunity to qualify for the degree of Master of Science.

MECHANICAL ENGINEERING (GAS TURBINES)

(GROUP DESIGNATOR NJ)

OBJECTIVE

To prepare officers in advanced mechanical engineering, with special emphasis in gas turbine application and development, for technical and administrative duties connected with naval machinery and engineering plants.

The students for the gas turbines program are normally selected, after the end of the first term, from the mechanical engineering (NH) group.

This comprises substantially the same program as mechanical engineering except that selected courses are directed toward gas turbine design and control problems, and thesis work is done in gas turbine field.

FIRST YEAR (NJ1)

FIRST TERM

Ch-121(B)	General and Petroleum Chemistry	4-2
EE-171(C)	Electrical Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
ME-501(C)	Statics	2-2
		14-10

SECOND TERM

Ae-102(C)	Aerodynamics (O, N) I	3-0
Ae-103(C)	Aerodynamics Laboratory I	0-2
EE-251(C)	Alternating-Current Circuits	3-4
Ma-112(B)	Differential Equations and Infinite Series	5-0
ME-502(C)	Dynamics	2-2
		13-8

THIRD TERM

EE-351(C)	Direct-Current Machinery	2-2
Ae-124(C)	Aerodynamics (O, N) II	3-0
Ae-125(C)	Aerodynamics Laboratory II	0-2
Ch-561(A)	Physical Chemistry	3-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
ME-503(A)	Advanced Dynamics	2-2
LP-101(L)	NPS Lecture Program I	0-1
		13-9

FOURTH TERM

EE-453(C)	Alternating-Current Machinery	3-4
Ma-114(A)	Functions of a Complex Variable and Vector Analysis	3-0
ME-111(C)	Engineering Thermodynamics	4-2
ME-511(C)	Strength of Materials	5-0
LP-102(L)	NPS Lecture Program II	0-1
		15-7

Intersessional period: "Elements of Management and Industrial Engineering" Course, MN-101, and a course in the "Art of Presentation" at U. S. Naval Postgraduate School, Monterey.

SECOND YEAR (NJ2)

FIRST TERM

Ae-501(A)	Hydro-Aero Mechanics I	4-0
Ma-115(A)	Differential Equations for Automatic Control	3-0
ME-112(B)	Engineering Thermodynamics	4-2
ME-512(A)	Strength of Materials	5-0
ME-611(C)	Mechanical Properties of Engineering Materials	2-2
		18-4

SECOND TERM

Ae-502(A)	Hydro-Aero Mechanics II	4-0
EE-711(C)	Electronics	3-2
ME-211(C)	Marine Power Plant Equipment	3-2
ME-711(B)	Mechanics of Machinery	4-2
Mt-201(C)	Introductory Physical Metallurgy	3-2
		17-8

THIRD TERM

Ae-508(A)	Compressibility	3-2
LP-101(L)	NPS Lecture Program I	0-1
ME-212(C)	Marine Power Plant Equipment	3-4
ME-513(A)	Theory of Elasticity	3-0
ME-712(A)	Dynamics of Machinery	3-2
Ma-125(B)	Numerical Methods for Digital Computers	2-2
		14-11

FOURTH TERM

Ae-431(A)	Aerothermodynamics of Turbomachines	4-1
Mt-208(C)	Physical and Production Metallurgy	4-2
LP-102(L)	NPS Lecture Program II	0-1
Ma-421(A)	Digital and Analog Computation	3-2
ME-310(B)	Heat Transfer	4-2
		15-8

Intersessional period: A field trip will be arranged in the gas turbine manufacturing industry.

MECHANICAL ENGINEERING (GAS TURBINES)

THIRD YEAR (NJ3)

FIRST TERM

Ae-451(A)	Gas Turbines I	3-0
EE-651(B)	Transients and Servomechanisms	3-4
ME-612(A)	Experimental Stress Analysis	3-2
ME-811(C)	Machine Design	3-2
Mt-203(B)	Physical Metallurgy (Special Topics)	3-2
		15-10

SECOND TERM

Ae-452(A)	Gas Turbines II	3-0
CE-521(A)	Plastics	3-2
ME-812(B)	Machine Design	3-4
Mt-301(A)	High Temperature Materials	3-0
	Thesis	0-4
		12-10

THIRD TERM

LP-101(L)	NPS Lecture Program I	0-1
Ph-610(C)	Survey of Atomic and Nuclear Physics	3-0
	Thesis	0-16
		3-17

FOURTH TERM

LP-102(L)	NPS Lecture Program II	0-1
ME-223(B)	Marine Power Plant Analysis	2-4
ME-240(B)	Nuclear Power Plants	4-0
Mt-302(A)	Alloy Steels	3-3
	Thesis	0-6
		9-14

This curriculum affords the opportunity to qualify for the degree of Master of Science in Mechanical Engineering.

NUCLEAR POWER

GROUP DESIGNATOR (NN)

OBJECTIVE

To educate officers in Reactor Engineering in order to prepare them for technical and administrative duties ashore and afloat involving the development and application of nuclear power.

FIRST YEAR (NN1)

FIRST TERM

Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Ch-121(B)	General and Petroleum Chemistry	4-2
ME-501(C)	Statics	2-2
EE-171(C)	Electrical Circuits and Fields	3-4
		14-10

SECOND TERM

Ma-112(B)	Differential Equations and Infinite Series	5-0
Mt-201(C)	Introductory Physical Metallurgy	3-2
EE-251(C)	Alternating-Current Fields	3-4
ME-502(C)	Dynamics	2-2
		13-8

THIRD TERM

Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Ch-561(A)	Physical Chemistry	3-2
Mt-208(C)	Physical and Production Metallurgy	4-2
Ph-660(B)	Atomic Physics	4-0
Ph-661(B)	Atomic Physics Laboratory	0-3
LP-101(L)	NPS Lecture Program	0-1
		14-8

FOURTH TERM

MA-114(A)	Functions of a Complex Variable and Vector Analysis	3-0
Ph-642(B)	Nuclear Physics	4-0
Ph-643(B)	Nuclear Physics Laboratory	0-3
ME-111(C)	Engineering Thermodynamics	4-2
ME-511(C)	Strength of Materials	5-0
LP-102(L)	NPS Lecture Program II	0-1
		16-6

Intersessional period: Field trip to industrial or research activities associated with the development of nuclear power.

SECOND YEAR (NN2)

FIRST TERM

ME-421(C)	Hydromechanics	3-2
ME-112(C)	Engineering Thermodynamics	4-2
ME-512(A)	Strength of Materials	5-0
ME-611(C)	Mechanical Properties of Engineering Materials	2-2
Ch-551(A)	Radiochemistry	2-4
		16-10

SECOND TERM

Ch-553(A)	Nuclear Chemical Technology	4-3
ME-422(B)	Hydromechanics	2-2
ME-210(C)	Marine Power Plant Equipment	3-2
ME-320(B)	Heat Transfer	3-2
Ph-651(A)	Reactor Theory	3-0
		15-9

THIRD TERM

ME-241(A)	Nuclear Power Plants	3-2
ME-710(B)	Mechanics of Machinery	4-2
Mt-402(B)	Nuclear Reactor Materials, Effects of Radiation	4-0
Mt-301(A)	High Temperature Materials	3-0
LP-101(L)	NPS Lecture Program I	0-1
		14-5

FOURTH TERM

ME-242(A)	Nuclear Power Plants	3-2
ME-250(A)	Nuclear Reactor Laboratory	0-4
ME-223(B)	Marine Power Plant Analysis	2-4
ME-820(C)	Machine Design	2-4
Ph-810(C)	Biological Effects of Radiation	3-0
LP-102(L)	NPS Lecture Program II	0-1
		10-15

This curriculum affords the opportunity to qualify for the degree, Bachelor of Science in Mechanical Engineering.

ORDNANCE ENGINEERING CURRICULA

MINE WARFARE CURRICULUM

GROUP DESIGNATOR (RW)

OBJECTIVE

To educate officers in the various phases of mine warfare in order that they may have a thorough knowledge of mines and mine countermeasures; assist in the development of mines and mine countermeasures, advise commanders afloat in matters concerning mining and mine countermeasures, and analyze and formulate preliminary sweeping instructions for new types of mines discovered in the operating area.

FIRST YEAR (RW1)

FIRST TERM

EE-171(C)	Electrical Circuits and Fields	3-4
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-151(C)	Differential Equations	5-0
Ma-152(B)	Infinite Series	3-0
Or-191(C)	Mines and Mine Mechanisms	2-0
		16-5

SECOND TERM

EE-251(C)	Alternating-Current Circuits	3-4
Ma-153(B)	Vector Analysis	3-0
Ma-157(B)	Complex Variable	4-0
Oc-110(C)	Introduction to Oceanography	3-0
Or-291(C)	Mine Countermeasures I	3-0
		16-4

THIRD TERM

Ae-102(C)	Aerodynamics (Ord) I	3-0
Ae-103(C)	Aerodynamics (Ord) Lab I	0-2
EE-751(C)	Electronics	3-4
Ma-156(B)	Partial Differential Equations	3-0
Ma-361(B)	Probability and Statistical Inference for Engineers I	2-1
Ph-141(B)	Analytical Mechanics	4-0
		15-7

FOURTH TERM

Ch-101(C)	General Inorganic Chemistry	3-2
Ma-362(B)	Probability and Statistical Inference for Engineers II	2-1
Oc-330(A)	Marine Geology and Geophysics	3-0
Or-292(C)	Mine Countermeasures II	1-2
Ph-142(B)	Analytical Mechanics	4-0
Ph-161(A)	Hydrodynamics	3-0
		16-5

Intersessional period: Extended field trip to Headquarters, Commander Mine Force, Pacific and appropriate West Coast Mine Warfare activities.

SECOND YEAR (RW2)

FIRST TERM

Ch-401(A)	Physical Chemistry	3-2
EE-773(A)	Magnetic Amplifiers	2-3
Oa-152(C)	Measures of Effectiveness of Mines	3-0
Oc-230(A)	Wave Phenomena in the Sea	3-0
Or-293(C)	Mine Countermeasures III	2-0
Ph-431(B)	Fundamental Acoustics	4-0
		17-5

SECOND TERM

Ch-580(A)	Electrochemistry	3-2
Ph-311(B)	Electrostatics and Magnetostatics	3-0
Ph-428(A)	Underwater Acoustics and Sonar Systems	3-3
Oa-153(B)	Game Theory and Application to Minefields	3-0
Or-294(A)	Mine Warfare Seminar	2-0
	Thesis	0-4
		14-9

THIRD TERM

Ma-116(A)	Matrices and Numerical Methods	3-2
Ph-312(A)	Applied Electromagnetics	3-0
Ph-442(A)	Shock Waves in Fluids	3-0
Ph-610(C)	Survey of Atomic and Nuclear Physics	3-0
	Thesis	0-6
		12-8

FOURTH TERM

CE-521(A)	Plastics	3-2
CE-591(A)	Blast and Shock Effects	3-0
Ma-421(A)	Digital and Analog Computation	3-2
Mt-201(C)	Intodductory Physical Metallurgy	3-2
Or-392(B)	Minefield Planning	2-0
	Thesis	0-4
		14-10

This curriculum affords the opportunity to qualify for the degree of Master of Science.

Completion of academic work at the Naval Postgraduate School is followed by a comprehensive field trip to appropriate East Coast activities for practical instruction in mine warfare planning, administration, research and development. This trip is arranged and supervised jointly by the sponsors of the curriculum, Chief of Naval Operations, Bureau of Ordnance, and Bureau of Ships.

NUCLEAR ENGINEERING (EFFECTS)

(GROUP DESIGNATOR RZ)

OBJECTIVE

To educate selected officers in such portions of the fundamental sciences as will furnish an advanced technical understanding of the phenomenology of the blast, thermal, nuclear, and biological aspects of atomic weapons effects including the employment and the defensive situations.

This curriculum is sponsored by the Armed Forces Special Weapons Project as a joint-Service course for certain selected officers of the Army, Navy, Air Force, Marine Corps, Coast Guard, and U. S. Public Health Service.

FIRST YEAR (RZ1)

FIRST TERM

Es-271(C)	Electronics I	3-2
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-181(C)	Partial Derivatives and Multiple Integrals	4-1
Mc-101(C)	Engineering Mechanics I	2-2
Ph-240(C)	Optics and Spectra	3-3
		14-9

SECOND TERM

Ch-101(C)	General Inorganic Chemistry	3-2
Es-272(C)	Electronics II	3-3
Ma-182(C)	Vector Analysis and Differential Equations	5-0
ME-500(C)	Strength of Materials	3-0
Mc-102(C)	Engineering Mechanics II	2-2
		16-7

THIRD TERM

Es-273(C)	Electronics III	3-2
Ma-183(B)	Fourier Series and Complex Variables	5-0
Ma-361(B)	Probability and Statistical Inference for Engineers I	2-1
Mc-311(A)	Vibrations	3-2
Ph-141(B)	Analytical Mechanics	4-0
		17-5

FOURTH TERM

Ch-442(C)	Physical Chemistry	4-2
Ma-362(B)	Probability and Statistical Inference for Engineers II	2-1
ME-550(B)	Elements of Dynamic Structural Analysis	5-0
Ph-142(B)	Analytical Mechanics	4-0
Ph-640(B)	Atomic Physics	3-0
Ph-641(B)	Atomic Physics Laboratory	0-3
Ph-750(L)	*Physics Seminar	0-1
		18-7

*Optional

Intersessional period: Field trip to Radiological Defense Laboratory and to Sandia Base for specially tailored Weapons Employment Course given by the Special Weapons Training Group of the Field Command, AFSWP.

SECOND YEAR (RZ2)

FIRST TERM

Ch-315(C)	Organic Chemistry	3-2
ME-350(B)	Heat Transfer	2-2
Ph-441(A)	Shock Waves in Fluids	4-0
Ph-642(B)	Nuclear Physics	4-0
Ph-643(B)	Nuclear Physics Laboratory	0-3
Ph-750(L)	Physics Seminar	0-1
		13-8

SECOND TERM

Bi-800(C)	General Biology	4-2
Ph-361(A)	Electromagnetism	3-0
Ph-530(B)	Thermodynamics	3-0
Ph-721(A)	Introductory Quantum Mechanics	4-0
Ph-750(L)	Physics Seminar	0-1
	Thesis	0-6
		14-9

THIRD TERM

Bi-801(B)	Animal Physiology	4-2
Ch-551(A)	Radiochemistry	2-4
Ph-362(A)	Electromagnetic Waves	3-0
Ph-750(L)	Physics Seminar	0-1
	Thesis	0-8
		9-15

FOURTH TERM

Bi-802(A)	Radiation Biology	4-2
CE-591(A)	Blast and Shock Effects	3-0
Ge-201(C)	Physical Geology	3-0
Ph-541(B)	Kinetic Theory and Statistical Mechanics	4-0
Ph-750(L)	Physics Seminar	0-1
	Thesis	0-4
		14-7

This curriculum affords the opportunity to qualify for the degree of Master of Science in Physics.

OPERATIONS ANALYSIS CURRICULUM

(GROUP DESIGNATOR RO)

OBJECTIVE

To develop the analytical ability of officers by providing a sound scientific background and extensive education in scientific and analytical methods so that they may formulate new work in operations analysis, apply the results of operations research studies with greater effectiveness, and solve the simple problems in operations analysis which arise both in the fleet and ashore.

FIRST YEAR (RO1)

FIRST TERM

Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-181(C)	Partial Derivatives and Multiple Integrals	4-1
Ma-391(C)	Basic Probability	4-0
Oa-892(L)	Orientation Seminar	0-1
Ph-241(C)	Radiation	3-3
		14-6

SECOND TERM

Ma-182(C)	Vector Analysis and Differential Equations	5-0
Ma-392(B)	Basic Statistics	3-2
Oa-291(C)	Introduction to Operations Analysis	4-0
Ph-341(C)	Electricity and Magnetism	4-2
		16-4

THIRD TERM

Ma-125(B)	Numerical Methods for Digital Computers	2-2
Ma-183(B)	Fourier Series and Complex Variables	5-0
Oa-292(B)	Methods of Operations Analysis	4-0
Ph-141(B)	Analytical Mechanics	4-0
Ph-321(B)	Electromagnetism	3-0
		18-2

FOURTH TERM

Ma-195(A)	Matrix Theory and Integration Theory	4-0
Oa-293(B)	Search Theory and Air Defense	4-0
Oa-391(A)	Games of Strategy	3-2
Oa-491(A)	Data Processing for Operations Analysis	3-2
Ph-142(B)	Analytical Mechanics	4-0
		18-4

Intersessional period: Students are assigned individually as working members of various industrial or military Operations Research groups engaged in military problems.

SECOND YEAR (RO2)

FIRST TERM

Ma-393(A)	Design of Experiments	3-2
Oa-201(A)	Logistics Analysis	3-2
Oa-294(A)	Special Topics in Operations Analysis	3-0
Oa-891(B)	Seminar	1-0
Ph-421(B)	Fundamental Acoustics	3-0
Ph-541(B)	Kinetic Theory and Statistical Mechanics	4-0
		17-4

SECOND TERM

Oa-202(A)	Econometrics	3-0
Oa-295(A)	Analysis of Weapons Systems	3-0
Oa-401(A)	Theory of Information Communication	3-0
Ph-425(A)	Underwater Acoustics	3-2
Ph-640(B)	Atomic Physics	3-0
Ph-641(B)	Atomic Physics Lab	0-3
		15-5

THIRD TERM

Co-123(C)	Naval Communications Afloat and Ashore	3-2
Oa-392(A)	Decision Theory	3-0
Ph-642(B)	Nuclear Physics	4-0
Ph-643(B)	Nuclear Physics Lab	0-3
	Thesis	0-10
		10-15

FOURTH TERM

Ma-394(A)	Advanced Statistics	3-0
Mr-120(C)	Operational Aspects of Meteorology and Oceanography	3-0
Oa-296(A)	Design of Weapons Systems	3-0
Oa-893(B)	Seminar	2-2
	Thesis	0-8
		11-10

This curriculum affords the opportunity to qualify for the degree of Master of Science.

ORDNANCE ENGINEERING CURRICULA

BASIC OBJECTIVE

To educate officers in the basic sciences and fundamental mathematics essential to their continuing development and advanced study in the technical engineering fields related to the problems of naval ordnance, ashore and afloat. The knowledge acquired will generally be applied through the medium of assignments in the Naval Ordnance Establishment ashore, and at sea, to the end that the best and most advanced ordnance is available to the Fleet.

GENERAL INFORMATION

All officers ordered to instruction in Ordnance Engineering initially matriculate in the 2-year (General-Industrial) curriculum. This curriculum offers broader coverage of the technical engineering fields at a somewhat lower level than the specialized curricula. At the end of the first term officer students will be selected for transfer into the specialized curricula within quotas assigned by and subject to the approval of the Chief of Naval Personnel. This selection is based on the expressed choice of the individual and the Superintendent's appraisal of his academic ability. Final selection and transfer into the Ordnance Engineering (Fire Control) curriculum is deferred until the end of the fourth term.

ORDNANCE ENGINEERING (GENERAL-INDUSTRIAL)

(GROUP DESIGNATOR O)

OBJECTIVE

To further the aims of the basic objective by providing a broad comprehension of the appropriate engineering fields. Major emphasis is placed on automatic control theory, with its supporting mathematics, as being most universally applicable in the field of naval ordnance, and a foundation is provided for the officers' continuing development with experience in associated engineering and scientific fields. The terminal course in Management and Industrial Engineering provides a comprehension of the problems in these areas and a general approach to their solutions.

FIRST YEAR (O1)

FIRST TERM

EE-171(C)	Electrical Circuits and Fields	3-4
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-151(C)	Differential Equations	5-0
Ma-152(B)	Infinite Series	3-0
		14-5

(Common to all Ord. Engr. Curricula)

SECOND TERM

Ch-101(C)	General Inorganic Chemistry	3-2
EE-251(C)	Alternating Current Circuits	3-4
Ma-157(B)	Complex Variable	4-0
Ma-153(B)	Vector Analysis	3-0
Mc-101(C)	Engineering Mechanics I	2-2
		15-8

(Common to OF)

THIRD TERM

Ch-401(A)	Physical Chemistry	3-2
EE-463(C)	Special Machinery	3-2
Es-261(C)	Electron Tubes and Circuits I	3-2
Ma-155(A)	Differential Equations for Automatic Control	3-0
Mc-102(C)	Engineering Mechanics II	2-2
Or-241(C)	Guided Missiles I	2-0
		16-8

(Common to OF)

FOURTH TERM

Ch-631(A)	Chemical Eng. Thermodynamics	3-2
EE-671(A)	Transients	3-4
Es-262(C)	Electron Tubes and Circuits II	3-2
Mc-201(A)	Methods in Dynamics	2-2
Or-242(B)	Guided Missiles II	2-0
		13-10

(Common to OF)

Intersessional period: Field trip to representative ordnance and industrial installations.

SECOND YEAR (O2)

FIRST TERM

Ch-571(A) Explosives	3-2
EE-670(A) Servomechanisms	3-3
EE-756(A) Electrical Measurement of Non-Electrical Quantities	3-3
Mc-402(A) Mechanics of Gyroscopic Instruments	3-0
Ph-450(B) Underwater Acoustics	3-2
	15-10

SECOND TERM

CE-542(A) Reaction Motors	3-2
EE-673(A) Non-Linear Servo Mechanisms	3-2
Es-446(C) Introduction to Radar	2-2
ME-500(C) Strength of Materials	3-0
ME-601(C) Materials Testing Lab	0-2
Ph-240(C) Optics and Spectra	3-3
	14-11

THIRD TERM

Ma-116(A) Matrices and Numerical Methods	3-2
Ma-351(B) Industrial Statistics I	3-2
Mc-311(A) Vibrations	3-2
Mt-201(C) Introductory Phys. Metallurgy	3-2
Ph-610(C) Survey of Atomic and Nuclear Physics	3-0
	15-8

FOURTH TERM

CE-591(A) Blast and Shock Effects	3-0
Ma-352(B) Industrial Statistics II	2-2
Ma-421(A) Digital and Analog Computation	3-2
Oa-151(B) Survey of Weapons Evaluation	3-0
Mt-202(C) Ferrous Phys. Metallurgy	3-2
Or-105(C) Underwater Ordnance	1-2
	15-8

This curriculum affords the opportunity to qualify for the degree of Bachelor of Science in Electrical Engineering.

Upon completion of the curriculum, officers may expect to attend the six week "Elements of Management and Industrial Engineering" course, MN-101, and a course in the "Art of Presentation" at the U. S. Naval Postgraduate School prior to detachment.

ORDNANCE ENGINEERING (FIRE CONTROL)
(GROUP DESIGNATOR OF)

OBJECTIVE

To further the aims of the basic objective by providing officer students with the fundamental mathematics and applicable basic sciences, followed by intensive study in Fire Control theory, to insure the officers' grasp of this important facet of Naval Ordnance. Emphasis is maintained on the broadened concepts of control associated with new weapons systems.

FIRST YEAR (OF1)

FIRST TERM

EE-171(C) Electrical Circuits and Fields	3-4
Ma-120(C) Vector Algebra and Geometry	3-1
Ma-151(C) Differential Equations	5-0
Ma-152(B) Infinite Series	3-0
	14-5

(Common to all Ord. Engr. Curricula)

SECOND TERM

Ch-101(C) General Inorganic Chemistry	3-2
EE-251(C) Alternating Current Circuits	3-4
Ma-153(B) Vector Analysis	3-0
Ma-157(B) Complex Variable	4-0
Mc-101(C) Engineering Mechanics I	2-2
	15-8

(Common to O)

THIRD TERM

Ch-401(A) Physical Chemistry	3-2
EE-463(C) Special Machinery	3-2
Es-261(C) Electron Tubes and Circuits I	3-2
Ma-155(A) Differential Equations for Automatic Control	3-0
Mc-102(C) Engineering Mechanics II	2-2
Or-241(C) Guided Missiles I	2-0
	16-8

(Common to O)

FOURTH TERM

CE-631(A) Chemical Eng. Thermodynamics	3-2
EE-671(A) Transients	3-4
Es-262(C) Electron Tubes and Circuits II	3-2
Mc-201(A) Methods in Dynamics	2-2
Or-242(B) Guided Missiles II	2-0
	13-10

(Common to O)

Intersessional period: Field trip to representative ordnance and industrial installations.

NOTE: The first academic year and Intersessional Period is common to the Ordnance Engineering (General-Industrial). Final selection is made after the fourth term and transfer to the (Fire Control) curriculum effected at the beginning of the second academic year.

SECOND YEAR (OF2)

FIRST TERM

Ch-571(A)	Explosives	3-2
EE-672(A)	Servomechanisms	3-3
EE-756(A)	Electrical Measurement of Non-Electrical Quantities	3-3
Es-268(C)	Electron Tubes and Ultra-High Frequency Techniques	3-2
Mc-402(A)	Mechanics of Gyroscopic Instruments	3-0
		15-10

SECOND TERM

CE-542(A)	Reaction Motors	3-2
EE-674(A)	Advanced Linear Servo Theory	3-0
Es-461(A)	Pulse Techniques	3-3
Mc-403(A)	Kinematics of Guidance	3-0
Ph-240(C)	Optics and Spectra	3-3
		15-8

THIRD TERM

EE-673(A)	Non-linear Servomechanisms	3-2
Ma-116(A)	Matrices and Numerical Methods	3-2
Ma-351(B)	Industrial Statistics I	3-2
Mc-311(A)	Vibrations	3-2
Ph-610(C)	Survey of Atomic and Nuclear Physics	3-0
		15-8

FOURTH TERM

EE-675(A)	Sampled Data Servo Systems	3-0
EE-676(A)	Linear and Non-Linear Servo Compensation	3-0
Ma-352(B)	Industrial Statistics II	2-2
Ma-421(A)	Digital and Analog Computation	3-2
Oa-151(B)	Survey of Weapons Evaluation	3-0
Or-105(C)	Underwater Ordnance	1-2
		15-6

Successful completion of the Naval Postgraduate School phase qualifies for the award of the degree of Bachelor of Science in Electrical Engineering.

Upon completion of the curriculum, officers may expect to attend the six weeks "Elements of Management and Industrial Engineering" course, MN-101, and a course in the "Art of Presentation" at the U. S. Naval Postgraduate School prior to detachment.

THIRD YEAR (OF3)

At Massachusetts Institute of Technology

FALL SEMESTER

16.33 Instrumentation and Control Lab.
16.39 Vector Kinematics and Gyroscopic Instrument Theory
16.411 Introduction to Weapons Systems
16.47 Rocket Powered Missiles
6.629 Radar System Engineering
Thesis

SPRING SEMESTER

16.421 Weapons Systems
16.44 Weapons Systems Laboratory
Professional Elective
Thesis

This curriculum affords an opportunity to qualify for the degree of Master of Science.

ORDNANCE ENGINEERING (GUIDED MISSILES)

(GROUP DESIGNATOR OG)

OBJECTIVE

To further the aims of the basic objective by providing officer students with the essentials for their development in and with the field of guided missiles, both ashore and afloat. With major emphasis on preparation for control problems, a foundation is provided for comprehending the associated problems involving the aerodynamics, structures, war-heads, and propulsion of guided and ballistic missiles.

FIRST YEAR (OG1)

FIRST TERM

EE-171(C)	Electrical Circuits and Fields	3-4
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-151(C)	Differential Equations	5-0
Ma-152(B)	Infinite Series	3-0
		14-5

(Common to all Ord. Engr. Curricula)

SECOND TERM

Ae-102(C)	Aerodynamics (Ord) I	3-0
Ae-103(C)	Aerodynamics (Ord) Laboratory I	0-2
EE-251(C)	Alternating Current Circuits	3-4
Ma-153(B)	Vector Analysis	3-0
Ma-157(B)	Complex Variable	4-0
Mc-101(C)	Engineering Mechanics I	2-2
		15-8

THIRD TERM

Ae-124(C)	Aerodynamics (Ord) II	3-0
Ae-125(C)	Aerodynamics Laboratory II	0-2
EE-463(C)	Special Machinery	3-2
Es-261(C)	Electron Tubes and Circuits I	3-2
Ma-155(A)	Differential Equations for Automatic Control	3-0
Mc-102(C)	Engineering Mechanics II	2-2
Or-241(C)	Guided Missiles I	2-0
		16-8

FOURTH TERM

Ae-505(A)	Compressible Flow (Ord) I	4-0
EE-671(A)	Transients	3-4
Es-262(C)	Electron Tubes and Circuits II	3-2
Mc-201(A)	Methods in Dynamics	2-2
Or-242(B)	Guided Missiles II	2-0
		14-8

Intersessional period: Extended field trips to appropriate ordnance and industrial activities providing a survey of current development work in the field of guided and ballistic missiles.

SECOND YEAR (OG2)

FIRST TERM

Ae-506(A)	Compressible Flow (Ord) II	3-2
EE-672(A)	Servomechanisms	3-3
EE-756(A)	Electrical Measurements of Non-Electrical Quantities	3-3
Es-268(C)	Electron Tubes and Ultra-High Frequency Techniques	3-2
Mc-402(A)	Mechanics of Gyroscopic Instruments	3-0
		15-10

SECOND TERM

Ae-145(B)	Missile Dynamics	3-2
Ch-101(C)	General Inorganic Chemistry	3-2
EE-674(A)	Advanced Linear Servo Theory	3-0
Es-461(A)	Pulse Techniques	3-3
Mc-403(A)	Kinematics of Guidance	3-0
		15-7

THIRD TERM

Ch-401(A)	Physical Chemistry	3-2
EE-673(A)	Non-Linear Servo Mechanisms	3-2
Es-422(B)	Radar Systems I	3-3
Ma-116(A)	Matrices and Numerical Methods	3-2
Mc-404(A)	Mechanics of Missiles	3-0
		15-9

FOURTH TERM

CE-631(A)	Chemical Engineering Thermodynamics	3-2
EE-675(A)	Sampled Data Servo Systems	3-0
EE-676(A)	Linear and Non-Linear Servo Compensation	3-0
Es-424(B)	Radar Systems II	3-3
Ma-421(A)	Digital and Analog Computation	3-2
		15-7

INTERSESSIONAL PERIOD—INDUSTRIAL EXPERIENCE TOUR

This period (9 weeks) is spent in a guided missiles laboratory working under the cognizance of or under contract to the Bureau of Ordnance. The officer student works as a junior engineer on a project related to or forming a part of his thesis.

THIRD YEAR (OG3)

FIRST TERM

CE-741(A)	Heat Transmission	3-2
Es-341(B)	Radiotelemetry and Simulation	3-3
Ma-351(B)	Industrial Statistics I	3-2
	Thesis	0-8
		9-15

SECOND TERM

CE-542(A)	Reaction Motors	3-2
Ch-571(A)	Explosives	3-2
Ma-352(B)	Industrial Statistics II	2-2
Mc-311(A)	Vibrations	3-2
	Thesis	0-6
		11-14

MID-YEAR GRADUATION

This curriculum affords the opportunity to qualify for the degree of Master of Science in Electrical Engineering.

ORDNANCE ENGINEERING (EXPLOSIVES AND PROPELLANTS)

(GROUP DESIGNATOR OP)

OBJECTIVE

To further the aims of the basic objective by providing officer students with an intensive course of study in the chemistry of explosives and propellants, along with a minimum coverage of the basic mathematics and related sciences most applicable to Ordnance Engineering billets in this field.

FIRST YEAR (OP1)

FIRST TERM

EE-171(C)	Electrical Circuits and Fields	3-4
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-151(C)	Differential Equations	5-0
Ma-152(B)	Infinite Series	3-0
		14-5

(Common to all Ord. Engr. Curricula)

SECOND TERM

Ch-101(C)	General Inorganic Chemistry	3-2
Ch-221(C)	Qualitative Analysis	3-2
CE-711(C)	Chemical Engineering Calculations	3-2
EE-251(C)	Alternating Current Circuits	3-4
Ma-154(B)	Differential Equations for Automatic Control	3-0
		15-10

THIRD TERM

Ch-231(C)	Quantitative Analysis	2-4
Ch-302(C)	Organic Chemistry	4-2
EE-463(C)	Special Machinery	3-2
EE-751(C)	Electronics	3-4
Or-241(C)	Guided Missiles I	2-0
		14-12

FOURTH TERM

Ch-443(C)	Physical Chemistry	4-2
Ch-571(A)	Explosives	3-2
CE-611(C)	Thermodynamics	3-2
EE-651(B)	Transients and Servomechanisms	3-4
Or-242(B)	Guided Missiles II	2-0
		15-10

Intersessional period: Extended field trips to ordnance activities or contractors working in the field of explosives or propellants.

SECOND YEAR (OP2)

FIRST TERM

Ch-324(A)	Organic Qualitative Analysis	2-4
Ch-444(A)	Physical Chemistry, Adv	3-4
CE-614(A)	Thermodynamics	3-2
Mt-201(C)	Introductory Physical Metallurgy	3-2
		11-12

SECOND TERM

Ch-416(A)	Physical Chemistry, Adv	3-2
CE-522(A)	Plastics and High Polymers	3-2
CE-624(A)	Advanced Thermodynamics	3-2
Ch-800(A)	Chemistry Seminar	0-2
Mt-202(C)	Ferrous Physical Metallurgy	3-2
		12-10

THIRD TERM

CE-625(A)	High Temperature Thermodynamics	2-2
CE-741(A)	Heat Transfer	3-2
Ma-351(B)	Industrial Statistics I	3-2
Mt-301(A)	High Temperature Materials	3-0
	Thesis	0-8
		11-14

FOURTH TERM

CE-112(A)	High Energy Fuels	3-2
CE-542(A)	Reaction Motors	3-2
CE-591(A)	Blast and Shock Effects	3-0
Ma-352(B)	Industrial Statistics II	2-2
	Thesis	0-6
		11-12

This curriculum affords an opportunity to qualify for the degree of Master of Science in Chemistry.

Upon completion of the curriculum, officers may expect to attend the six weeks "Elements of Management and Industrial Engineering" course, MN-101, and a course in the "Art of Presentation" at the U. S. Naval Postgraduate School prior to detachment.

ORDNANCE ENGINEERING (UNDERWATER ORDNANCE)

(GROUP DESIGNATOR OU)

OBJECTIVE

To further the aims of the basic objective by providing officer students with the basic sciences and engineering fundamentals essential to their professional development in and with the field of Underwater Ordnance. Major emphasis is placed on the control and guidance of mobile underwater weapons with a foundation provided for the comprehension of associated problems in this field.

FIRST YEAR (OU1)

FIRST TERM

EE-171(C)	Electrical Circuits and Fields	3-4
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-151(C)	Differential Equations	5-0
Ma-152(B)	Infinite Series	3-0
		14-5

(Common to all Ord. Engr. Curricula)

SECOND TERM

Ch-101(C)	General Inorganic Chemistry	3-2
EE-251(C)	Alternating-Current Circuits	3-4
Ma-153(B)	Vector Analysis	3-0
Ma-157(B)	Complex Variable	4-0
Mc-101(C)	Engineering Mechanics I	2-2
		15-8

THIRD TERM

Ae-102(C)	Aerodynamics (Ord) I	3-0
Ae-103(C)	Aerodynamics (Ord) Lab I	0-2
EE-463(C)	Special Machinery	3-2
Es-261(C)	Electron Tubes and Circuits I	3-2
Ma-155(A)	Differential Equations for Automatic Control	3-0
Ma-156(A)	Partial Differential Equations	3-0
Mc-102(C)	Engineering Mechanics	2-2
		17-8

FOURTH TERM

EE-671(A)	Transients	3-4
Es-262(C)	Electron Tubes and Circuits II	3-2
Mc-201(A)	Methods in Dynamics	2-2
Or-105(C)	Underwater Ordnance	1-2
Ph-161(A)	Hydrodynamics	3-0
		12-10

Intersessional period: Extended field trips to appropriate activities providing a survey of current development work in the field of Underwater Ordnance.

SECOND YEAR (OU2)

FIRST TERM

Ch-401(A)	Physical Chemistry	3-2
EE-672(A)	Servomechanisms	3-3
EE-756(A)	Electrical Measurement of Non-Electrical Quantities	3-3
Mc-402(A)	Mechanics of Gyroscopic Instruments	3-0
Ph-431(B)	Fundamental Acoustics	4-0
		16-8

SECOND TERM

Ch-580(A)	Electrochemistry	3-2
EE-674(A)	Advanced Linear Servo Theory	3-0
Mc-403(A)	Kinematics of Guidance	3-0
Ph-311(B)	Electrostatics and Magnetostatics	3-0
Ph-428(A)	Underwater Acoustics	3-3
		15-5

THIRD TERM

EE-673(A)	Non-Linear Servomechanisms	3-2
Ma-116(A)	Matrices and Numerical Methods	3-2
Ma-351(B)	Industrial Statistics I	3-2
Ph-312(A)	Applied Electromagnetics	3-0
Ph-442(A)	Shock Waves in Fluids	3-0
		15-6

FOURTH TERM

EE-675(A)	Sampled Data Servo Systems	3-0
Ma-352(B)	Industrial Statistics II	2-2
Ma-421(A)	Digital and Analog Computation	3-2
Mc-311(A)	Vibrations	3-2
Ph-461(A)	Transducer Theory and Design	3-3
		14-9

This curriculum affords an opportunity to qualify for the degree of Master of Science in Electrical Engineering.

Upon completion of the curriculum, officers may expect to attend the six week "Elements of Management and Industrial Engineering" course, MN-101, and a course in the "Art of Presentation" at the U. S. Naval Postgraduate School prior to detachment.

ORDNANCE ENGINEERING (SPECIAL PHYSIC)S

(GROUP DESIGNATOR OX)

OBJECTIVE

To further the aims of the basic objective by educating officers in the fundamentals of Nuclear Physics with particular emphasis on those topics basic to the field of nuclear and thermonuclear weapons in order to develop their capacity for understanding and evaluating the capabilities and limitations of these weapons.

FIRST YEAR (OX1)

FIRST TERM

EE-171(C)	Electrical Circuits and Fields	3-4
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-151(C)	Differential Equations	5-0
Ma-152(B)	Infinite Series	3-0
		14-5

(Common to all Ord. Engr. Curricula)

SECOND TERM

EE-251(C)	Alternating-Current Circuits	3-4
Ma-153(B)	Vector Analysis	3-0
Ma-157(B)	Complex Variable	4-0
Ph-141(B)	Analytical Mechanics	4-0
Ph-240(C)	Optics and Radiation from Atomic Systems	3-3
		17-7

THIRD TERM

EE-474(C)	Synchros	2-0
Es-261(C)	Electron Tubes and Circuits I	3-2
Ma-155(A)	Differential Equations for Automatic Control	3-0
Ma-156(A)	Partial Differential Equations	3-0
Ph-142(B)	Analytical Mechanics	4-0
Ph-361(A)	Electromagnetism	3-0
		18-2

FOURTH TERM

EE-671(A)	Transients	3-4
Es-262(C)	Electron Tubes and Circuits II	3-2
Ph-144(A)	Analytical Mechanics	4-0
Ph-362(A)	Electromagnetic Waves	3-0
Ph-530(B)	Thermodynamics	3-0
		16-6

Intersessional Period: Field trips to activities concerned with nuclear weapons development, test, and defense including a specially tailored Weapons Employment Course presented by the Special Weapons Training Group of the Field Command, AFSWP.

SECOND YEAR (OX2)

FIRST TERM

EE-670(A)	Servomechanisms	3-3
Es-267(A)	Ultra-High Frequency Techniques	3-2
Ph-541(B)	Kinetic Theory and Statistical Mechanics	4-0
Ph-640(B)	Atomic Physics	3-0
Ph-641(B)	Atomic Physics Lab	0-3
Ph-750(L)	Physics Seminar	0-1
		13-9

SECOND TERM

EE-673(A)	Non-Linear Servomechanisms	3-2
Es-461(A)	Pulse Techniques	3-3
Ph-642(A)	Nuclear Physics	4-0
Ph-643(A)	Nuclear Physics Lab	0-3
Ph-721(A)	Introductory Quantum Mechanics	4-0
Ph-750(L)	Physics Seminar	0-1
		14-9

THIRD TERM

Es-161(A)	Electronic Instrumentation I	3-3
Ma-116(A)	Matrices and Numerical Methods	3-2
Ma-351(B)	Industrial Statistics I	3-2
Ph-644(A)	Advanced Nuclear Physics	4-0
Ph-645(A)	Advanced Nuclear Physics Lab.	0-3
Ph-750(L)	Physics Seminar	0-1
		13-11

FOURTH TERM

Ma-352(B)	Industrial Statistics II	2-2
Ma-421(A)	Digital and Analog Computation	3-2
Ph-441(A)	Shock Waves in Fluids	4-0
Ph-650(A)	Nuclear Instrumentation	4-0
Ph-723(A)	Physics of the Solid State	4-0
Ph-750(L)	Physics Seminar	0-1
		17-5

Intersessional period: Eastern field trip to BuOrd and appropriate organizations in the Washington, D. C. area concerned with nuclear weapons and to a national laboratory engaged in nuclear research.

THIRD YEAR (OX3)

The third year consists of approximately ten months' work in a junior staff capacity at the Berkeley Radiation Laboratory of the University of California. A thesis is prepared during this period under the aegis of the Naval Postgraduate School. This curriculum affords the opportunity to qualify for the degree of Master of Science in Physics from the Naval Postgraduate School.

SPECIAL MATHEMATICS CURRICULUM

SPECIAL MATHEMATICS

(GROUP DESIGNATOR S)

OBJECTIVE

A two- or three-year curriculum, sponsored by the Chief of Naval Operations, to further the education of specially selected officers in higher mathematics, with emphasis on mathematical logic, mathematical statistics, and the application of digital computers.

The course has been given at the University of Illinois, and more recently at the Naval Postgraduate School. Special courses are taken to meet the requirements of the individual student.

CURRICULA CONDUCTED ENTIRELY AT OTHER INSTITUTIONS

The short titles and descriptive names of the courses are taken from the college catalogue concerned. Further information must be sought in such catalogue.

All of these curricula are subject to changes from year to year, due to scheduling problems at the institution, the backgrounds of individual students, and other reasons.

Each curriculum is assigned to one of the curricular officers of the Engineering School for supervision and administration of the Postgraduate School responsibilities, including initiation of changes to the curriculum, contact with students and college faculty, and related functions.

DESCRIPTIONS

CIVIL ENGINEERING (Qualification)

(GROUP DESIGNATOR ZGQ)

At Rensselaer Polytechnic Institute

OBJECTIVE

A seventeen-month curriculum, to qualify officers for civil engineering duties. Successful completion of this course normally leads to appointment in the Civil Engineer Corps. At present this is the only program for transfer of line officers to the Civil Engineering Corps.

Refresher Period 8 weeks

11.90 Mathematics (CEC)
17.05 Mechanics and Strength of Materials (CEC)
5.08 Surveying Curves and Earthwork (CEC)

SUMMER SESSION

5.76 Structural Analysis I
5.78 Reinforced Concrete I
10.11 Engineering Geology

FALL TERM

5.05 Photogrammetry (CEC)
5.09 Contracts and Specifications
5.15 Highways and Airports (CEC)
5.75 Building Construction
5.77 Structural Design I
5.80 Structural Analysis II
7.72 Utilization of Electrical Energy in Naval Establishment (CEC)

SPRING TERM

5.32 Soil Mechanics (CEC)
5.79 Reinforced Concrete II
T5.82 Indeterminate Structures I
12.42 Heating and Ventilation (CEC)
13.541 Metallurgy and Welding (CEC)
G5.82 Shipbuilding and Ship Repair Facilities (CEC)
T16.60 Physics of Nuclear Reactors

SECOND SUMMER SESSION

5.59 Sanitary Engineering
7.69 Power Plants (CEC) Electrical Engineering
12.48 Power Plants (CEC) Mechanical Engineering
5.35 Foundation Engineering (CEC)

This curriculum affords the opportunity to qualify for the degree of Bachelor of Civil Engineering.

CIVIL ENGINEERING, ADVANCED

ELECTRICAL ENGINEERING

A program of 12 months' study at a civilian university specializing in power plants and electrical power distribution. The curriculum will afford the opportunity for the student to qualify for a Masters Degree.

CIVIL ENGINEERING, ADVANCED

MECHANICAL ENGINEERING

A program of 12 months' study at a civilian university specializing in power plants, heating and ventilation. The curriculum will afford the opportunity for the student to qualify for a Masters Degree.

CIVIL ENGINEERING, ADVANCED

SOIL MECHANICS AND FOUNDATIONS
(GROUP DESIGNATOR ZGR)

At Rensselaer Polytechnic Institute

OBJECTIVE

To provide advanced technical education for selected CEC officers in the field of soil mechanics and foundations.

SUMMER TERM

11.25 Engineering Mathematics
10.11 Engineering Geology
Soil Mechanics and Foundations Refresher

CURRICULA AT OTHER INSTITUTIONS

FALL TERM

11.41 Advanced Calculus
10.12 Advanced Engineering Geology
G5.30 Soil Mechanics I
G5.32 Foundation Engineering I
G5.87 Prestressed Concrete
G5.37 Soil Mechanics III

SPRING TERM

G5.31 Soil Mechanics II
G5.33 Foundation Engineering II
T5.25 Hydrology
G5.82 Shipbuilding and Ship Repair Facilities (CEC)
G5.36 Soil Mechanics Seminar
G5.49 Thesis

This Curriculum affords the opportunity to qualify for the degree of Master of Civil Engineering.

CIVIL ENGINEERING, ADVANCED STRUCTURES (GROUP DESIGNATOR ZGI)

At the University of Illinois

OBJECTIVE

To provide advanced technical instruction for selected CEC officers in the field of structural design.

FIRST SUMMER

Math 343 Advanced Calculus
CE461 Structural Theory and Design
CE493 Special Problems

FALL SEMESTER

CE481 Numerical and Approx. Methods of Structural Analysis
CE486 Investigations in Reinforced Concrete Members
CE493 Special Problems
CE461 Structural Theory and Design
CE373 Int. to Soil Mechanics
TAM421 Mechanics of Materials
TAM461 Inelastic Behavior of Eng. Materials

SPRING SEMESTER

CE482 Buckling, Vibrations and Impact
CE484 Behavior of Structures under Dynamic Load
CE467 Investigations in Reinforced Concrete Members
CE493 Special Problems
CE374 Applied Soil Mechanics
TAM462 Inelastic Behavior of Eng. Materials

The student selects courses from those tabulated above to suit his background needs and to carry the normal load of five units per term.

SECOND SUMMER

CE462 Structural Theory and Design
CE491 Thesis
TAM424 Properties of Eng. Materials

This curriculum affords the opportunity to qualify for the degree of Master of Science in Civil Engineering.

CIVIL ENGINEERING, ADVANCED SANITARY ENGINEERING (GROUP DESIGNATOR ZGM)

At the University of Michigan

OBJECTIVE

To provide advanced technical instruction for selected CEC officers in the field of water supply and sewerage.

SUMMER

CE120 Fundamentals of Experimental Research
CE152 Water Purification and Treatment
CE131 Cost Analysis and Estimating

FALL

BACT109 Bacteriology for Engineers
CE153 Sewerage and Sewage Disposal
CE155 Environmental Sanitation
EH260 Sanitary Chemistry
EH264 Stream Sanitation

SPRING

CE157 Industrial Waste Treatment
CE250 Sanitary Engineering Research
CE254 Advanced Sanitary Engineering Design
CE255 Sanitary Engineering Seminar
EH265 Advanced Stream Sanitation
NE190 Elements of Nuclear Engineering
or
EH228 Radiological Health

This curriculum affords the opportunity to qualify for the degree of Master of Science in Engineering.

CIVIL ENGINEERING, ADVANCED WATERFRONT FACILITIES (GROUP DESIGNATOR ZGP)

At Princeton University

OBJECTIVE

To provide advanced technical instruction in waterfront development, including planning, design, construction, rehabilitation and maintenance of waterfront facilities.

SUMMER TERM

Mathematics
Strength of Materials
Reinforced Concrete
Fluid Mechanics
Soil Mechanics

FALL TERM

CE505 Advanced Structures
CE511 Waterfront Structures
CE513 Port and Harbor Engineering. Research preparatory to the writing of the thesis
One elective from the following group:
CE501 Soil Stabilization
ME531 Applied Elasticity
ME525 Industrial Management
SOC 544 Urban Sociology

SPRING TERM

CE512 Waterfront Structures
Thesis
Two electives from the following group:
CE502 Soil Mechanics
CE504 Municipal Engineering
CE508 Soil Physics
POLITICS 512 Public Administration

This curriculum affords the opportunity to qualify for the degree of Master of Science.

HYDROGRAPHIC ENGINEERING
(GROUP DESIGNATOR ZV)
At Ohio State University

OBJECTIVE

A one-year course in Hydrographic Engineering given to officers nominated by the Hydrographer. The curriculum presents a sound fundamental theoretical knowledge of geodesy, cartography and photogrammetry, particularly as applied to hydrographic surveying, and the compilation and production of charts and maps. The course enables the graduate to perform future hydrographic duties at the Hydrographic Office, on hydrographic survey expeditions or on major fleet staffs.

JUDGE ADVOCATE OFFICERS ADVANCED COURSE
(GROUP DESIGNATOR ZHV)
at JAG's School (Army), Charlottesville, Virginia

OBJECTIVE

A nine months' curriculum designed to prepare more experienced officer-lawyers for advanced staff responsibilities in the various legal fields. Course encompasses all branches of military law with emphasis on the administration of justice under the Uniform Code of Military Justice; military affiairs; civil affairs arising out of the operation of, or interest to, the military Departments, including claims, civil litigation, and martial law; military reservations; international law, including the law of war; procurement and contract law; and legal assistance to military personnel.

METALLURGICAL ENGINEERING
(GROUP DESIGNATOR ZNM)
At Carnegie Institute of Technology

OBJECTIVE

To obtain the maximum possible metallurgical background in a nine-month program designed specifically for the graduate of the Naval Construction and Engineering Curriculum.

FALL SEMESTER

E611 Physical Metallurgy
E641 Ferrous Metallurgy
E645 Metallography Lab.
E647 Non-Ferrous Metallography
E651 Mechanical Metallurgy
E661 Modern Metallurgical Practice
S125 Physical Chemistry
S291 Statistical Quality Control

SPRING SEMESTER

E612 Physical Metallurgy
E642 Ferrous Metallography
E646 Metallography Lab.
E648 Non-Ferrous Metallography
E624 Process Metallurgy
E662 Modern Metallurgy Practice
S126 Physical Chemistry
S292 Statistical Quality Control

Successful completion of this curriculum may lead to a B.S. degree in Metallurgy depending on the academic background of the student.

NAVAL ARCHITECTURE (ADVANCED HYDRODYNAMICS) CURRICULUM
(GROUP DESIGNATOR ZNA)

University of California
(Two Semesters)

OBJECTIVE

To provide advanced education in the hydrodynamic aspects of Naval Architecture.

Required Courses
ME298 Ship Theory (Hydrodynamics) (3) two semesters
ME298 Foil and Hydrofoil Theory (3) one semester
MA270 Technical Hydrodynamics (3) one semester

Electives as required for complete program of about 12 units per semester from:
ME298 Ship Theory (Structures) (3)

ME298 Free Surface Effects (2)
ME298 Theory of Plates and Shells (4)
PH222 Mathematical Methods of Theoretical Physics (3)
Statistics 130E Statistical Inference for Engineers (3)
ME298 Acoustics in Naval Architecture (3)
ME299 Special Study

NAVAL CONSTRUCTION AND ENGINEERING (GROUP DESIGNATOR ZNB)

At Massachusetts Institute of Technology and at Webb Institute of Naval Architecture

OBJECTIVE

To qualify officers for naval construction and engineering assignments. Successful completion of this curriculum normally leads to "Engineering Duty" designation.

Hull Design and Construction Subspecialty (XIII-A-1) at M.I.T.

FIRST SUMMER

2.046 Strength of Materials
8.03S Physics (Electricity)
13.20 Elementary Ship Design
M73 Review of Mathematics

FIRST YEAR

FALL

1.612 Fluid Mechanics
2.081 Str. of Materials
2.402 Heat Engineering
13.71 History of Warships
M351 Adv. Calc. for Eng.

SPRING

1.44 Struc. Eng. Elem.
10.311 Heat Transfer
13.012 Naval Arch.
13.12 Warship Gen. Arrgts.
13.791 Marine Propellers
352 Adv. Calc. for Eng.
Intersessional period: Field trip.

SECOND YEAR

FALL

1.63 Appl. Hydromechanics
3.391 Prop. of Metals
13.13 Warship Struc. Th. I
13.22 Warship Gen. Design
13.75 Warship Prop. I
13.90 Warship Elec. Eng.
N101 Int. Nucl. Tech. I

SPRING

1.452 Structural Analysis
3.392 Prop. of Metals
13.14 Warship Struc. Th. II
13.24 Warship Struc. Des. I
13.76 Warship Prop. II
N102 Int. Nucl. Tech. II
Elective:
1.683 Exp. Hydromechanics
Intersessional period: Field trip.

THIRD YEAR

FALL

2.126 Exp. Stress Anal.
3.15 Welding Eng.
13.15 Warship Basic Des.
13.16 Warship Basic Des. II
13.25 Warship Struc. Des. II
13.54 Mar. Eng. Dynamics
Thesis
1.561 Adv. Struc. Mech. Elective.

SPRING

13.04 Ship Design Adv.
13.26 Prel. Des. of War.
13.92 Problems in Shipyard Management
Thesis
Elective:
1.562 Adv. Struct. Mech.

This curriculum affords the opportunity to qualify for the degree of Naval Engineer and the degree of Master of Science in Naval Construction and Marine Engineering.

NOTE: Three other sub-specialties are offered, all of which contain basic ship design, but proportionately greater amount of other phases of marine engineering. These are:

XIII-A-2 Marine Electrical Engineering
XIII-A-3 Ship Propulsion Engineering
XIII-A-4 Nuclear Engineering

Hull Design and Construction at Webb Institute of Naval Architecture

This three-year curriculum is basically equivalent to the Hull Design and Construction Subspecialty at M.I.T. The schedule provides for a long winter practical work period (field trip), each year, during which the students work in a naval shipyard or other suitable installation.

FIRST SUMMER

Practical Naval Architecture I
Calculus Review
Mechanics Review

FIRST YEAR

Calculus III and IV
Differential Equations
Theoretical Fluid Mechanics I and II
Ship Model Testing
Thermodynamics I
Mechanical Processes
Mechanics of Materials I and II
Laying Off

Practical Naval Architecture II and III
Theoretical Naval Architecture I and II
Naval Architecture Design I and II
Ship Resistance and Propellers I

SECOND YEAR

Engineering Economic Analysis
Industrial Organization
Metallurgy I and II
Advanced Structures I and II
Structural Laboratory
Electrical Engineering IV
Ship Resistance and Propellers II
Elementary Nuclear Physics and Reactors
Theoretical Naval Architecture III
Theory of Warship Design I and II
Warship Design I and II
Thermodynamics II
Marine Engineering III and IV

THIRD YEAR

Advanced Theoretical Fluid Mechanics
Vibrations
Machine Design
Theory of Warship Design III and IV
Warship Design III and IV
Marine Engineering V and VI
Internal Combustion Engines
Nuclear Power in Warship Design
Thesis

This curriculum affords the opportunity to qualify for the degree of Master of Science.

NAVAL INTELLIGENCE
(GROUP DESIGNATOR ZI)

At the U. S. Naval Intelligence School, Washington, D. C.

OBJECTIVE

Nine months of instruction to train selected officers in all phases of intelligence. Following the intelligence course the students normally study a foreign language to qualify as an interpreter-translator. The length of time devoted to language study is dependent upon the language studied and the previous linguistic training of the student.

NUCLEAR ENGINEERING (Advanced)
(GROUP DESIGNATOR ZNE)

At Massachusetts Institute of Technology

OBJECTIVE

To qualify officers for the technical direction of nuclear power development in the Navy. Graduates of this program can normally expect to be assigned duties within the nuclear power development program under the direction of the Bureau of Ships. This curriculum affords the opportunity to qualify for the degree of Master of Science.

FIRST SUMMER

8.06N Nuclear Physics
M351 Advanced Calculus
M352 Advanced Calculus
8.051 Atomic and Nuclear Physics

FALL

8.531 Nuclear Physics for Engineers I
3.396 Technology of Nuclear Reactor Material
2.522 Heat Transfer, Advanced
N20 Biological Effects of Radiation
N21 Nuclear Reactor Theory I

SPRING

8.532 Nuclear Physics for Engineers II
N23 Nuclear Reactor Engineering
N41 Nuclear Engineering Laboratory I
Thesis

One elective selected from:
N22 Nuclear Reactor Theory II
2.521 Advanced Heat Transfer II
6.67 Nuclear Reactor Control
3.43 Corrosion
3.44 Behavior of Metals at Elev. Temp.

SECOND SUMMER

Thesis

OCEANOGRAPHY
(GROUP DESIGNATOR ZO)

At the University of Washington

OBJECTIVE

A twelve-month curriculum to prepare officers for assignment to billets requiring knowledge in the field of oceanography. The curriculum provides a comprehensive theoretical and practical foundation in the various aspects of oceanography, including submarine geology, physical oceanography, chemical oceanography, marine meteorology, and marine biology. A summer period of work at sea and in the laboratory is included. For students with an adequate educational background, this curriculum affords the opportunity to qualify for the degree of Bachelor of Science.

PERSONNEL ADMINISTRATION AND TRAINING
(GROUP DESIGNATOR ZP)

At Stanford University

OBJECTIVE

A one-year curriculum to prepare officers for assignment in personnel administration and supervision or administration of training activities. It includes instruction in Statistical Methods; General, Educational and Social Psychology; General and Educational Sociology; General School Supervision; Counselling Techniques; Guidance; Personnel Management; Administration; Business and Professional Speaking; Personnel Test and Measurements; and Record Studies.

PETROLEUM ADMINISTRATION AND MANAGEMENT

(Gas, Oil and Water Rights)
(GROUP DESIGNATOR ZHS)

at Southern Methodist University

OBJECTIVE

A one year curriculum to prepare officer-lawyers for assignment to billets concerned with the administration and management of the Naval Petroleum Reserves and with the special problems in water rights. This curriculum provides the student with a study of government regulations in oil and gas law taxation problems, and special research and study of the evolution of law concerning water rights, current law affecting these rights, and technical problems encountered.

This course leads to a Masters Degree for qualified officers. Appropriation restrictions may require the student to pay for his thesis expenses.

PETROLEUM ENGINEERING

(GROUP DESIGNATOR ZL)

At the University of Pittsburgh and in the petroleum industry

OBJECTIVE

A program consisting of two terms of academic work at the University of Pittsburgh followed by about one year in the field with a major integrated oil company. It is designed to equip naval officers with a knowledge of petroleum production engineering as well as a broad understanding of the petroleum industry. Future billet assignments may be in the Naval Petroleum Reserve system and in the higher echelons of the Defense Department concerned with petroleum logistics and where liaison with the oil industry is required.

FIRST TERM

FALL

Ch.E. 17	Petroleum Processes for Petroleum Engineers
Ch.E. 11	Industrial Calc. for Pet. Engr.
Geology 2	Historical Geology
Pet. Engr. 101	Drilling and Development
Pet. Engr. 104	Business of Oil and Gas Prod.
Pet. Engr. 106	Pet. Production Laboratory
Pet. Engr. 110	Fundamentals of Reservoir Engr.

SECOND TERM

SPRING

Ch.E. 12	Industrial Calc. for Pet. Engr.
Pet. Engr. 102	Pet. Production Practice
Pet. Engr. 111	Principles of Nat. Gas Engr.
Pet. Engr. 113	Natural Gas Laboratory
Pet. Engr. 127	Valuation of Oil and Gas Porp.
Pet. Engr. 107	Gathering, Transp. and Storage
Geology 120	Geology of Oil and Gas for Engr.

The curriculum does not lead to a baccalaureate degree.

RELIGION

(GROUP DESIGNATOR ZU)

At selected universities

OBJECTIVE

Each officer student enrolled in this curriculum pursues courses of instruction in such subjects as psychology, theology, homiletics, counselling, hospital ministry and education.

An officer selected in this curriculum will be enrolled at Harvard University, Catholic University, University of Chicago, University of Notre Dame, Fordham University, Union Theological Seminary, or the Menninger Foundation, depending on the field of study selected.

SOCIAL SCIENCES

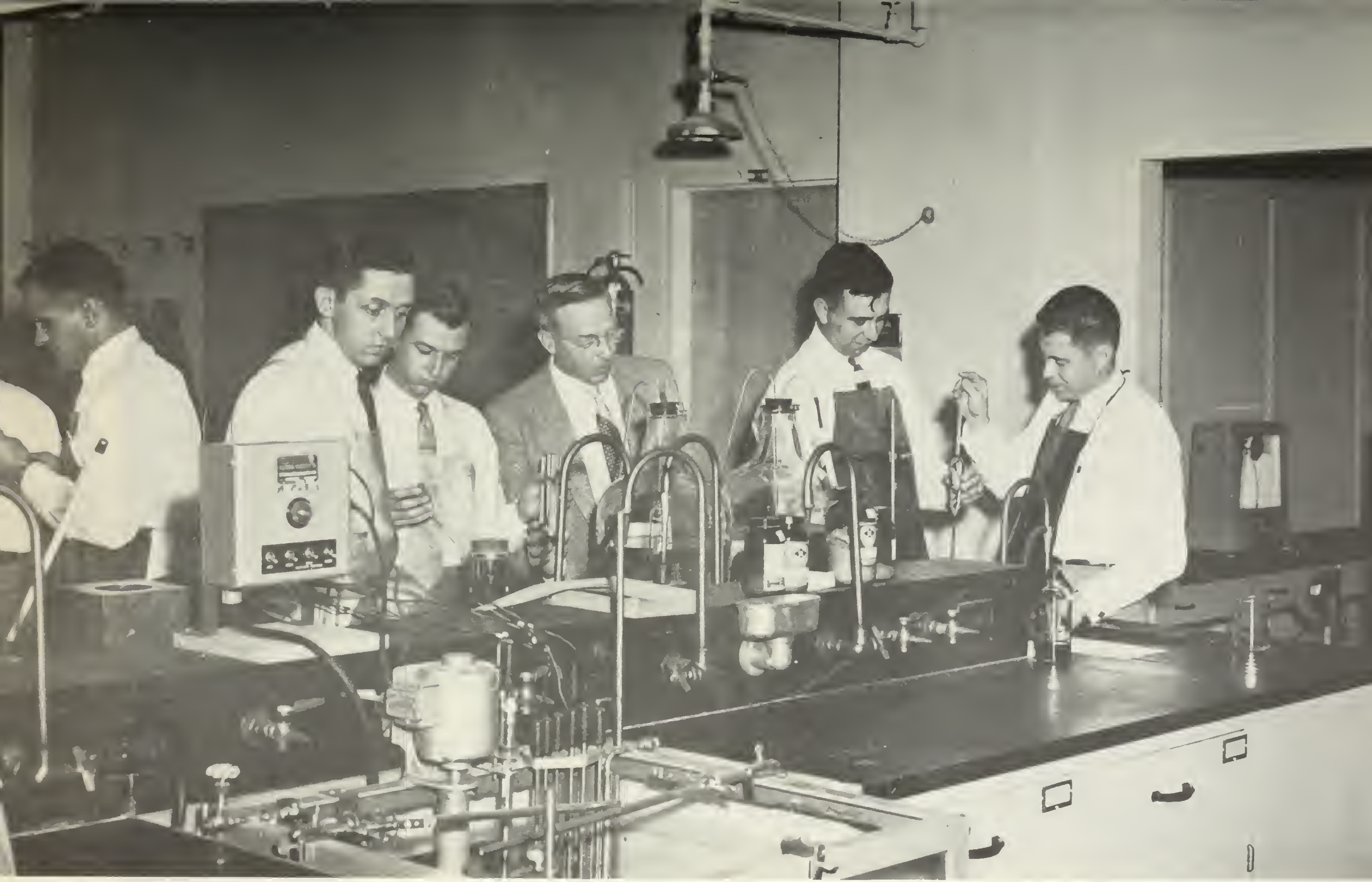
(GROUP DESIGNATOR ZST)

at Tufts University

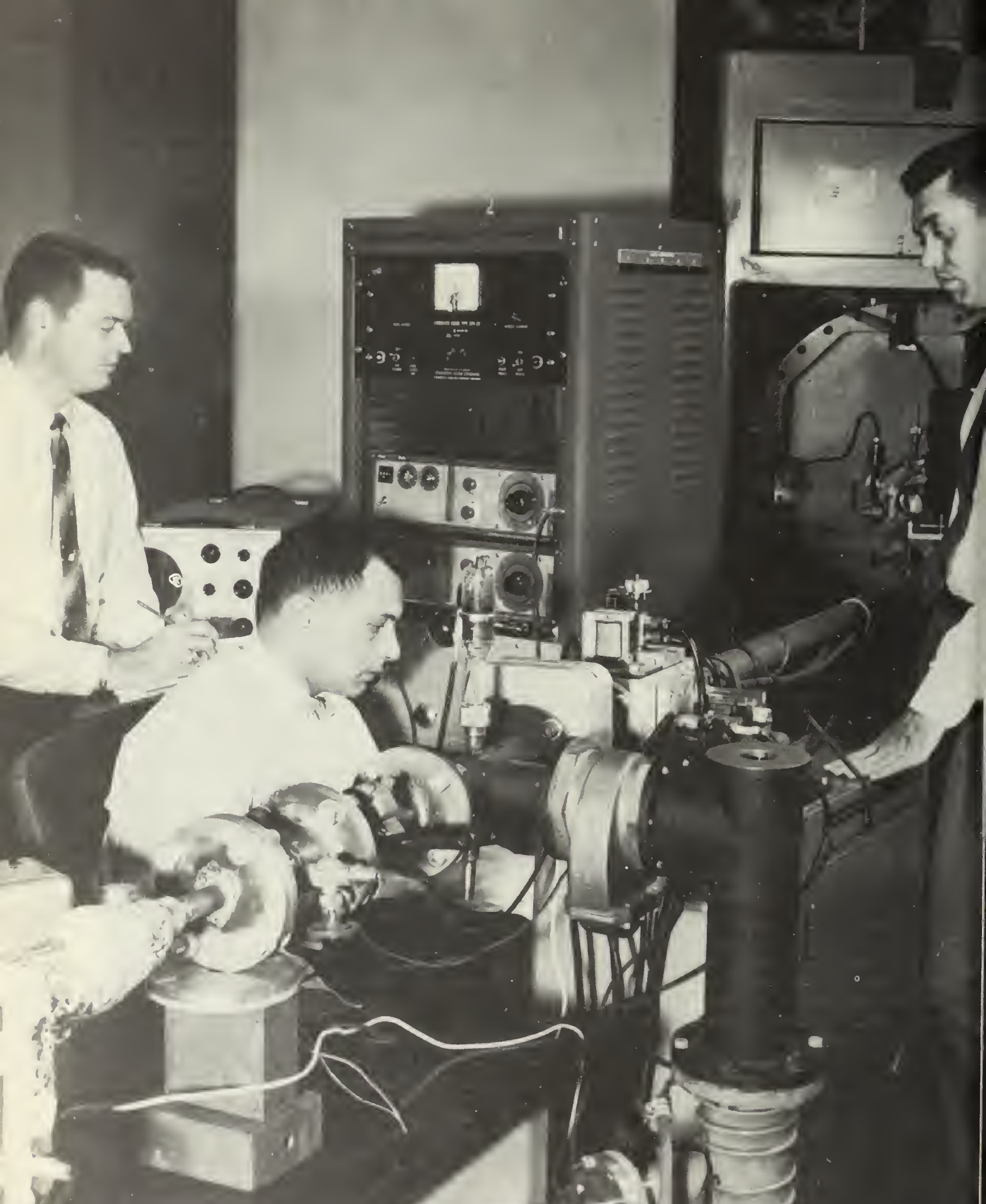
OBJECTIVE

A two year curriculum to prepare officers of mature judgment and broad background of professional knowledge in the fields of international relations, economics, political science, sociology, geography and history. Leads to a Master's Degree for qualified officers.

It is expected that this curriculum will also be presented at Stanford University.



Physical Chemistry Laboratory



Students utilizing the two-million-volt Van de Graff nuclear accelerator, part of the physics laboratory equipment.

THE ENGINEERING SCHOOL

ENGINEERING SCHOOL COURSE DESCRIPTIONS

Explanatory Notes

Descriptive name of course is followed by two numbers, separated by a hyphen. The first number signifies classroom hours; the second, laboratory hours.

THE ACADEMIC LEVEL OF A COURSE IS INDICATED BY A LETTER IN PARENTHESIS AFTER THE COURSE NUMBER AS FOLLOWS:

(A) Full graduate course

(B) Partial graduate course

(C) Undergraduate course

(L) Lecture course—no academic credit

One term credit-hour is given for each hour of lecture or recitation, and half of this amount for each hour of laboratory work. A term credit-hour is equivalent to two thirds of the conventional college semester credit hour because the Engineering School term is of ten-weeks duration in contrast to the usual college semester of 15 or 16 weeks.

AEROLOGY

Mr Courses

Mr-100(C) Fundamentals of Atmospheric Circulation 2-0

Primarily designed to give non-aerological officer students a survey of meteorology. The topics included are essentially the same as in Mr-200; however, there is greater emphasis on large-scale and small-scale circulations.

Texts: Taylor: Elementary Meteorology; Petterssen: Introduction to Meteorology.

Prerequisite: None.

Mr-110(C) Aerological Aspects of Atomic, Biological, and Chemical Warfare 1-1

Classified information involving the effects of weather on ABC warfare.

Text: Los Alamos Scientific Laboratory: The Effects of Atomic Weapons.

Prerequisites: Ph-196(C) or equivalent and Mr-212(C).

Mr-120(C) Operational Aspects of Meteorology and Oceanography 3-0

The properties of the atmosphere and the oceans and their distribution; the mean pattern of the general circulation and the seasonal and short-term variations from the mean; methods of predicting atmospheric and oceanographic conditions, and the influence of these conditions on naval operations.

Texts: Shepard: Submarine Geology; NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare; departmental notes.

Prerequisite: None.

Mr-200(C) Introduction to Meteorology 3-0

A general course which treats descriptively the composition and vertical structure of the atmosphere, physical processes, general circulation, air masses, fronts, cyclones and anticyclones.

Texts: Taylor: Elementary Meteorology; Petterssen: Introduction to Meteorology.

Prerequisite: None.

Mr-201(C) Weather Codes and Elementary Weather-Map Analysis 3-9

Lectures cover the encoding, decoding, and plotting of data; objectives of analysis; upper-air map analysis, including contours and height extrapolation; surface-chart analysis, including isobars, fronts, representativeness and diurnal variation of meteorological elements; atmospheric properties and processes and their graphical representation; three-dimensional frontal structure. Laboratory work includes decoding and plotting of data, analysis of 500-mb and surface charts, and familiarization flights in an aircraft specially modified to serve as an aerological laboratory.

Texts: Berry, Bollay, and Beers: Handbook of Meteorology; H.O. 206: Radio Weather Aids; various Navy and Weather Bureau code publications; departmental notes.

Prerequisite: Mr-200(C).

Mr-202(C) Weather-Map Analysis 2-9

Lectures cover wave cyclones and occlusions; upper-air analysis, including temperature, moisture, the tropopause, and the jet stream; graphical arithmetic; large-scale aspects of analysis. Practical work is continued in all phases of analysis of sea-level and upper-air charts (especially 850-mb and 500-mb charts), aided by soundings and local weather observations. Space and time differentials as well as advection charts are analysed and interpreted. Daily map discussions are begun. A series of flights is made in which students prepare cross sections of data observed enroute, copy broadcasts, and become familiar with flight problems.

Texts: NavAer 50-1P-502: Practical Methods of Weather Analysis and Prognosis; departmental notes.

Prerequisite: Mr-201(C).

Mr-203(C) Upper-Air Analysis and Prognosis 2-9

A continuation of Mr-202(C). Lectures cover integrated analysis of the lower and upper troposphere; pressure-change mechanisms, and other features of upper-air prognostic value, including long waves, blocks, cut-off lows, vorticity considerations, short waves, and zonal winds. In the laboratory, students prepare thickness and thermal-advection charts, isotach analyses, and make isobaric height extrapolations. Elementary methods of upper-air prognosis are introduced, and three-dimensional consistency in analysis is stressed. The weather-flight series is continued from Mr-202(C).

Texts: Berry, Bollay, and Beers: Handbook of Meteorology; NavAer 50-1P-502: Practical Methods of Weather Analysis and Prognosis: Riehl et al.: Forecasting in Middle Latitudes; departmental notes.

Prerequisite: Mr-202(C).

Mr-204(C) Weather Analysis and Forecasting 2-9

A continuation of Mr-203(C). Discussions of upper-air prognostic techniques are continued with more detailed applications of long waves and vorticity to upper-air prognosis; weather types; prognosis at the surface with special emphasis on movement and intensification of surface pressure systems and fronts. Objective and subjective techniques of forecasting weather elements are introduced. In the laboratory, students prepare analyses and prognoses of surface and upper-level charts, stressing time as well as space consistency. Space-mean and geostrophic relative vorticity charts are also constructed. The weather flight series is continued from Mr-203(C).

Texts: Riehl et al.: Forecasting in Middle Latitudes; NavAer 50-1P-502: Practical Methods of Weather Analysis and prognosis; selected NavAer, AROWA, and AWS publications; departmental notes.

Prerequisite: Mr-203(C).

Mr-205(C) Forecasting Weather Elements and Operational Routines 4-0

Lectures cover significance and forecasting of clouds, precipitation, temperature, wind, icing, turbulence, and severe weather; flight forecasting and weather briefing; forecasting for ship and amphibious operations; radar meteorology; CAA and general flight manuals, instructions, and supplements; aerological office organization, administration, and operations. Students prepare a climatology study or work on a technical problem.

Texts: NavAer 50-110R-50: Weather Briefing Manual; OpNav Inst 3140.32: Manual of the Aerological Service; other selected publications; departmental notes.

Prerequisites: Mr-213(C) and Mr-400(C).

Mr-211(C) Weather Codes, Maps, and Elementary Weather-Map Analysis 2-12

Lectures cover the encoding, decoding, and plotting of data; objectives of analysis; upper-air map analysis, including contours, the jet stream, and height extrapolation; surface-chart analysis, including isobars, fronts, representativeness and diurnal variation of meteorological elements; atmospheric properties and processes and their graphical representation; three-dimensional frontal structure. Laboratory work includes decoding and plotting of data, analysis of 500-mb and surface charts, and familiarization flights in an aircraft specially modified to serve as an aerological laboratory.

Texts: Berry, Bollay, and Beers: Handbook of Meteorology; H.O. 206; Radio Weather Aids; various Navy and Weather Bureau code publications; departmental notes.

Prerequisite: Mr-200(C) concurrently.

Mr-212(C) Surface and Upper-Air Analysis 4-12

Continuation of Mr-211(C). Lectures cover synoptic characteristics of wave cyclones and occlusions; upper-air analysis, including temperature and moisture fields; graphical arithmetic; thickness and height-change charts. Prognostic techniques discussed include mechanism of pressure change, long-wave and vorticity methods, thickness and continuity charts. The laboratory consists of practice in preparation of sea-level, constant-pressure, and differential charts, with elementary techniques of prognosis. A series of flights is made in which students prepare observed cross sections, learn to use computers, take observations, copy broadcasts, and become familiar with flight problems.

Texts: NavAer 50-1P-502: Practical Methods of Weather Analysis and Prognosis; departmental notes.

Prerequisites: Mr-200(C), Mr-211(C), and Mr-402(C).

Mr-213(C) Upper-Air and Surface Prognosis 3-12

Movement and development of surface pressure systems, movement of fronts, weather types, airmass properties and weather, wind forecasts, and a checkoff list for general prognostic procedure. Laboratory work includes analysis and prognosis for North America and the adjacent Pacific, both surface and 500 mb, using supplementary charts of pressure changes, vorticity, and stability indices; and forecasts for various selected stations and areas. Flight program same as for Mr-212(C).

Texts: Same as for Mr-212(C).

Prerequisites: Mr-212(C), Mr-311(B), and Mr-403(B) concurrently.

Mr-215(B) Advanced Weather Analysis and Forecasting 2-9

Lectures concern forecasting of actual operational weather. Topics covered are radiosonde analysis for stability, and frontal and air-mass identification; severe-weather forecasting including tornadoes, hail, turbulence, maximum wind gusts, icing, and operational weather affecting jet aircraft. In the laboratory, analysis of surface and upper-air charts by coordinated teams is introduced; spot and period forecasts are made for selected stations. Weather elements forecasted include surface winds, weather, visibility, and temperatures; upper-level winds, temperatures, and pressure patterns; and ceilings.

Texts: AWSM 105-37: Severe Weather Forecasting; NavAer 00-80T-37: All Weather Flight Manual; selected articles from Monthly Weather Review and AMS publications; departmental notes.

Prerequisite: Mr-204(C).

Mr-216(B) Advanced Weather Analysis and Forecasting 3-0

Lectures cover general operational weather problems; weather briefing for overseas flight clearances, carrier strikes, and amphibious operations; single-station forecasting; radar meteorology; CAA and general flight manuals, instuctions, and supplements; fleet and area commanders' instruction; detailed climatology of major areas of interest; aerological office organization, administration, and operations.

Texts: NavAer 50-110R-50: Weather Briefing Manual; other selected NavAer publications.

Prerequisite: Mr-215(B).

Mr-217(B) Advanced Weather Analysis and Forecasting 0-16*

Students are assigned watches in weather central duties, aerological office routines, and flight forecasting utilizing surface, constant-pressure, jet-stream and isotach analyses; time cross sections, constant absolute-vorticity trajectories, space-mean, pressure-change, and relative-vorticity charts are constructed; daily prognostic surface and upper-air charts are prepared and forecasts made for selected stations; flight cross sections, forecasts, and clearances are prepared for selected over-water and over-land routes; rawinsondes are taken, plotted, and analyzed and experience is gained in teletype, radio-facsimile, and other aerological office routine and operation. A series of maps for tropical areas is analyzed.

Text: None.

Prerequisite: Mr-215(B) or Mr-213(C).
*Presented as 0-20 course for the M curriculum.

Mr-220(B) Selected Topics in Applied Meteorology 4-0

Tropical and polar meteorology; the general circulation; other topics as time permits.

Texts: Riehl: Tropical Meteorology; Petterssen, Jacobs, and Haynes: Meteorology of the Arctic; NavAer publications; departmental notes.

Prerequisites: Mr-311(B) or Mr-302(B), and Mr-402(C).

Mr-228(B) Southern Hemisphere and Tropical Meteorology 2-0

Southern Hemisphere synoptic meteorology, tropical synoptic models (with emphasis on the tropical cyclone), and tropical forecasting.

Text: Riehl: Tropical Meteorology.

Prerequisite: Mr-321(A).

Mr-229(B) Selected Topics in Meteorology 2-0

General circulation of the atmosphere, arctic and antarctic meteorology, extended-range forecasting, and recent developments as time permits.

Texts: Haltiner and Martin: Dynamical and Physical Meteorology; selected NavAer and AWS publications.

Prerequisites: Mr-322(A), Ma-125(B), and Ma-331(A).

Mr-301(B) Elementary Dynamic Meteorology I 4-0

The equations of motion; trajectories and streamlines; thermal wind; mechanism of pressure changes and kinematics of pressure systems.

Texts: Haltiner and Martin: Dynamical and Physical Meteorology; departmental notes.

Prerequisites: Mr-200(C), Ph-191(C), and Ma-162(C).

Mr-302(B) Elementary Dynamic Meteorology II 3-0

A continuation of Mr-301(B). Topics covered include frontogenesis; frontal characteristics; vorticity changes; general circulation.

Texts: Same as for Mr-301(B).

Prerequisites: Mr-301(B), Mr-402(C), and Ma-163(C).

Mr-311(B) Introduction to Dynamic Meteorology 5-0

The equations of motion; trajectories and streamlines; thermal wind; mechanism of pressure changes; kinematics of pressure systems; vorticity changes.

Texts: Berry, Bollay, and Beers; Handbook of Meteorology; Haltiner and Martin: Dynamical and Physical Meteorology.

Prerequisites: Mr-200(C), Mr-402(C), and Ma-163(C).

Mr-321(A) Dynamic Meteorology I 3-0

The equations of motion in absolute and relative reference frames. Horizontal flow. Geostrophic and gradient winds. Streamlines and trajectories. Constant-pressure and isentropic coordinates. Vertical variations of wind and pressure systems; thermal wind. Frontogenesis and surfaces of discontinuity. Kinematics of pressure systems. Continuity and tendency equations.

Texts: Haltiner and Martin: Dynamical and Physical Meteorology; Petterssen: Weather Analysis and Forecasting.

Prerequisites: Mr-413(B) and Ma-132(B).

Mr-322(A) Dynamic Meteorology II 3-0

A continuation of Mr-321(A). Convergence and divergence. Wave-shaped and closed pressure systems. Circulation theorems. Vorticity equation. Perturbation method for the solution of the equations of motion. Numerical integration of the equations of motion for the barotropic and baroclinic models.

Texts: Same as for Mr-321(A) plus Haurwitz: Dynamic Meteorology.

Prerequisites: Ma-125(B) and Ma-330(C) concurrently, Ma-133(A), and Mr-321(A).

Mr-323(A) Dynamic Meteorology III (Turbulence and Diffusion) 3-0

The topics presented include the general effects of viscosity and turbulence; the equations of motion for viscous and turbulent flows; diffusion of momentum, and wind variation in the surface layer; diffusion of other properties including heat, water vapor, smoke, etc.; diurnal temperature variation; transformation of air masses.

Texts: Haltiner and Martin: Dynamical and Physical Meteorology; Sutton: Micrometeorology.

Prerequisites: Mr-322(A), Ma-125(B), and Ma-330(C).

Mr-400(C) Introduction to Meteorological Instruments 2-0

Basic principles of standard meteorological instruments used in naval aerology for surface and upper-air observations; instrument installation, care, maintenance; and observation techniques.

Texts: OpNav Inst 3140.32: Manual of the Aerological Service; departmental notes.

Prerequisite: Ph-191(C) or equivalent.

Mr-402(C) Introduction to Meteorological Thermodynamics 3-2

A treatment of elementary thermodynamics and its application in meteorology, with particular emphasis on thermodynamic charts and diagrams. Atmospheric stability, instability phenomena, and forecasting techniques are discussed.

Text: Haltiner and Martin: Dynamical and Physical Meteorology.

Prerequisites: Ph-191(C) and Ma-162(C) or equivalent.

Mr-403(B) Introduction to Micrometeorology 4-0

Properties of radiating matter in general; solar and terrestrial radiation and their effects on the temperature distribution in the frictional layer; the heat budget; structure of the wind and its significance in turbulent transfer; air-mass modification; forecasting the micrometeorological variables and their use in diffusion from point and line sources.

Texts: Haltiner and Martin: Dynamical and Physical Meteorology; departmental notes.

Prerequisites: Mr-302(B) or Mr-311(B), and Ma-381(C) or equivalent.

Mr-410(C) Meteorological Instruments 2-2

Principles of design and operation of meteorological instruments used in naval aerology with special emphasis on new developments and requirements. Application of electronic meteorological instruments used by the fleet aerologist.

Texts: Middleton and Spilhaus: Meteorological Instruments; selected papers and departmental notes.

Prerequisites: Ma-162(C) or equivalent and Ph-196(C) or equivalent.

Mr-412(A) Physical Meteorology 3-0

Radiation in general. Solar radiation and the measurement of the solar constant. The geographic and seasonal distribution of insolation. Absorption, scattering, and diffuse reflection of solar radiation in the atmosphere. Terrestrial radiation and the atmospheric radiation chart. Computations of atmospheric radiation heat loss or gain. Applications to air-mass modification and to minimum temperature forecasting with arbitrary sky-condition and turbulence effects. The heat budget of the earth-atmosphere system. Selected topics on atmospheric optics and electricity.

Texts: Haltiner and Martin: Dynamical and Physical Meteorology; Neuberger: Introduction to Physical Meteorology.

Prerequisite: Mr-413(B).

Mr-413(B) Thermodynamics of Meteorology 3-2

The physical variables; equations of state; first law of thermodynamics; properties of gases; properties of water and moist air; thermodynamic diagrams; air-mass identification indices; geopotential determinations, altimetry; instability phenomena and criteria.

Texts: Holmboe, Forsythe, and Gustin: Dynamic Meteorology; Haltiner and Martin: Dynamical and Physical Meteorology; U. S. Dept. of Commerce: The Thunderstorm.

Prerequisites: Ma-131(C) and Ph-196(C).

Mr-415(B) Radar Propagation in the Atmosphere 2-0

Propagation of electromagnetic waves in general and of microwaves in particular. The vertical profile of refractive index as a condition for ducting, superrefraction, and subrefraction of microwaves in layers above and below the transmitter. Ray tracing. Air-mass profiles of refractive index. Some analogies with radio and light transmission. Detection of visual objects. Scattering of microwaves by precipitation elements, and detection of echoes on PPI and RHI scopes. Synoptic interpretation of various echo types.

Texts: Johnson: Physical Meterology; selected NavAir publications; departmental notes.

Prerequisites: Mr-323(A) and Ma-331(A), or Mr-403(B), and Ma-381(C).

Mr-422(A) The Upper Atmosphere 5-0

The composition of the upper atmosphere. The nature of the upper atmosphere as determined from several lines of observation. The ionosphere and related optical and electrical activity. The sun and its effect on the atmosphere. Terrestrial magnetic variations. Atmospheric oscillations of tidal origin. The aurora.

Texts: Mitra: The Upper Atmosphere; Johnson: Physical Meteorology; departmental notes.

Prerequisites: Ma-331(A) and Mr-323(A).

Mr-500(C) Introduction to Climatology of the Oceans and Atmosphere 3-0

Introduction to oceanography. Physical properties of sea water and their distributions; heat budget of the oceans; horizontal and vertical oceanic circulations. Interaction of the oceans and atmosphere. Distribution of the major meteorological elements with respect to season, geography, and orography. Definitions of climatic zones and types according to Koppen, and their meteorological descriptions, with applications.

Texts: Sverdrup: Oceanography for Meteorologists; Haurwitz and Austin: Climatology; Berry, Bollay, and Beers: Handbook of Meteorology.

Prerequisite: Mr-200(C).

Mr-510(C) Climatology 2-0

The distribution with respect to season, geography, and orography of the major meteorological elements. Definitions of climatic zones and types according to Koppen and their meteorological descriptions. Micrometeorology. Regional climatology of the oceans. Climatology as a tool in objective forecasting.

Text: Haurwitz and Austin: Climatology.

Prerequisite: Mr-200(C).

Mr-520(B) Applied Climatology 2-2

Review of methods of classifying climates. Synoptic climatology. Statistical evaluation of climatological data. Methods of presenting climatological data to non-aerological personnel. Objective forecasting techniques. Application of above during laboratory period.

Texts: Conrad and Pollack: Methods in Climatology; Jacobs: Wartime Developments in Applied Climatology.

Prerequisites: Mr-510(C) or equivalent and Ma-331(A).

Mr-521(B) Synoptic Climatology 3-2

The study and statistical evaluation of the major meteorological elements in relation to the macro- and microclimates. Definitions and descriptions of the Koppen system of climatic types. Methods of presenting climatological data to non-aerological personnel. Construction and use of forecast registers. Objective forecasting techniques and their applications to practical problems, the latter to be done during the laboratory period, culminating with a term paper.

Texts: Haurwitz and Austin: Climatology; Conrad and Pollak: Methods in Climatology; Jacobs: Wartime Developments in Applied Climatology.

Prerequisites: Mr-200(C) and Ma-381(C) or Ma-331(A) concurrently.

Mr-610(B) Sea and Swell Forecasting 2-2

Lectures cover the generation, propagation, and dispersion of ocean waves; statistical properties of waves; and shoaling and refraction. Wind waves and swell are forecast from meteorological data in the laboratory.

Texts: H.O. 603: Practical Methods for Observing and Forecasting Ocean Waves; H.O. 604: Techniques for Forecasting Wind Waves and Swell; H.O. 234: Breakers and Surf.

Prerequisites: Mr-212(C) or equivalent, and Ma-381(C) or equivalent.

Mr-611(B) Ocean Waves and Wave Forecasting 3-6

Similar to Mr-610(B), but including treatment of waves produced in tropical storms, synoptic wave charts and ship routing, movement of ships in a seaway, and further consideration of the wave spectrum and its properties.

Texts: Same as for Mr-610(B), plus selected technical reports.

Prerequisites: Same as for Mr-610(B), plus Oc-210(B).

Mr-612(B) Polar Ice and Sea Ice Forecasting 3-4

Arctic geography; sea ice terminology, observations, and codes; ice-potential; ice formation, growth, and disintegration; ice drift and its relation to winds and currents. Sea ice forecasts.

Texts: H.O. 609: A Functional Glossary of Ice Terminology; H.O. Sea Ice Manual (unpublished).

Prerequisites: Mr-200(C) and Oc-210(B).

Mr-810(A) Seminar in Meteorology and Oceanography 2-0

Students study and prepare synopses of current publications or original data concerning meteorology or oceanography and present them for group discussion.

Text: None.

Prerequisites: Mr-422(A) or Mr-403(B), Mr-521(B), Oc-621(B), and Ma-331(A) or Ma-381(C).

AERONAUTICS

Ae Courses

Ae-001(L) Aeronautical Lecture Series 0-2

Lectures on general aeronautical engineering subjects by prominent authorities from the Bureau of Aeronautics, research laboratories and the industry.

Text: None.

Prerequisite: None.

Ae-002(L) Aeronautical Lecture Series 0-1

Lectures on electrical engineering subjects in connection with aeronautical engineering by prominent authorities from the Bureau of Aeronautics, research laboratories, and the industry.

Text: None.

Prerequisite: None.

Ae-100(C) Basic Aerodynamics 3-2

Properties of fluids; statics; velocity and pressure; Bernoulli's theorem; cavitation; theory of lift; blade screws and propellers; viscous flows; vortices; laminar and turbulent boundary layer flows; separation phenomena; surface friction; resistance of floating bodies; dynamics of compressible fluids. The laboratory periods include experimental work in the wind tunnel, allied to the topics above; technical analysis and report writing.

Texts: Dodge, Thompson: Fluid Mechanics; Rouse: Elementary Fluid Mechanics.

Prerequisite: None.

Ae-121(C) Technical Aerodynamics 3-4

Characteristic flows and pressures about bodies; surface friction; wake drag; aerodynamic characteristic of airfoil sections; three-dimensional airfoil theory; induced drag; interference drag; high lift devices; velocity polar. The laboratory periods include wind tunnel experiments, analysis and technical report writing on topics allied to the above class work.

Texts: Dwinnell: Principles of Aerodynamics; Pope: Wind Tunnel Testing.

Prerequisite: Ae-100(C).

Ae-131(C) Technical Aerodynamics Performance I 4-2

The aerodynamics characteristics of the airplane; propeller and jet engine characteristics; sea level performance; performance at altitudes; range and endurance; special performance problems; charts.

The laboratory periods are devoted to computations and performance analysis.

Text: Perkins and Hage: Airplane Performance, Stability and Control.

Prerequisite: Ae-121(C).

Ae-136(B) Aircraft Performance— Flight Analysis 3-2

Aerodynamic characteristics of composite aircraft; propeller and engine characteristics; aircraft performance; range and endurance; special performance problems; performance parameters; flight test reduction and analysis. Laboratory analysis of performance of an aircraft will be made based upon wind tunnel tests; analysis of practical problems from flight test.

Texts: Pope: Wind Tunnel Testing; Hamlin: Flight Testing.

Prerequisite: Ae-121(C).

Ae-141(A) Dynamics I 3-2

Fundamental definitions; the forces and moments on the entire airplane; the equations of motion; the moments of the wing, tail and other parts of the airplane; C.G. location, effect on static stability; neutral points; maneuver points; fixed control and free control stability; elevator, aileron, rudder effectiveness; control design features; maneuverability and controllability; turns and loops. The laboratory work consists of wind tunnel experimentation and analysis of the above topics on models.

Texts: Higgins: USNPGS Notes; Perkins: Aircraft Stability and Controllability; Hamlin: Flight Testing.

Prerequisite: Ae-131(C).

Ae-142(A) Dynamics II 3-4

The Euler equations of motion; the moments of inertia of aircraft; the aerodynamic reactions and derivatives; solution of the symmetrical or longitudinal motion analysis; solution of the asymmetrical or lateral motion analysis; effect of control freedom, of controls and response; spins. The laboratory work consists of wind tunnel experimentation on models to study some of the above problems.

Texts: The same as in Ae-141(A).

Prerequisite: Ae-141(A).

Ae-146(A) Dynamics 3-2

Fundamental definitions, forces and moments of composite aircraft; equations of motion; static stability and trim; effects of CG location; static margins; free control stability; dynamic longitudinal stability; dynamic lateral stability, force and moment; derivatives; stability charts; controllability; maneuverability; three-dimensional motions; spins. Laboratory work consists of experimentation and analysis of static and dynamic stability of some particular aircraft.

Texts: Same as in Ae-141(A).

Prerequisite: Ae-131(C) or Ae-136(B).

Ae-151(B) Flight Testing and Evaluation I 2-0

The technical aerodynamics of airplanes, especially performance and test methods.

Texts: Dommasch, Sherby and Connolly: Airplane Aerodynamics; NATC Patuxent, Flight Test Manual; NavAer publications.

Prerequisite: Ae-132(B).

Ae-152(B) Flight Testing and Evaluation II 2-0

Theoretical longitudinal stability and control of aircraft, related test methods and aircraft evaluation.

Texts: Same as Ae-151(B).

Prerequisites: Ae-141(A) or Ae-146(A).

Ae-153(B) Flight Testing and Evalution III 2-0

Theoretical lateral-directional control of aircraft, related test methods and aircraft evaluation.

Texts: Same as Ae-151(B).

Prerequisite: Ae-142(A) or Ae-146(A).

Ae-161(B) Flight Testing and Evaluation Laboratory I 0-4

Flight program accompanying Ae-151(B). Test flying in naval aircraft by aviator students and reduction of resulting data: airspeed calibration; level flight performance and fuel consumption; climb performance.

Ae-162(B) Flight Testing and Evaluation Laboratory II 0-4

Flight program accompanying Ae-152(B). Test flying in naval aircraft by aviator students: stalls; static and dynamics longitudinal stability; static and maneuvering neutral points; control effectiveness; trim changes; Mach effects.

Ae-163(B) Flight Testing and Evaluation Laboratory III 0-4

Flight program accompanying Ae-153(B). Test flying in naval aircraft by aviator students: rate of roll; adverse yaw; control effectiveness with asymmetric power; static and dynamics lateral-directional stability; over-all qualitative evaluation of aircraft.

Ae-200(C) Rigid Body Statics 3-2

This course parallels Mc-101, extending the coverage of rigid body statics graphically and analytically to meet design requirements of aircraft components. Topics include: plane, compound and complex trusses; centroids, moments of inertia, properties of aircraft sections; moments of inertia of aircraft, balance diagrams; simple, compound and complex space frames; load lines, shear and bending moment diagrams; influence lines.

Texts: Bruhn: Analysis and Design of Airplane Structures; Niles and Newell: Airplane Structures, 3rd Ed., Vol. I; Timoshenko and Young: Statics.

Prerequisites: To be taken with Mc-101, with same prerequisite.

Ae-211(C) Strength of Materials 4-2

Elastic body analysis applied to aircraft structures and machines. Topics are: the elementary state of stress in ties, struts, shear members, circular shafts, simple beams, short beam-struts, cores, simple columns, thin cylinders; extended discussion of deflection of straight beams, frames with straight members; statically indeterminate cases using diagrammatic and moment-distribution methods.

Texts: Bruhn: Analysis and Design of Airplane Structures; Niles and Newell: Airplane Structures, 3rd Ed., Vol. I; Timoshenko: Strength of Materials, Vol. I.

Prerequisite: Ae-200(C).

Ae-212(C) Stress Analysis I 4-2

The general state of plane stress in complicated components of airframes and machines, and the stability of continuous beam columns. Topics are: plane stress, principal stresses, Mohr circle of stress, stress ellipse; shear stress developed in bending, effect on deflection; shear flow in bending under transverse loads, center of twist; bending of beams with open or hollow sections; torsion of shafts of non-circular section, membrane analogy, torsional shear flow; torsion and bending; built-up beams, shear-resistant webs, tension field webs, wooden beams; beam-columns and ties.

Texts: Bruhn: Analysis and Design of Airplane Structures; Niles and Newell: Airplane Structures, Vols. I and II; Timoshenko: Strength of Materials, Vols. I and II.

Prerequisite: Ae-211(C).

Ae-213(B) Stress Analysis II 4-2

A continuation of Ae-212. Strain energy, curved bars and frames. Topics are: strain energy, applications to impact loading; Castigliano theorem; displacements in trusses, trusses with redundant members; virtual energy applications, Maxwell-Mohr method; law of reciprocal deflection, influence line applications; energy methods applied to buckling; curved bars, stresses and deflections; rotating machine parts.

Texts: The same as in Ae-212(C).

Prerequisite: Ae-212(C).

Ae-214(A) Stress Analysis III 3-0

A continuation of Ae-213. The general three dimensional state of stress, strain and displacement in elastic media. Thin stiff plates under lateral load in bending. Axially symmetrical plates and membranes. Discontinuity effects in shells. Beams on elastic foundation, applications to cylinder and hemisphere or flat plate or hollow ring. Thick walled spheres and cylinder under inner and outer pressures, application to rotating discs.

Texts: The same as in Ae-213(B).

Prerequisite: Ae-213(B).

Ae-215(A) Advanced Stress Analysis 4-0

A continuation of Ae-214. Rectangular plates in pure bending, in bending and under middle surface loading; buckling, crippling; selected topics from theory of elasticity and plasticity; advanced stability considerations.

Texts: The same as in Ae-214 plus Sechler and Dunn: Airplane Structural Analysis and Design.

Prerequisite: Ae-214(A).

Ae-311(C) Airplane Design I 2-4

Detail methods of design and analysis of a jet airplane. Preliminary layout, three-view drawing, weight and balance; aerodynamic characteristics and basic performance; flight loads from V-n diagram; dynamic balancing; wing shear and moment curves; detail structural design of wing.

Texts: The same as Ae-213(B); also Corning, Airplane Design; Sechler and Dunn: Airplane Structural Analysis and Design; Bureau of Aeronautics Specifications NAVAER SS-1C.

Prerequisite: Ae-213(B).

Ae-312(B) Airplane Design II 1-4

A continuation of Ae-311(C). Stress analysis of wing including stringer stresses; shear flows; skin stresses and skin buckling check; semi-tension field analysis of front spar web, spar caps, stiffners. Analysis of riveted, bolted, welded fittings.

Texts: Same as Ae-311(C).

Prerequisite: Ae-311.

Ae-316(C) Airplane Design 2-4

Detail methods of airplane or missile design and analysis. Preliminary layout; three view drawing; weight and balance; aerodynamic characteristics and basic performance; design criteria; inertia loads; wing shear and moment curves; detail structural design and stress analysis of wing including stringer stresses, shear flow, skin buckling check, semi-tension field analysis of front spar.

Texts: The same as Ae-213(B); also Corning, Airplane Design.

Prerequisite: Ae-213(B).

Ae-409(C) Thermodynamics I (Aeronautical) 4-2

Fundamentals of thermodynamics edited especially for application to aerothermodynamics and aircraft propulsion. Topics include fundamental laws, energy concepts, terminology and symbolism, properties of gases and vapors, property relationships, theoretical cycles and elementary compressible flow.

Texts: Kiefer, Kinney and Stuart: Engineering Thermodynamics; Keenan and Keys: Thermodynamic properties of Steam; Keenan and Kaye: Gas Tables.

Prerequisite: Ae-100(C).

Ae-410(B) Thermodynamics II (Aeronautical) 3-2

This course extends the study of fundamental thermodynamics in preparation for advanced work in aerothermodynamics and aircraft propulsion. Topics include one-dimensional compressible flow, internal combustion engine and turbine cycles and elements of heat transfer.

Texts: Kiefer, Kinney and Stuart: Engineering Thermodynamics; Stoever: Applied Heat Transmission; Keenan and Kaye: Gas Tables.

Prerequisite: Ae-409(C).

Ae-411(B) Aircraft Engines 4-2

This course extends the study of combustion with particular reference to piston engine and gas turbine applications. Topics are: fuel mixtures; ignition; flame propagation and stability; utilization, conversion and mechanical aspects; survey of current engine design and construction.

Texts: Lichty: Internal Combustion Engines; Taylor and Taylor: Internal Combustion Engines; USNPGS Notes.

Prerequisite: Ae-410(B).

Ae-412(B) Thermodynamics Laboratory 0-3

Laboratory experiments and computations involving air flow, combustion, gas analysis and heat transfer as applied to aircraft propulsion machinery. Familiarization with and use of specialized instrumentation.

Text: None.

Prerequisite: To be accompanied by Ae-411(B).

Ae-421(B) Aircraft Propulsion 3-2

Sea level and altitude performance characteristics of piston engines, propellers, turbo-jet and turboprop engines. Topics are: maximum performance; cruise control; laboratory and flight testing; test data correction methods; aircraft performance review with particular reference to the propulsion system. The practical work of this course consists of supervised analysis of test data taken at various Naval Air Test Centers.

Texts: Fraas: Aircraft Power Plants; Nelson: Airplane Propeller Principles; Godsey and Young: Gas Turbines for Aircraft; Sutton: Rocket Propulsion Elements.

Prerequisite: Ae-411(B).

Ae-428(A) Operating Principles of Turbomachines 3-2

General relations for flows with energy changes, relative and absolute motions, momentum theorem. Operating principles of axial-flow and centrifugal machines, compressors and turbine. Operating characteristics to establish relations between theoretical and actual performance in special compressor test rig.

Text: USNPS Notes.

Prerequisite: Ae-411(B), and accompanied by Ae-508(A).

Ae-431(A) Aerothermodynamics of Turbomachines 4-1

Fundamental course in the study of flows of elastic fluids in turbomachines. Topics are: absolute and relative fluid motions; equations of motions and energy equations for actual fluids; momentum theorems for absolute and relative flows; flow in cascades; operating principles of turbomachines; axial-flow compressors; mixed-flow and centrifugal compressors; axial-flow turbines; centripetal turbines. The laboratory periods are devoted to measurements and analysis of flow phenomena in an especially instrumented Compressor Test Rig.

Text: USNPGS Notes.

Prerequisite: Ae-503(A).

Ae-451(A) Gas Turbines I 3-0

Thermodynamic studies of gas turbine cycles; free-piston plants; part load performance; heat transfer and losses in regenerators; control problems; design features; operating experiences.

Text: USNPGS Notes.

Prerequisite: Ae-431(A).

Ae-452(A) Gas Turbines II 3-0

Advanced aerothermodynamics; three-dimensional flow phenomena; analysis and design of bladings; analysis and design of turbomachines and gas turbines with emphasis on rational methods and future developments.

Text: USNPGS Notes.

Prerequisite: Ae-451(A).

Ae-453(A) Advanced Problems in Gas Turbines I

Discussion and solution of original problems of theoretical or experimental nature.

Hours to be arranged.

Texts: As required.

Prerequisite: Ae-452(A).

Ae-454(A) Advanced Problems in Gas Turbines II

Hours to be arranged.

Continuation of Ae-453(A).

Ae-501(A) Hydro-Aero Mechanics I 4-0

This is the first of a sequence of four courses which study in detail the rational mechanics of fluid media; Vector calculus and aerodynamical applications; fluid kinematics and flow description; stream and velocity potential functions; dynamic equations for a perfect fluid; solution by scalar and vector methods; properties of elemental and combined flows; two-dimensional problems; use of complex numbers in flow description; conformal transformation; complex integration; Blasius equations; Kutta-Joukowski theorem; lift and pitching moment on an infinite wing.

Texts: Streeter: Fluid Dynamics; Kuethe and Schetzer: Foundations of Aerodynamics; Abbott and von Doenhoff: Theory of Wing Sections.

Prerequisite: Ae-131(C).

Ae-502(A) Hydro-Aero Mechanics II 4-0

Helmholtz vortex theory; the three-dimensional airfoil; induced velocity, angle of attack, drag; lift distribution; least induced drag; tapered and twisted wings; Chordwise and spanwise load distribution, tunnel-wall effect; viscous fluids: Navier-Stokes Equations, Prandtl boundary layer equations, Blasius solution, Karman integral relation.

Texts: The same as in Ae-501(A).

Prerequisite: Ae-501(A).

Ae-503(A) Compressibility I 4-0

Compressible flow; thermodynamic fundamentals; adiabatic flow equations; propagation of plane disturbances; one-dimensional channel flow; oblique shock waves and shock reflections; optical measurement techniques.

Texts: Kuethe and Schetzer: Foundations of Aerodynamics; Liepmann and Puckett: Aerodynamics of a Compressible Fluid; Sauer: Theoretical Gas Dynamics; Ferri: Elements of Aerodynamics of Supersonic Flow.

Prerequisites: Ae-410(B) and Ae-502(A).

Ae-504(A) Compressibility II 3-2

Two and three-dimensional compressible flows; two-dimensional linearized theory and application to airfoils in compressible flow; three-dimensional linearized theory; hodograph methods; method of characteristics; exact solutions in two-dimensional flow; transonic flow problems; similarity laws for transsonic and hypersonic flows; viscous shear and heat transfer, boundary layer in compressible flows. Transonic and supersonic wind tunnel tests are conducted in conjunction with class discussion.

Texts: The same as in Ae-503(A).

Prerequisite: Ae-503(A).

Ae-508(A) Compressibility 3-2

Thermoaerodynamic fundamentals of flow in compressible fluids; adiabatic equations; propagation of plane distrubances; one-dimensional channel flow; oblique shock waves, reflections; two-dimensional compressible flows; linearized theory and application to airfoils in compressible flow; method of characteristics; three-dimensional linearized theory; similarity laws; viscous compressible flow and heat transfer. Laboratory periods are used in transonic and supersonic wind tunnel tests and in measurements by optical instrumentation.

Texts: The same as in Ae-503(A).

Prerequisites: Ae-410(B) and Ae-502(A).

BIOLOGY

Bi Courses

Bi-800(C) General Biology 6-0

General botany, zoology, animal physiology, biochemistry, genetics, and ecology.

Text: Villee: Biology.

Prerequisite: Ch-315(C).

Bi-801(B) Animal Physiology 6-0

A general course in animal physiology, emphasizing human functional aspects.

Text: Winton and Bayliss: Human Physiology.

Prerequisite: Bi-800(C).

Bi-802(A) Radiation Biology 6-0

Physiological and genetic effects of radiation and blast. Calculation and measurement of dose; methods of experimental radiobiology.

Text: Bacq and Alexander: Fundamentals of Radiobiology.

Prerequisites: Ph-642(B); Bi-801(B).

Bi-810(C) Biological Effects of Radiation 3-0

Principles of biological dose measurement. Tolerance levels; genetic and physiological effects of ionizing radiations.

Text: Spear: Radiation and Living Cells.

Prerequisite: Ph-640(B).

CHEMISTRY AND CHEMICAL ENGINEERING

Ch Courses (Chemistry) and CE Courses (Chemical Engineering)

Ch-101(C) General Inorganic Chemistry 3-2

A study of the principles governing the chemical behavior of matter. Includes topics such as kinds of matter, stoichiometric calculations, utility of the mole concept, kinetic theory, atomic structure, speed of chemical reactions, chemical equilibrium, introduction to organic chemistry and specialized topics (explosives, corrosion, etc.). Elementary physical chemistry experiments such as determination of molecular formulas, pH, reaction rates etc., are performed in the laboratory.

Text: Hildebrand: Principles of Chemistry.

Prerequisite: None.

Ch-102(C) General Inorganic Chemistry 4-2

Topics include properties of matter, atomic and molecular structure, valence, weight relations in chemical reactions, oxidation-reduction, electrochemistry, gases, solutions, chemical equilibrium, reactions of metallic ions and ionic equilibria encountered in qualitative analysis. The laboratory work is qualitative analysis performed on a semimicro scale.

Texts: Pauling: General Chemistry; Curtman: Introduction to Semimicro Qualitative Analysis.

Prerequisite: None.

Ch-103(C) Elementary Physical Chemistry 3-2

A course in theoretical chemistry for operations analysis curriculum; a study of principles governing the behavior of matter when subjected to various influences. Modern concept of the structure of matter, kinetic theory, dynamic equilibria in various systems, etc. In the development of the subject the mathematical approach is emphasized. Discussion of the various topics utilizes examples selected from situations of interest to officers in the military services.

The laboratory work consists of experiments, largely quantitative, illustrating the principles discussed in the lectures.

The course is designed to serve both as a refresher and a terminal background course for officers whose major interest lies in fields other than chemistry, physics, or related sciences.

Text: Hildebrand: Principles of Chemistry.

Prerequisite: None.

Ch-105(B) Physical Chemistry 3-2

A course in theoretical chemistry for naval engineers. Includes such topics as atomic structure, kinetic theory, gases, liquids, thermochemistry, electrochemistry and kinetics. The laboratory work will consist of experiments which illustrate principles discussed in the lectures.

Texts: Hildebrand: Principles of Chemistry; Prutton and Maron: Fundamental Principles of Physical Chemistry.

Prerequisite: None.

CE-111(A) Fuel and Oil Chemistry 2-2

The occurrence, classification and refining of petroleum, theory of combustion of fuels, theory of lubrication, physical and chemical properties of fuels and lubricants and their correlation with performance, and the analysis of Orsat data. Laboratory work consists of conducting standard tests on fuels and lubricants, and Orsat analysis of combustion gases.

Text: Gruse and Stevens: Chemical Technology of Petroleum; Pugh and Court: Fuels and Lubricating Oils.

Prerequisite: Ch-101(C).

CE-112(A) Fuels, Combustion, High Energy Fuels 3-2

A brief survey of the organic and physical chemistry necessary for an appreciation of the problems associated with special fuels. The nature of conventional fuels and of high-energy fuels, their limitations, and possible future developments; methods of reaction rate control; etc.

Text: To be designated.

Prerequisite: Physical Chemistry.

Ch-121(B) General and Petroleum Chemistry 4-2

Topics covered in this course are: classfication of matter atomic theory, atomic structure, gas laws, thermochemistry, chemical equilibria, chemical kinetics, elementary stoichiometry, organic chemistry, occurrence, classification and refining of petroleum, theory of combustion, theory of lubrication, physical and chemical properties of fuels and lubricants and their correlation with performance, and analysis of Orsat data. Laboratory work consists of experiments illustrating topics covered in lectures and standard tests on fuels and lubricants.

Texts: Hildebrand: Principles of Chemistry; Pugh and Court: Fuels and Lubricating Oils; Gruse and Stevens: Chemical Technology of Petroleum.

Prerequisite: None.

Ch-213(C) Quantitative Analysis 2-3

A review of the theoretical principles underlying analytical chemical methods, and the calculations involved in quantitative determinations. The laboratory work consists of typical volumetric and gravimetric determinations.

Text: Pierce and Haenisch: Quantitative Analysis.

Prerequisite: Ch-102(C).

Ch-221(C) Qualitative Analysis 3-2

The first part of a course in analytical chemistry, including the treatment of ionization, chemical equilibrium, solubility product, complex-ion formation and oxidation-reduction reactions, as they apply to qualitative analysis. The laboratory work consists of the separation and detection of selected ions on a semimicro scale.

Text: Curtman: Introduction to Semimicro Qualitative Analysis.

Prerequisite: Ch-101(C) or Ch-121(B).

Ch-222(C) Qualitative Analysis 2-2

A brief course, in which separation and detection of selected cations on a semimicro scale is used as a basis for the study of acid-base systems, chemical equilibrium, solubility product, complex ions, hydrolysis, and oxidation-reduction reactions.

Text: Curtman: Introduction to Semimicro Qualitative Analysis.

Prerequisite: Ch-101(C) or Ch-121(B).

Ch-231(C) Quantitative Analysis 2-4

A continuation of Ch-221(C), dealing with the principles and calculation involved in quantitative analysis. The laboratory work consists of typical volumetric and gravimetric determinations.

Text: Pierce and Haenisch: Quantitative Analysis.

Prerequisites: Ch-101(C) or Ch-121(B) and Ch-221(C).

Ch-302(C) Organic Chemistry 4-2

An introduction to the properties, reactions and relationships of the prinicpal classes of aliphatic and aromatic organic compounds. The laboratory work includes preparative experiments and experiments illustrating typical organic reactions.

Text: Schwenck and Martin: Basic Organic Chemistry.

Prerequisite: Ch-101(C) or equivalent.

Ch-311(C) Organic Chemistry 3-2

The first half of a course in organic chemistry, consisting of the study of the properties and reactions of aliphatic compounds. The laboratory work is designed to illustrate typical organic reactions.

Text: Brewster: Organic Chemistry—A Brief Course.

Prerequisite: Ch-101(C).

Ch-312(C) Organic Chemistry 3-2

A continuation of Ch-311(C), dealing chiefly with aromatic compounds. Organic synthetic methods are emphasized in the laboratory.

Text: Brewster: Organic Chemistry—A Brief Course.

Prerequisite: Ch-311(C).

Ch-315(C) Organic Chemistry 3-2

An introduction to the properties, reactions and relationships of the principal classes of organic compounds, as a basis for work in the biological sciences.

Text: Schwenck and Martin: Basic Organic Chemistry.

Prerequisite: Ch-102(C).

Ch-321(A) Organic Qualitative Analysis 2-2

Identification of organic compounds on the basis of physical properties, solubility behavior, classification reactions and the preparation of derivatives.

Text: Shriner and Fuson: Identification of Organic Compounds.

Prerequisite: Ch-301(C) or Ch-312(C) or Ch-315(C).

Ch-322(A) Organic Chemistry, Advanced 3-2

A more detailed consideration of reactions used in organic syntheses, with particular attention to reaction mechanisms and electronic configurations.

Text: Royals: Advanced Organic Chemistry.

Prerequisite: Ch-301(C) or Ch-312(C) or Ch-315(C).

Ch-323(A) The Chemistry of High Polymers 3-0

Mechanism of polymerization; addition and condensation polymers; phenoplastics; aminoplastics; elastomers; natural high polymers and their modification; structure and physical properties of high polymers.

Text: Ritchie: Chemistry of Plastics and High Polymers.

Prerequisite: Ch-301(C) or Ch-312(C) or Ch-315(C) and Ch-521(A).

Ch-324(A) Qualitative Organic Chemistry 2-4

Identification of organic compounds on the basis of physical properties, solubility behavior, classification reactions and the preparation of derivatives.

Text: Shriner and Fuson: Identification of Organic Compounds.

Prerequisite: One term of Organic Chemistry.

Ch-401(A) Physical Chemistry (Ord) 3-2

Physical chemistry for ordnance students; a study of the laws governing behavior of matter. Gases, liquids, solids, chemical kinetics, thermochemistry, and chemical thermodynamics with emphasis placed on chemical equilibrium in gaseous mixtures. Numerical problems on gas mixtures, equilibria in explosion products, and flame temperatures form an integral part of the course.

The laboratory work consists of experiments illustrating principles discussed in the lectures.

Texts: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews and Williams: Experimental Physical Chemistry.

Prerequisites: Ch-101(C) or equivalent and Ch-613(A) or equivalent.

Ch-411(C) Physical Chemistry 3-2

Gases, solids, physical properties and molecular structure, thermodynamics, thermochemistry, liquids and solutions. The laboratory work consists of experiments which illustrate principles discussed in the lectures.

Texts: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews, Williams: Experimental Physical Chemistry.

Prerequisite: Ch-101(C) or Ch-121(B).

Ch-412(C) Physical Chemistry 3-2

Continuation of Ch-411(C). Chemical equilibrium, chemical kinetics, electrical conductance, electromotive force, colloids and atomic and nuclear structure. Related laboratory work is included.

Texts: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews, Williams: Experimental Physical Chemistry.

Prerequisite: Ch-411(C).

Ch-413(A) Physical Chemistry (Advanced) 2-2

A graduate course covering selected topics in physical chemistry, such as electrochemistry, electronic configurations and dipole moments, and the physical chemistry of the solid and liquid states. The laboratory work supplements the material covered in the lectures and introduces the student to problems and techniques encountered in research.

Text: To be assigned.

Prerequisites: Two terms of physical chemistry, one term of thermodynamics.

Ch-414(C) Physical Chemistry 3-2

This is the first course of a two-term sequence in Physical Chemistry designed for students specializing in radiology. Topics covered include the gaseous, liquid, and solid states; chemical thermodynamics; thermochemistry, and the properties of solutions. The laboratory work consists chiefly of quantitative analysis.

Text: Prutton and Maron: Fundamental Principles of Physical Chemistry; Pierce and Haenish: Quantitative Analysis.

Prerequisite: Ch-102(C).

Ch-415(C) Physical Chemistry 3-2

This course is a continuation of the Physical Chemistry sequence designed for students majoring in radiology. Topics covered are chemical equilibria, chemical kinetics, electrical conductance, electromotive force, colloids, atomic and nuclear structure and cryogenics. Laboratory work is related to the subject matter.

Text: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews, Williams and Staff: Experimental Physical Chemistry.

Prerequisite: Ch-414(C).

Ch-416(A) Physical Chemistry, Advanced 3-4

A graduate course covering selected topics in physical chemistry, such as electronic configurations and dipole moments, and the physical chemistry of of the solid and liquid states. The laboratory work supplements the material covered in the lectures and introduces the student to problems and techniques encountered in research.

Texts: To be assigned.

Prerequisite: Physical Chemistry.

Ch-442(C) Physical Chemistry 4-2

A short course in physical chemistry for chemistry majors. Gases, solids, thermochemistry, liquids, solutions, chemical equilibruim, chemical kinetics, electrochemistry and colloids. Laboratory experiments which illustrate principles discussed in the lectures are performed.

Text: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews, Williams, and Staff: Experimental Physical Chemistry.

Prerequisite: Ch-101(C) or equivalent.

Ch-443(C) Physical Chemistry 4-2

Gases, solids, thermochemistry, liquids, solutions, chemical kinetics, and colloids. Laboratory experiments which illustrate principles discussed in the lectures are performed.

Texts: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews, Williams and Staff: Experimental Physical Chemistry.

Prerequisite: Ch-101(C) or equivalent.

Ch-444(A) Physical Chemistry 3-4

A continuation of Ch-443(C). Chemical equilibruim, chemical kinetics, electrical conductance, electromotive force, colloids, and atomic and nuclear structure. Related laboratory work is included.

Texts: Prutton and Maron: Fundamental Principles of Phyical Chemistry; Daniels, Mathews and Williams: Experimental Physical Chemistry.

CE-521(A) Plastics 3-2

A study of the nature of plastics. Emphasis is placed on application, limitations as engineering materials, and correlation between properties and chemical structure. Service applications are cited as examples whenever possible. The laboratory exercises consist of the preparation of typical plastics, molding experiments, a study of their properties, and identification tests.

Text: Kinney: Engineering Properties and Applications of Plastics.

Prerequisite: Ch-101(C) or Ch-121(B).

CE-522(B) Plastics and High Polymers 3-2

A study of the nature of plastics and high polymers. Emphasis is placed on the correlation between properties and chemical structure; applications and limitations as engineering materials. The laboratory exercises consist of the preparation of typical plastics, molding experiments, a study of their physical properties and identification tests.

Text: Kinney: Engineering Properties and Applications of Plastics.

Prerequisite: Organic Chemistry.

Ch-531(A) Physical Chemistry 2-0
(for Metallurgy Students)

A continuation of the study of physical chemistry, emphasizing aspects of importance in metallurgy. Chemical equilibria in smelting and refining processes in deoxidation and in carburizing; principles of controlled atmospheres; activity and activity coefficients in metal solutions; concentration gradients and diffusion effects.

Prerequisites: Physical chemistry and Mt-202(C).

CE-542(A) Reaction Motors 3-2

A course covering the classification of reaction motors, basic mechanics, nozzle theory, propellant performance calculations, physical and chemical properties of propellants, design of solid and liquid propellant rocket engines and systems, rocket testing and ducted jet propulsion engines. Emphasis is on solid propellant systems. Laboratory period is devoted to working problems and to laboratory testing of performance and related parameters.

Texts: Sutton: Rocket Propulsion Elements; Bonney: Aerodynamics, Propulsion, Structures and Design Practice; Selected readings.

Prerequisites: Ch-101(C) or equivalent and one term of thermodynamics.

Ch-551(A) Radiochemistry 2-4

Discussions on important aspects of radioactivity from standpoint of the chemical transformations which accompany it and which it may induce; techniques for measurement and study of ionizing radiation; methods of separation of unstable nuclides, identification and assay.

Text: Williams: Principles of Nuclear Chemistry.

Prerequisite: Physical Chemistry.

Ch-552(A) Radiochemistry 3-4

A discussion of chemical properties and behaviors of unstable elements. Topics considered are the formation and decay schemes of the more important unstable nuclides, methods of isolation and purification and analysis of mixtures; exchange reactions; reactions that take place in consequence of nuclear reactions.

Text: To be assigned.

Prerequisite: Ch-551(A).

CE-553(A) Nuclear Chemical Technology 4-3

Applications of chemistry and chemical engineering to the processing of materials, products and wastes associated with nuclear reactors including the following topics: chemistry of uranium, plutonium and fission products, technology of nuclear fuel production, separation of products of nuclear reactors, radioactive waste disposal.

Texts: Glasstone: Principles of Nuclear Reactor Engineering; Bruce et al; Progress in Nuclear Energy III, Process Chemistry; Chemical Engineering Progress Symopsium Series on Nuclear Engineering Parts I—III.

Prerequisites: Ch-121(B) and Ch-561(A) or equivalent.

Ch-554(A) Chemistry of Nuclear Fuels 2-2

Basic chemistry of the actinide elements, particularly uranium, plutonium, and thorium, related to their isolation and separation in reprocessed fuels. Discussion of oxidation states and chemical behavior including complex formation, solubilities and resin exchange phenomena. Principle products of fission and their separation from fuel elements.

Text: None.

Prerequisite: Physical Chemistry.

Ch-561(A) Physical Chemistry 3-2

A course in physical chemistry for students who are non-chemistry majors. Thermodynamics, thermochemistry, gases, liquids, solutions, chemical equilibrium and chemical kinetics. Numerical problems on gas mixtures, combustion, equilibria in combustion products and flame temperatures are emphasized. Related laboatory experiments are included.

Texts: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews, Williams and Staff: Experimental Physical Chemistry.

Prerequisite: CE-111(A) or Ch-121(B).

Ch-571(A) Explosives 3-2

Modes of behavior and principles of use of explosive substances are related to their chemical and physical properties; underlying principles of explosives testing and evaluation; theory of detonation; propagation of flame front in propellants. Trends in new explosives investigation, selection, and development are surveyed. Laboratory work involves related parameters such as brisance, power, sensitivity, nitrogen content, heats of explosion and combustion. Independent exploratory work is encouraged.

Prerequisites: One term each of Thermodynamics and Physical Chemistry.

Ch-580(A) Electrochemistry 3-2

Basic principles of electrochemistry. Electrolytic solutions, half-cell reactions, practical aspects of primary and secondary cells.

Prerequisite: Physical Chemistry.

Ch-581(A) Chemistry of Special Fuels 2-2

A brief survey of the organic and physical chemistry necessary for an appreciation of the problems associated with special fuels. The nature of conventional fuels and of high-energy fuels, their limitations, and possible future developments; methods of reaction rate control; etc.

Prerequisite: Physical Chemistry.

CE-591(A) Blast and Shock Effects 3-0

Nature of explosions, propagation of shock waves, scaling laws for damage from explosions, thermal radiation and incendiary effects; ionizing radiation effects; principles of protection of personnel against damage.

Text: Hirschfelder and Associates: The Effects of Atomic Weapons.

Prerequisites: Physical Chemistry, and Thermodynamics.

CE-611(C) Thermodynamics 3-2

Study of the fundamentals of thermodynamics, the concept of energy and its classification and transformations, concept of entropy, the first and second laws and their application, thermodynamic properties of substances, ideal gases, thermochemistry. The laboratory period is devoted to problem working.

Text: Kiefer, Kinney and Stuart: Principles of Engineering Thermodynamics.

Prerequisite: Ch-101(C).

CE-612(C) Thermodynamics 3-2

A continuation of CE-611, covering the application of thermodynamic principles to processes involving non-ideal gases, complex systems in chemical equilibrium, and the flow of compressible fluids. The laboratory period is devoted to problem working.

Texts: Kiefer, Kinney and Stuart: Principles of Engineering Thermodynamics; Smith: Introduction to Chemical Engineering Thermodynamics.

Prerequisite: CE-611(C).

CE-613(A) Chemical Engineering Thermodynamics 3-2

Designed for non-chemical majors, the course extends previous studies in mechanical engineering thermodynamics to include the thermodynamic analysis and solution of chemical engineering problems. Emphasizing applications of principles by solution of problems, the subject matter includes specialized treatment of the thermal and thermodynamic properties of materials; thermochemistry; equilibrium and the phase rule; phase relations; chemical equilibria and energy relations, particularly at higher temperatures and pressures. Special attention is devoted to the thermodynamics of combustion processes.

Texts: Smith: Introduction to Chemical Engineering Thermodynamics; Kiefer, Kinney and Stuart: Principles of Engineering Thermodynamics.

Prerequisites: One term of Physical Chemistry and one term of Thermodynamics.

CE-614(A) Thermodynamics 3-2

A continuation of CE-611 covering the application of thermodynamic principles to processes involving non-ideal gases, complex systems in chemical equilibrium and the flow of compressible fluids. The laboratory period is devoted to problem working.

Texts: Kiefer, Kinney and Stewart: Principles of Engineering Thermodynamics; Smith: Introduction to Chemical Engineering Thermodynamics.

Prerequisite: CE-611(C).

CE-624(A) Thermodynamics 3-2

Covering the application of thermodynamic principles to processes involving non-ideal gases, complex systems in chemical equilibrium, and the flow of compressible fluids. The laboratory period is devoted to problem working.

Texts: Kiefer, Kinney and Stuart: Principles of Engineering Thermodynamics.

Prerequisite: CE-614(A).

CE-625(A) Thermodynamics 2-2

Thermodynamics of materials at high temperatures; the effects of chemical dissociation. Numerical computations form an integral part of the course.

Texts: Kiefer, Kinney, and Stuart: Principles of Engineering Thermodynamics.

Prerequisites: Thermodynamics, Physical Chemistry.

CE-631(A) Chemical Engineering Thermodynamics 3-2

An extension of CE-711(C) to include such thermodynamic analyses as are fundamental and requisite to the solution of many ordnance problems; preparation for subsequent study of reaction motors and interior ballistics.

In addition to treatment of the First and Second Laws of Thermodynamics, the subject matter includes thermodynamic properties of matter, compression and expansion processes, phase equilibria, criteria of equilibrium, fugacity, chemical reaction equilibria.

Texts: Smith: Introduction to Chemical Thermodynamics; Kiefer, Kinney and Stuart: Principles of Engineering Thermodynamics; Keenan and Keyes: Thermodynamic Properties of Steam; Keenan and Kaye: Gas Tables.

Prerequisite: CE-711(C) or CE-701(C).

CE-701(C) Chemical Engineering Calculations 3-2

Recognition and solution of engineering problems involving mass and energy relationships in chemical and physical-chemical reactions. Problems are chosen from engineering practice whenever possible and emphasize such applications as: reacting materials; particularly at high temperatures; gaseous and liquid-vapor equilibria; combustion of fuels; production and utilization of basic chemicals.

Texts: Hougen and Watson: Chemical Process Principles, Part I; Lewis and Radasch: Industrial Stoichiometry; Perry: Chemical Engineers' Handbook.

Prerequisite: Ch-101(C), or Ch-121(B).

CE-711(C) Chemical Engineering Calculations 3-2

An introductory course in chemical engineering, with part of the numerical problems selected from ordnance applications; material and energy balances in various unit operations and in typical chemical reactions, processess and plants; principles of thermochemistry; composition of equilibrium mixtures.

Texts: Hougen and Watson: Chemical Process Principles, Part I; Robinson: Thermodynamics of Firearms.

Prerequisite: Ch-101(C).

CE-721(B) Unit Operations 3-2

An introduction to the study of the unit operations of chemical engineering. Selection of and primary emphasis on particular unit operations will be made on the basis of current student specialties; e.g., Petroleum Engineering. Among the unit operations, treatment will be given to flow of fluids, filtration, agitation, mixing, sedimentation, heat transmission, evaporation, and drying. Both theoretical and applied material will be illustrated by quantitative examples.

Texts: Brown and Associates: Unit Operations; Perry: Chemical Engineers' Handbook.

Prerequisites: CE-701(C) and Ch-411(C).

CE-722(A) Unit Operations 3-2

A continuation of CE-721: Size reduction, sizing, crystallization, gas absorption, liquid-liquid extraction, batch and continuous distillation; fractionation columns.

Texts: Brown and Associates: Unit Operations; Perry: Chemical Engineers' Handbook.

Prerequisite: CE-721(B).

CE-731(A) Petroleum Refinery Engineering 3-0

A study of the engineering, chemical, and economic aspects of modern petroleum refinery practice. This course includes the following topics: evaluation of crude oils, process studies such as catalytic cracking, aviation gasoline manufacture, Fischer-Tropsch synthesis, chemical refinery of lubricating oils, theory, design, cost, and operation of refinery process equipment, factors determining method of treatment, plant design, applied reaction kinetics, and catalysis and applied thermodynamics of hydrocarbons.

Texts: Nelson: Petroleum Refinery Engineering; Sachanen: Conversion of Petroleum; Huntington: Natural Gas and Natural Gasoline; Selected readings in current technical journals.

Prerequisite: CE-722(A).

CE-732(A) Petroleum Refinery Engineering 3-2

A continuation of CE-731.

Texts: Nelson: Petroleum Refinery Engineering; Sachanen: Conversion of Petroleum; Huntington: Natural Gas and Natural Gasoline; Selected readings in current technical journals.

Prerequisite: CE-731(A).

CE-741(B) Heat Transmission 3-2

A course covering the principles of heat transmission by conduction, convection and radiation, steady conduction, transient conduction, Schmidt and relaxation methods of approximation, dimensional analysis. Emphasis is on principles applicable to problems in ordnance engineering such as rocket thrust chamber cooling and heat transfer to flying vehicles. Laboratory period is devoted to working problems.

Texts: McAdams: Heat Transmission; Jakob: Heat Transfer; Selected readings.

Prerequisite: One term of thermodynamics.

Ch-800(A) Chemistry Seminar

This course involves library investigations of assigned topics, and reports on articles in the current technical journals.

COMMUNICATION ENGINEERING

Co Courses

Co-141(C) Public Speaking 0-2

Instruction and practice in the effective delivery of speech.

Text: None.

Prerequisite: None.

Co-201(C) Communication Principles and Procedures I 3-1

An introduction to the principles of naval communication procedures, with a study of the basic communication publications relating to the various procedures; a study of the Naval communications system.

Text: Official Communications Publications.

Prerequisite: None.

Co-202(C) Communication Principles and Procedures II 3-2

A continuation of Co-201(C).

Text: Official Communications Publications.

Prerequisite: Co-201(C).

Co-211(C) Cryptographic Methods and Procedures 3-2

A study of cryptography as used in the U. S. Navy by a study of the detailed operating procedures.

Text: Classified Official Publications.

Prerequisite: Co-202(C).

Co-221(C) Communications Planning I 2-0

A study of the functions and facilities of naval communications, including details of tactical communicatons and preparation of communications-electronics plans and orders.

Text: Classified Official Publications.

Prerequisite: None.

Co-222(C) Communications Planning II 3-2

A continuation of Co-221(C).

Text: Classified Official Publications.

Prerequisite: Co-221(C).

Co-223(C) Communications Planning III 3-2

A continuation of Co-221(C) and Co-222(C).

Text: Classified Official Publications.

Prerequisite: Co-222(C).

Co-231(C) Naval Warfare Tactics and Procedures I 2-0

A course designed to provide a practical working knowledge of Naval tactics and procedures, and the fundamental principles underlying the successful prosecution of naval warfare.

Text: Classified Official Publications.

Prerequisite: None.

Co-232(C) Naval Warfare Tactics and Procedures II 4-3

A continuation of Co-231(C).

Text: Classified Official Publications.

Prerequisite: Co-213(C).

Co-233(C) Naval Warfare Tactics and Procedures III 4-3

A continuation of Co-231(C) and Co-232(C).

Text: Classified Official Publications.

Prerequisite: Co-232(C).

Co-261(C) Administration and Management 3-0

A study of the administration and management of publications and security; a study of the Navy Postal System; censorship.

Text: Official Publications.

Prerequisite: None.

CRYSTALLOGRAPHY

Cr Courses

Cr-271(B) Crystallography and X-Ray Techniques 3-2

The essential concepts of crystallography, including: symmetry, point groups, plane lattices, space lattices, space groups, coordinate sytems, indices, crystal classes, crystal systems, common forms and combinations in the various systems, the stereographic projection, modern x-ray diffraction and radiographic apparatus and techniques, the theory of x-ray diffraction, powder methods, single crystal and moving film methods, high temperature diffraction techniques, back reflection and transmitted beam methods. The laboratory work includes a study of crystal models for symmetry, forms, and combinations; the construction of stereographic projections; and actual practice in making and interpreting of x-ray diffraction photographs.

Texts: Buerger: Elementary Crystallography; Barrett: Structure of Metals.

Prerequisite: Ch-101(C)

Cr-301(B) Crystallography and Mineralogy 3-4

Designed primarily for the student who will continue with courses in mineralogy, geology, and petrology. The student is introduced to the fundamental concepts of crystallography, including: symmetry, point groups, plane lattices, space lattices, space groups, coordinate systems, indices, crystal classes, crystal systems, common form and combinations in the various systems and classes, the stereographic projection, and the theory of x-ray diffraction and the application of x-ray powder methods as applied to identification of minerals. The laboratory work includes a study of crystal models for symmetry forms, and combinations; the practical application and construction of stereographic projections; determination of minerals by x-ray powder diffraction patterns.

Text: Rogers: Introduction to the Study of Minerals.

Prerequisite: Ch-101(C).

Cr-311(B) Crystallography and Mineralogy 3-2

Subject matter similar to Cr-301, but designed for students who will continue with courses in chemistry.

Text: Rogers: Introduction to the Study of Minerals.

Prerequisite: Ch-101(C).

ELECTRICAL ENGINEERING

EE Courses

EE-011(C) Electrical Fundamentals 4-0

A basic presentation of electrical phenomena to acquaint officer students with fundamentals of the field. Topics include: resistance, voltage, current, magnetism, inductance, capacitance, resonance, three-phase systems, power relations, instruments, and transformers. Pertinent laboratory exercises are performed.

Texts: Dawes: Industrial Electricity, Parts I and II.

Prerequisites: Ma-011(C) or equivalent.

EE-012(C) Electrical Machinery 4-1

The fundamentals and important applications of direct-current and alternating-current machinery with emphasis upon naval aspects. Topics include: external characteristics of shunt and compound generators; shunt, series, and compound motors, alternators; synchronous and induction motors. Laboratory exercises and demonstrations are utilized.

Texts: Dawes: Industrial Electricity, Parts I and II.

Prerequisites: EE-011(C).

EE-021(C) Direct-Current Circuits and Machinery 5-3

A basic presentation of the direct-current circuits and parameters, and of direct-current machines and applications. Topics include: electrical and magnetic fields, general circuit theory including circuit parameters, basic measurement and metering; shunt and compound direct-current generators; shunt, series and compound motors; applications with emphasis upon naval aspects. Laboratory work illustrates the basic theory and provides experience in the operation and testing of the equipment.

Text: Dawes: Electrical Engineering, Vol. I, 4th Edition.

Prerequisites: Ph-013(C) and Ma-053(C).

EE-022(C) Alternating-Current Circuits and Machinery 5-3

A basic presentation of alternating-current circuits and parameters, and of alternating-current machinery and applications. Topics include: single-phase series and parallel circuits, resonance, vector representation, the commonly used network theorems, coupled circuits, balanced polyphase circuits, transformer, alternator, synchronous motor, induction motor, single-phase commutator motor, control systems and an introduction to servomechanisms.

Text: Dawes: Electrical Engineering, Vol. II, 4th Edition.

Prerequisites: EE-021(C).

EE-111(C) Fundamentals of Electrical Engineering 3-2

Basic concepts of direct-current circuits and static electric and magnetic fields are considered. Electrical units, resistivity, electromotive forces, basic measurements and metering equipment, Kirchhoff's laws, magnetism, typical magnetic circuits and simple electrostatic fields are studied.

Text: Dawes: Electrical Engineering, Vol. I, 4th Edition.

Prerequisites: Differential and Integral Calculus and Elementary Physics.

EE-151(C) Direct Current Circuits and Fields 3-2

An intermediate level course for those curricula which do not require a thorough background in direct current circuts and fields. Topics covered include electrical units, Kirchhoff's laws, direct current circuit analysis by the conventional methods including the nodal methods, electrostatic and electromagnetic fields, inductance, capacitance and ferro magnetic circuits. A limited amount of laboratory and supervised problem work is given in the one practical work period per week.

Text: Corcoran: Basic Electrical Engineering.

Prerequisites: Differential and Integral Calculus and Elementary Physics.

EE-171(C) Electrical Circuits and Fields 3-4

As a foundation in electricity and magnetism for a curriculum majoring in electrical science, the basic laws are studied in detail. Units, Kirchhoff's laws, electrostatic fields, magnetic fields, ferromagnetism, direct-current networks, direct-current measurements, calculation of resistance, capacitance and inductance are covered. Basic laboratory experiments deal with measurements, the proper use of metering equipment and magnetic circuits. Supervised problem work is included.

Text: Corcoran and Reed: Introductory Electrical Engineering.

Prerequisites: Differential and Integral Calculus and Elementary Physics.

EE-231(C) Circuits and Machines 3-2

General principles of DC machines, their control and application. The qualitative characteristics of the various machines are developed from basic principles, then a study of the theory of alternating currents is begun. Experiments are performed to demonstrate the general machine characteristics and the use of control devices.

Text: Dawes: Electrical Engineering, Vols. I and II, 4th Edition.

Prerequisite: EE-111(C).

EE-241(C) Alternating-Current Circuits 3-2

For those curricula that do not require an extensive coverage. Consists of an elementary treatment of single-phase series and parallel circuits, resonance, vector representation and vector algebra, the most commonly used network theorems, non-sinusoidal wave analysis, coupled circuits, and balanced polyphase circuits. Laboratory and problem work illustrate the basic theory.

Texts: Kerchner and Corcoran: Alternating Current Circuits, 3rd Edition; Skroder and Helm: Circuit Analysis by Laboratory Methods, 2nd Edition.

Prerequisite: EE-151(C) or EE-171(C).

EE-251(C) Alternating-Current Circuits 3-4

This course presents the essentials of alternating-current circuits. Single-phase circuits, resonance, vector representation and complex numbers, basic metering, coupled circuits, and balanced polyphase circuits are treated. The elements of non-sinusoidal wave analysis are included. Laboratory experiments cover series and parallel resonance, single-phase and polyphase metering and elementary bridge measurements. Time is allotted for supervised problem work.

Texts: Kerchner and Corcoran: Alternating Current Circuits, 3rd Edition; Skroder and Helm: Circuit Analysis by Laboratory Methods, 2nd Edition.

Prerequisite: EE-171(C).

EE-271(C) Alternating-Current Circuits 3-2

The basic theory of the alternating-current circuit for those curricula that require an extensive coverage. Single-phase series and parallel circuits, resonance, vector algebra and vector representation of electrical magnitudes, network theorems, non-sinusoidal wave analysis, balanced polyphase circuits and power measurements in polyphase circuits. Problems and laboratory work illustrate the basic theory.

Texts: Kerchner and Corcoran: Alternating Current Circuits, 3rd Edition; Skroder and Helm: Circuit Analysis by Laboratory Methods, 2nd Edition.

Prerequisite: EE-171(C).

EE-272(B) Alternating-Current Circuits 3-2

A continuation of EE-271. Unbalanced polyphase circuits, instruments and measurements, coupled circuits, bridge theory and symmetrical components. Problems and laboratory work illustrate the basic principles.

Texts: Kerchner and Corcoran: Alternating Current Circuits, 3rd Edition; Skroder and Helm: Circuit Analysis by Laboratory Methods, 2nd Edition.

Prerequisite: EE-271(C).

EE-273(C) Electrical Measurements I 2-3

An introduction to the measurement of the fundamental quantities: current, voltage, capacitance, inductance, and the magnetic properties of materials. Direct-current bridges, the measurement of high resistance, characteristics of direct-current galvanometers, potentiometer principles, commercial potentiometer types, direct-current indicating instruments.

Text: Stout: Basic Electrical Measurements.

Prerequisite: EE-272(C).

EE-274(B) Electrical Measurements II 2-3

A continuation of EE-273(C). Alternating-current bridge circuits, components, and accessories. Measurement of the properties of dielectrics.

Text: Stout: Basic Electrical Measurements.

Prerequisite: EE-273(C).

EE-314(C) Electrical Machinery 3-4

The fundamentals of representative direct-current and alternating-current machines are studied in classroom and supplemented with laboratory experiments. The theory, practical construction, types of windings and the performance of direct-current generators and motors, alternators, transformers, synchronous motors, induction motors, and single-phase motors are briefly covered.

Text: Dawes: Electrical Engineering, Vols. I and II, 4th Edition.

Prerequisite: EE-251(C).

EE-351(C) Direct-Current Machinery 2-2

Fundamentals of direct-current machinery with emphasis upon operating characteristics and applications. The external characteristics are devoloped from basic relations. Problems and laboratory work supplement that of the classroom.

Text: Dawes: Electrical Engineering, Vol I.

Prerequisite: EE-151(C) or EE-171(C).

EE-371(C) Direct-Current Machinery 3-2

A thorough presentation of the theory and performance of direct-current machines and control devices. Armature windings, armature reaction and commutation are fully covered. The operating characteristics of generators and motors are developed from basic relations so as to provide a foundation for subsequent work in design. Problems are assigned to illustrate the application of the theory. Laboratory work supplements the work of the classroom.

Text: Langsdorf: Principles of Direct-Current Machines.

Prerequisite: EE-171(C).

EE-451(C) Transformers and Synchros 2-2

The theory, construction and performance of single-phase transformers and polyphase transformer connections are covered in the first part of the course. Approximately the latter half of the term is given to the study of synchros, their theory, construction and performance under normal and abnormal conditions. Laboratory experiments parallel the classroom study.

Texts: Hehre and Harness: Electrical Circuits and Machinery, Vol. II; Ordnance Pamphlet 1303; Synchros.

Prerequisite: EE-251(C).

EE-452(C) Alternating-Current Machinery 3-4

A continuation of EE-451(C). It completes a general presentation of AC machinery for those curricula that do not require an extensive treatment. Alternators, synchronous motors, polyphase and single-phase induction motors are presented. A brief survey of induction generators, induction regulators and the commutator type AC motor is included. Laboratory and problem work illustrate the basic theory.

Text: Hehre and Harness: Electrical Circuits and Machinery, Vol. II.

Prerequisite: EE-451(C).

EE-453(B) Alternating-Current Machinery 3-4

The basic principles, constructional features and perforance characteristics of single and polyphase transformers. Polyphase transformer connections.

Special transformers and the induction regulator. Theory and operational characteristics of single and polyphase induction motors, alternating-current generators and synchronous motors. Basic principles and perfomance characteristics of synchro generators, motors and control transformers under normal operating conditions. Laboratory and problem work illustrate the basic theory.

Texts: Puchstein, Lloyd and Conrad: Alternating Current Machines, 3rd Edition; Ordnance Pamphlet 1303.

Prerequisite: EE-251(C).

EE-455(C) Asynchronous Motors 2-2

An elementary presentation of the principles and operating characteristics of the induction motor and of single-phase commutator motors. Emphasis is placed upon the unbalanced operation of the two-phase symmetrical induction motor. Laboratory and problem work supplement the theory.

Text: Hehre and Harness: Electrical Circuits and Machinery, Vol. II.

Prerequisite: EE-451(C).

EE-461(C) Transformers and Synchros 3-2

For those curricula which do not require an extensive coverage of these topics. Single-phase transformer principles, constructional features and operating characteristics. Special transformers. Synchro and induction motor windings. Single-phase and polyphase synchro constructional features. Mathematical analysis of the torque, current and voltage characteristics of synchros operating under normal and fault conditions. Synchros in control circuits. Laboratory and problem work illustrate the basic principles.

Text: Hehre and Harness: Electrical Circuits and Machinery, Vol. II; Ordnance Pamphlet 1303.

Prerequisite: EE-241(C) or EE-251(C).

EE-462(B) Special Machinery 4-2

Basic principles and operating characteristics of single-phase and polyphase induction motors and single-phase commutator motors. Operation of two-phase induction motors with unbalanced voltages and variable phase angles. Theory and operating characteristics of amplidyne and rototrol generators. Operation of direct-current motors on variable voltage. Calculation of the transfer function for motors and generators. Laboratory and problem work illustrate the basic principles.

Text: Hehre and Harness: Electrical Circuits and Machinery, Vol. II.

Prerequisite: EE-461(C).

EE-463(C) Special Machinery 3-2

The theory and performance of single phase, iron core transformers at power and audio frequencies with particular attention to attenuation and phase shift as affected by leakage inductance and distributed capacitance; synchro control transformer, synchro motor and synchro generator principles under normal operating conditions; polyphase and single phase induction motor principles and operating characteristics in control applications are emphasized. A brief treatment of DC machinery and special machinery theory (amplidyne, etc.) is included to illustrate the significance of time constants, transfer functions and concepts important in control applications. Laboratory and problem work supplement the theory.

Texts: Dawes: Electrical Engineering, Vols. I and II, 4th Edition; Ordnance Pamphlet 1303; Department Notes.

Prerequisite: EE-251(C).

EE-471(C) Alternating-Current Machinery 3-4

For those curricula giving advanced work in electrical engineering. Basic theory and operating characteristics of single-phase and polyphase transformers, special transformers, polyphase and single-phase induction motors, induction generators and commutator type alternating-current motors. Motor and generator armature windings, voltage and mmf waves. Laboratory and problem work illustrate the basic theory.

Text: Puchstein, Lloyd and Conrad: Alternating Current Machines, 3rd Edition.

Prerequisite: EE-272(B).

EE-472(C) Alternating-Current Machinery 3-4

A continuation of EE-471(C). Alternator and synchronous motor theory and operating characteristics based on cylindrical rotor and two-reaction theories. Armature windings. Voltage, current and mmf waves. Load saturation characteristics, regulation and losses. Frequency changers. Parallel operation of synchronous machines. Synchro principles and mathematical analysis of operating characteristics for normal and fault conditions. Laboratory and problem work illustrate the basic principles.

Text: Puchstein, Lloyd and Conrad: Alternating Current Machines, 3rd Edition.

Prerequisite: EE-471(C).

EE-473(B) Synchros 2-2

Basic theory and mathematical analysis of single-phase and polyphase synchros. Voltage, current and torque relations under normal and fault conditions. Equivalent circuits and vector diagrams, control circuits using synchros. Laboratory and problem work supplement the study of basic principles.

Text: None.

Prerequisite: EE-251(C) or EE-271(C).

EE-474(C) Synchros and Special Machines 2-0

An introduction to the theory of transformers with application to synchros. Special emphasis on the synchro generator-control transformer combination. Elements of induction motor theory with emphasis on the two phases servo motor, its time constants and transfer function representation.

Texts: Ordnance Pamphlet 1303; Department Notes.

Prerequisite: None.

EE-551(B) Transmission Lines and Filters 3-2

An intermediate level course for those curricula which do not require the more thorough treatment given in EE-571(B). Transmission line parameters, general transmission line equations for distributed parameters, infinite line, open and short circuited lines, loading, reflection and equivalent circuits. Impedance transformation and impedance matching with stubs and networks. Constant K, M-derived and composite filters. Problems and laboratory work illustrate the basic theory.

Text: Ware and Reed: Communication Circuits.

Prerequisite: EE-251(C).

EE-571(B) Transmission Lines and Filters 3-4

A more thorough coverage of transmission line and filter theory and more emphasis on transmission at power frequencies than given in EE-551(B). Transmission line parameters, general transmission line equations, transmission line vector diagrams and charts. Losses, efficiency and regulation. Loading, open-circuited lines, short-circuited lines and reflection. Equivalent circuits. Impedance transformation, impedence matching with networks and stubs. Transient voltages and currents on lines. Constant K, M-derived and composite filters for low pass, high pass, band pass and band elimination. Problems and laboratory work illustrate the basic principles.

Texts: Woodruff: Electric Power Transmission and Distribution; Ware and Reed: Communication Circuits.

Prerequisite: EE-271(C).

EE-651(B) Transients and Servomechanisms 3-4

Basic principles of electric transients and servomechanisms. DC and AC transients in series, parallel, series-parallel and coupled circuits. The solution of the differential equations by classicial and Laplace operational methods. Servomechanisms with viscous damping and differential and integral control. Problems and laboratory experiments illustrate the theory.

Texts: Kurtz and Corcoran: Introduction to Electric Transients; Chestnut and Mayer: Servomechanism and Regulating System Design, Vol I; Wheeler: Basic Theory of the Electronic Analog Computer.

Prerequities: EE-451(C) and EE-711(C) or EE-751(C).

EE-655(B) Filters and Transients 3-2

Basic principles of filters and electrical transients. T and Pi section filters and composite filters. DC and AC transients in series, parallel, series-parallel and coupled circuits. The solution of the differential equations by classical methods and Laplace operational methods.

Texts: Kerchner and Corcoran: Alternating Current Circuits; Kurtz and Corcoran; Introduction to Electrical Transients.

Prerequisites: EE-251(C).

EE-656(B) Machines and Servos 3-4

Elements of synchros with special attention to the synchro generator-control transformer combination. The two phase induction motor, the operating characteristics and transfer function. Dynamic performance of DC motors and generators. Elements of servomechanism theory. Nyquist stability criteria, correlation between transient response and frequency response. Steady state performance. Applications using electrical machines.

Text: Thaler: Elements of Servomechanism Theory.

Prerequisites: Circuits and Transients.

EE-660(A) Circuit Analysis 3-2

The study of electric networks utilizing the pole and zero approach. Concepts of sinusoidal steady state response and transient response are unified using this method. The Cauer and Foster forms of reactive networks are studied. Feedback circuits and electronic circuits are investigated. Filter circuits are considered from the image parameter point-of-view.

Text: Van Valkenburg: Network Analysis.

Prerequisite: EE-251(C) or equivalent.

EE-661(A) Circuit Synthesis 3-2

The concepts studied in EE-660(A) are extended to form a foundation for the design of electrical networks.

Texts: Reed: Electric Network Synthesis; Truxal: Control System Synthesis.

Prerequisite: EE-660(A).

EE-670(A) Introduction to Servomechanisms 3-3

The mathematical theory of linear feedback control systems is presented in detail. This is a terminal course intended for curricula that do not include more advanced courses in servomechanisms. Both frequency domain and time domain methods are covered. Topics include the Nyquist stability criterion, the Bode diagram and its uses, the root locus method and pole aero configurations.

Texts: Thaler and Brown: Servomechanism Analysis; Nixon: Principles of Automatic Controls.

Prerequisite: EE-671(A).

EE-671(A) Transients 3-4

The basic theory and practical applications of transient phenomena are treated in detail. Emphasis is on electric circuits and electromechanical system transients. Topics covered are: DC and AC transients in series, parallel, series-parallel, coupled and multiloop circuits; transients in motors, generators, and elementary servo systems; transfer functions, elementary non-linear transients; the analogue computer and its use. The Laplace transform method is used.

Texts: Gardner and Barnes: Transients in Linear Systems; Wheeler: Basic Theory of the Electronic Analog Computer; Department Notes.

Prerequisite: EE-251(C) or EE-272(C).

EE-672(A) Servomechanisms 3-3

The mathematical theory of linear feedback-control systems is discussed in detail. Topics are: Basic system equations, time domain and frequency domain relationships, methods for improving performance, damping, differentiation and integration and their relationship to phase concepts, polar and logarithmic plots, design calculations, introduction to the root locus method. Problems and laboratory work illustrate the theory.

Text: Thaler and Brown: Servomechanisms Analysis.

Prerequisites: EE-671(A), EE-452(C) or EE-473(B) and EE-751(C) or equivalent.

EE-673(A) Nonlinear Servomechanisms 3-2

A detailed study of phase plane methods and describing function methods. Application of these methods in the analysis and design of nonlinear servos, with emphasis on relay servos.

Texts: Chestnut and Mayer: Servomechanism and Regulating System Design, Vol. I; Department Notes.

Prerequisite: EE-672(A).

EE-674(A) Advanced Linear Servo Theory 3-0

This course includes the following topics; System analysis in the time domain; pole, zero, and root locations, and their interpretation in terms of system performance; root loci and their uses, correlations between the time domain and the frequency domain; methods for computing the transient response from the frequency response; multiple loop servo systems and coupled servo systems, with emphasis on stability criteria.

Texts: Truxal: Automatic Feedback Control System Synthesis; Department Notes.

Prerequisites: EE-671(A) and EE-672(A).

EE-675(A) Sampled Data Servo Systems 3-0

A study of the response of servo systems to discontinuous information. The effect of location of the sampler and of the rate of sampling. Z-transformation theory. Data smoothing and prediction. Application of phase plane techniques.

Texts: Truxal: Automatic Feedback Control System Synthesis; Department Notes.

Prerequisites: EE-673(A) and EE-674(A).

EE-676(A) Linear and Nonlinear Servo Compensation Theory 3-0

Extension of normal compensation methods to multiple loop servos. Nonlinear compensation for otherwise linear servos. Linear and nonlinear servos.

Text: Department Notes.

Prerequisites: EE-673(A) and EE-674(A).

EE-677(A) Survey of Feedback Control Literature 1-0

An analysis of current developments in feedback control systems, as disclosed by papers in current technical journals. This course is intended only for candidates for the Doctor's Degree.

Text: None.

Prerequisites: EE-671(A) and EE-672(A).

EE-711(C) Electronics 3-2

The elementary theory of the control of electron motion by electric and magnetic fields in vacuum, gaseous conduction phenomena and electron tube characteristics are presented as a basis for the study of electronic circuits. The principles of the amplifier, rectifier and oscillator circuits are presented in their essentials. Some consideration is given to the special tubes encountered in electronic devices. Laboratory work serves to integrate the principles presented in the classroom practical applications and circuits.

Text: Corcoran and Price: Electronics.

Prerequisite: EE-251(C).

EE-731(C) Power Electronics 3-2

The theory and application of various types of electron tubes is covered with particular emphasis on the thyratron. The principles of electronics circuitry as applied to the control of power in motors, generators and selsyn instruments constitute the general theme of the course. Application in naval devices is stressed. The laboratory work consists of experiments to demonstrate the theory.

Text: Corcoran and Price: Electronics.

Prerequisite: EE-231(C).

EE-745(A) Electronic Control and Measurement 3-3

This course presents the principles and practice of electronic control and measurement as found in research laboratories and in industry. It includes the theory of such basic circuits as vacuum tube volt-meters, direct coupled amplifiers, oscillators, timing circuits and frequency sensitive circuits with particular attention to their application in the measurement and control of current, voltage, frequency, speed, pressure, temperature and illumination. Some time is devoted to the study of data transmission methods by modulation and detection in carrier systems. Applications are studied in the laboratory.

Text: Gray: Applied Electronics, 2nd Edition.

Prerequisite: EE-751(C) or EE-772(B).

EE-751(C) Electronics 3-4

This is an introduction to the theory and practice of engineering electronics. Topics treated are: electron motion in electric and magnetic fields, thermionic emission, vacuum tube characteristics, gaseous discharge phenomena, gas tube characteristics, transistor theory and applications. The theory of electronic components is extended to a study of their application in rectifier, amplifier and oscillator circuits with as thorough a coverage as time will allow. Problems and laboratory work supplement the lectures.

Text: Ryder: Electronic Engineering Principles, 2nd Edition.

Prerequisites: EE-251(C) or equivalent.

EE-755(A) Electronic Control and Measurement 3-4

The principles and practice of electronic control and measurement as found in research laboratories and in industry. Includes the theory of such basic circuits as vacuum tube voltmeters, direct coupled amplifiers, oscillators, timing circuits and frequency sensitive circuits with particular attention to their application in the measurement and control of current, voltage, frequency, speed, pressure, temperature and illumination. Some time is devoted to the study of data transmission methods by modulation and detection in carrier systems. Applications are studied in the laboratory.

Text: Gray: Applied Electronics, 2nd Edition.

Prerequisite: EE-751(C) or EE-772(B).

EE-756(A) Electrical Measurement of Non-Electrical Quantities 3-3

The measurement of pressure, speed acceleration, vibration strain, heat, sound, light, time, displacement, and other non-electrical quantities by electrical means. Consideration of special problems of measurement encountered in development of missiles and missile guidance systems.

Texts: Kinnard: Applied Electrical Measurements; Grey: Applied Electronics, 2nd Edition.

Prerequisite: EE-751 or EE-772(B).

EE-771(B) Electronics 3-2

The theory of electron tubes and circuits for those curricula requiring a more advanced treatment. Topics covered include: electron motion in electric and magnetic fields, thermionic emission, gaseous discharge phenomena, vacuum and gas tube characteristics and the principles of such tubes as the ignitron, glow tube, cathode-ray tube and the phototube. Circuit applications of rectifiers, detectors, and amplifiers is covered, with particular attention to those found in industrial and naval power and control devices. Laboratory exercises and problems supplement the lectures.

Text: Gray: Applied Electronics, 2nd Edition.

Prerequisite: EE-251(C) or equivalent.

EE-772(B) Electronics 3-2

A continuation of EE-771(B). Topics covered include tuned amplifier circuit theory, class B power amplifiers, class C amplifiers and oscillators. Feedback amplifier theory is given as a basis for analog computer and electronic control applications. Transistor theory and transistor circuitry is presented at the end of the course. Laboratory work supplements the lecture periods.

Text: Gray: Applied Electronics, 2nd Edition.

Prerequisite: EE-771(B).

EE-773(A) Magnetic Amplifiers 2-3

Basic principles of magnetic amplifiers and magnetic amplifier circuits, including feedback and biasing. Emphasis placed on circuits useful in industrial control and military applications.

Text: Storm: Magnetic Amplifiers.

Prerequisite: EE-251(C).

EE-851(B) Magnetic Design 4-0

Selected topics in electromagnetic design principles to satisfy the requirements of a particular curriculum. Typical topics are synchros, transformers, relays, magnetic amplifiers, solenoids, and instruments.

Text: None.

Prerequisites: EE-111 and EE-251.

EE-871(A) Electrical Machine Design 4-0

A quantitative analysis of machine characteristics using the design approach. Serves to develop an appreciation for the limitations and possibilities in electrical machine construction especially for naval applications, and the ability to evaluate properly the merits of present designs. In particular, this course consist of the quantitative study and design of a transformer to meet certain specifications. Later the analysis of the DC machine is begun.

Text: Slichter: Principles Underlying the Design of Electrical Machinery.

Prerequisite: EE-472(C).

EE-872(A) Electrical Machine Design 4-0

A continuation of EE-871(A). The completion of the quantitative analysis and design of a DC machine and the beginning of a similar analysis of the synchronous machine.

Text: Slichter: Principles Underlying the Design of Electrical Machinery.

Prerequisite: EE-871(A).

EE-873(A) Electrical Machine Design 4-0

A continuation of EE-872(A). The completion of the quantitative analysis and design of a synchronous machine and a similar analysis and design of the induction machine.

Text: Slichter: Principles Underlying the Design of Electrical Machinery.

Prerequisite: EE-872(A).

EE-874(A) Electrical Machine Design 4-0

A continuation of EE-873(A). The design of the induction machine is analyzed quantitatively and its operating characteristics, both as a motor and as an induction generator, are determined.

Text: Slichter: Principles Underlying the Design of Electrical Machinery.

Prerequisite: EE-873(A).

EE-971(A) Seminar 1-0

In the seminar sessions, papers on research and developments in the field of electrical science are presented to the more advanced group of students. Some appreciation for research methods is developed. In these sessions papers treating of student research in progress and matters of major important in electrical engineering are delivered by the faculty and by the students pursuing an advanced engineering curriculum.

Text: None.

Prerequisite: A background of advanced work in electrical engineering.

ENGINEERING ELECTRONICS

Es Courses

Fundamentals of Electric Circuits and Circuit Elements I	Es-111(C)
Fundamentals of Electric Circuits and Circuit Elements II	Es-112(C)
Circuit Analysis and Measurements I	Es-113(C)
Circuit Analysis and Measurements II	Es-114(C)
Transient Circuit Theory	Es-116(C)
Advanced Circuit Theory I	Es-121(B)
Advanced Circuit Theory II	Es-122(A)
Pulse Techniques	Es-123(B)
Radio Frequency Measurements	Es-124(C)
Computers and Data Processors	Es-125(B)
Radio Frequency Measurement and Microwave Techniques	Es-126(C)
Pulse and Digital Techniques	Es-127(B)
Information Theory I	Es-128(A)
Communication Theory	Es-128(B)
Communication Theory	Es-129(B)
Information Networks	Es-136(A)
Information Theory II	Es-139(A)
Transmission Lines and Filters	Es-141(C)
Electronic Instrumentation	Es-161(A)
Electron Tube Circuits I	Es-212(C)
Electron Tube Circuits II	Es-213(C)
Electron Tube Circuits III	Es-214(C)
Transistor Electronics	Es-221(A)
Transistor Electronics	Es-222(B)
Electron Tubes	Es-225(B)
Microwave Tubes and Techniques	Es-226(A)
Ultra-High Frequency Techniques	Es-227(B)
Electron Tubes and Circuits I	Es-261(C)
Electron Tubes and Circuits II	Es-262(C)
Electron Tubes and Ultra-High Frequency Techniques	Es-267(A)
Introduction to Microwaves	Es-268(C)
Electronics I	Es-271(C)
Electronics II	Es-272(C)
Electronics III	Es-273(C)
Electron Tubes and Circuits	Es-287(C)
Communication Systems I	Es-321(B)
Missile Guidance Systems	Es-323(B)
Transmitters and Receivers	Es-326(B)
Electronic Systems	Es-327(B)
Transmitters and Receivers	Es-328(B)
Communication Systems II	Es-332(B)
Communication Systems III	Es-333(B)
Communication Systems IV	Es-334(B)
Electronic Systems	Es-335(B)
Radio Telemetry and Simulation	Es-341(B)
Electronics I	Es-371(C)
Electronics II	Es-372(C)
Electronics Fundamentals	Es-376(C)
Systems I (Transmitters, Receivers)	Es-381(C)
Systems II (Teletype, Image Systems, Pulse Systems, ECM)	Es-382(B)
Systems III (Radar, Navigation, Naval and Air Tactical Data Systems)	Es-383(B)
Pulse Techniques	Es-421(B)
Radar Systems I	Es-422(B)
Radar Systems II	Es-423(B)
Radar Systems IIA	Es-424(B)
Introduction to Radar	Es-426(B)
Radar System Engineering I	Es-431(B)
Radar System Engineering II	Es-432(B)
Radar Data Processing and Computer-Controlled Systems	Es-433(B)
Introduction to Radar	Es-446(C)
Pulse Techniques	Es-447(C)
Introduction to Radar (Airborne)	Es-456(C)
Pulse Techniques	Es-461(A)
Countermeasures	Es-536(B)
Sonar Systems Engineering Design and Developments	Es-537(B)
Introduction to Electromagnetics	Es-615(C)
Electromagnetics I	Es-621(C)
Electromagnetics II	Es-622(B)
Electromagnetics III	Es-623(A)
Guided Waves and Resonators	Es-626(C)
Electromagnetics II	Es-627(A)
Antennas, Transmission Lines	Es-726(B)
Antennas and Feed Systems	Es-727(B)
Lines, Antennas, and Propagation	Es-728(C)
Antennas and Propagation	Es-787(B)
Systems Lectures I	Es-821(C)
Systems Lectures II	Es-822(C)
Systems Seminar	Es-823(C)
Project Seminar	Es-836(A)

Es-111(C) Fundamentals of Electrical Circuits and Circuit Elements I 4-4

Basic concepts of circuits and electromagnetic fields. Emphasis upon the setting up and solution of network equations. Principal topics are: Electric field, potential, properties of dielectrics, current and resistance, d-c circuits, magnetic field, magnetic field of a current and of a moving charge, induced electromotive force, magnetic properties of matter, inductance and capacitance, alternating current and voltage, vector representation, complex quantities, elementary circuit concepts, loop and nodal method.

Texts: Sears: Electricity and Magnetism; Tang: Alternating-Current Circuits; Varner: The 14 Systems of Units.

Prerequisite: Mathematics through the calculus.

Es-112(C) Fundamentals of Electric Circuits and Circuit Elements II 4-3

A continuation of Es-111(C). An introduction to alternating current circuit theory. Principal topics are: series circuits, series resonance, parallel circuits, parallel resonance, network theorems, coupled circuits, equivalent coupled circuits, impedence transformation, non-sinusoidal waves, synthesis and Fourier analysis, d-c transients, filter principles.

Texts: Tang: Alternating-Current Circuits; Everitt: Communication Engineering; Varner: The 14 Systems of Units.

Prerequisite: Es-111(C).

Es-113(C) Circuit Analysis and Measurements I 3-3

An introduction to the principles and techniques of elementary measurements at audio and radio frequencies. The principal topics are: measurement of AC current and voltage with particular reference to the response to complex wave forms, principles and characteristics of vacuum tube voltmeters, measurement of frequency, measurement of impedance by bridge and Q-meters. An introduction to transmission lines. Definition of terms, line parameters and transmission units.

Text: Terman and Pettit: Electronic Measurements.

Prerequisite: Es-112(C).

Es-114(C) Circuit Analysis and Measurements II 3-3

The infinite line. Properties of open wire and cables; loading. Reflections and the solution of the general line. Derivation and use of circle diagrams. Use of lines and stubs as transformers and matching devices. Use of a line as an impedance measuring device. Qualitative extension of transmission line principles to waveguides and waveguide components. Constant K and m-derived filters.

Text: Everitt: Communication Engineering.

Prerequisite: Es-113(C).

Es-116(C) Transient Circuit Theory 4-2

An introduction to the transient phenomena and circuit properties in electrical networks. Solutions on the loop and nodal basis. The Laplace Transform is presented, without development, to be used as a tool. Lumped constant and distributed constant networks are studied.

Text: Notes by G. R. Giet.

Prerequisites: Es-112(C) and Ma-123(A).

Es-121(B) Advanced Circuit Theory I 4-2

Advanced circuit theory with transient analysis. Principles of differential equations. Basic circuit relations, philosophy of circuit behavior. The Laplace transform treated as a tool and used in circuit analysis and study of circuit properties. Normalized networks. Harmonic analysis, the Fourier integral and Fourier transform and their use in further study of circuit properties. Development of the Laplace transform from the Fourier transform. Superposition formulae, indicial admittance, impulse functions. Translation, repeated action circuit analysis.

Texts: Notes by Giet; Gardner and Barnes: Transients in Linear Systems; Goldman: Frequency Analysis, Modulation, and Noise.

Prerequisite: Es-114(C).

Es-122(A) Advanced Circuit Theory II 4-2

A continuation of Es-121(B). Two terminal pair networks, matrix algebra applied to the analysis of two terminal pair networks both passive and active, including tube and transistor circuits. Transient analysis of distributed constant circuits, long lines. Introduction to circuit synthesis given a driving point impedance. Foster's Reactance theorem. Synthesis of LC, RL, RC and RLC networks.

Texts: Notes by Giet; Gardner and Barnes: Transients in Linear Systems; Goldman: Frequency Analysis, Modulation, and Noise.

Prerequisite: Es-121(B).

Es-123(B) Pulse Techniques 3-3

Pulse shaping: clipping, clamping, peaking coupling, integrating. Pulse-forming networks and artificial lines. Trigger and multivibrator circuits. Time-base generators. Pulse transformers and blocking oscillators. Transistor switching circuits.

Texts: M.I.T. Radar School Staff: Principles of Radar (Third Edition); Millman and Taub: Pulse and Digital Circuits.

Prerequisites: Es-221(A), Es-213(C) and Es-166(C).

Es-124(C) Radio Frequency Measurements 2-3

This is a continuing study of the problems involved in the measurement of the quantities of interest in electronic circuits. The principles and techniques of measurement of power, impedance and phase over an extended frequency range are studied.

The laboratory work will be devoted to drill on the use of these techniques with particular emphasis on the capabilities and limitations of the more commonly used methods and test equipments.

Text: Terman and Pettit: Electronic Measurements.

Prerequisites: Es-113(C) and Es-114(C).

Es-125(B) Computers and Data Processors 3-3

A study of component engineering, logical design and systems engineering considerations in the application of electronic computer methods to data processing and automatic control problems. Principles of organization of digital, analog, and incremental information processing systems. Elements of logical design. Simulation of dynamic systems. Synthesis of computer programs for automatic control. Methods for prediction, smoothing, and tracking. Displays and human engineering.

Texts: Richards: Arithmetic Operations in Digital Computers; Wass: Introduction to Electronic Analog Computers.

Prerequisite: Es-214(C).

Es-126(C) Radio-Frequency Measurement and Microwave Techniques 2-6

An advanced and extended treatment of the principles and techniques of measurement over the entire frequency band, using lumped, transmission line and waveguide components. The areas considered are those of the measurement of frequency, power, phase, and impedance, by means of lines, bridges and resonance methods. Emphasis in the laboratory is on the development of the ability of the student to analyze a new problem and to plan and implement a method of attack.

Texts: Terman and Pettit: Electronic Measurements; Hartshorn: Radio Frequency Measurements.

Prerequisites: Es-114(C) and Es-225(B).

Es-127(B) Pulse and Digital Techniques 3-3

Study of circuit methods applicable to radar, television, digital computers, pulse communication, data-processing, digital control, and similar systems. Voltage and current time base generators, blocking oscillators, frequency division and multiplication, bit storage elements, AND OR gates, transmission gates, comparators, time modulation, ANDIG and DIGAN converters.

Text: Millman and Taub: Pulse and Digital Circuits.

Prerequisites: Es-121(B), Es-214(C) and Es-221(A).

Es-128(A) Information Theory I 3-0

Statistical methods in communications engineering are studied. These include information measure, channel capacity, coding, signal spectra, signal space, and an introduction to correlation techniques.

Texts: Shannon and Weaver: Mathematical Theory of Communication; Laning and Battin: Random Processes in Automatic Control; Selected technical reports and references from scientific periodicals.

Prerequisites: Es-122(A) and Ma-321(B).

Es-128(B) Communication Theory 4-0

Application of statistical methods to selected problems arising in electronics engineering. These problems will include: noise in electronic components; filtration and detection in the presence of noise; information theory—information measure, channel capacity, and coding.

Text: Instructor's Notes.

Prerequisites: Es-116(C), Ma-320(C).

Es-129(B) Communication Theory 4-0

Elementary treatment of selected concepts from probability and statistics. Application of these concepts to an introductory discussion of selected problems arising in electronics engineering. These problems may include: sampling and quality control in electronics manufacturing; noise in electronic components; filtration and detection in the presence of noise; information theory, channel capacity, and coding.

Text: Instructor's Notes.

Prerequisite: Es-116(C).

Es-136(A) Information Networks 3-2

Adaptions of symbolic logic for the analysis of binary information networks using relays, vacuum-tubes, transistors, or magnetic cores. Abstract models for switching networks. Combinational and sequential circuits. Logical design of arithmetic and control elements. Dynamic simulation. Transfer function synthesis. Sampled-data control systems and z-transform theory. Frequency domain treatment of analog and digital computer programs. Weighting functions for smoothing, prediction and tracking. Digital and Analog techniques for the detection of small signals in noise.

Texts: Instructor's Notes. Selected references from the Periodical Literature.

Prerequisies: Es-127(B) and Es-128(A).

Es-139(A) Information Theory II 3-0

A continuation of Es-129(A). The primary emphasis during this course is on the optimization of circuits and systems subjected to stochastic inputs. The optimization of both linear and non-linear data processing operators is considered. The optimization of sampled data systems is discussed. Optimum signal detection criteria are compared, and standard engineering methods are evaluated and compared with optimum techniques. Problems of current scientific interest are introduced and discussed.

Texts: Selected technical reports and references from scientific periodicals.

Prerequisites: Es-128(A) and concurrent registration in Es-136(A).

Es-141(C) Transmission Line and Filters 4-3

A study of the properties of open wire lines and cables under steady state conditions. The infinite and terminated line. Use of line properties for impedance transformation and impedance measurement. Introduction to filter theory and design; the prototype and m-derived constant K filters.

Text: Everitt: Communication Engineering.

Prerequisite: EE-251(C).

Es-161(A) Electronic Instrumentation 3-3

The principal topics are: pulse-amplitude analysis circuits, scaling circuits, electronic counter systems, counting-rate meters, coincidence and anti-coincidence circuits, electrometers, special power-supply considerations.

Texts: Elmore and Sands: Electronics; Millman and Taub: Pulse Digital Circuits; Selected references.

Prerequisite: Es-461(A).

Es-212(C) Electron Tube Circuits I 4-3

The physical principles and characteristics of vacuum and gas tubes is stressed in the first half of this course. This is followed by basic tube circuit theory of amplifier and rectifier circuits.

Texts: Geppert: Basic Electron Tubes; Corcoran and Price: Electronics; Seely: Electron-Tube Circuits.

Prerequisite: Es-111(C).

Es-213(C) Electron Tube Circuits II 4-3

A continuation of Es-212(C). The principal topics are: voltage regulators, grid clamping bias, anode and cathode followers, cathode bias and degeneration, difference amplifier, V.T.V.M., phase inverters, voltage and current servos, grounded grid amplifier, D.C. amplifiers, feedback and operational amplifiers, wide-band amplifiers, tuned voltage and power amplifiers.

Texts: Notes by Bauer: Corcoran and Price: Electronics; Seely: Electron Tubes Circuits; Cruft: Electronic Circuits and Tubes.

Prerequisite: Es-212(C).

Es-214(C) Electron Tube Circuits III 4-3

A continuation of Es-213. The principal topics are: Sine-wave oscillators: amplitude modulation and detection; frequency conversion; frequency-modulation techniques.

Texts: Cruft Electronics Staff: Electronic Circuits and Tubes; Seely: Electron-tube Circuits; Terman: Radio Engineering.

Prerequisite: Es-213(C).

Es-221(A) Transistor Electronics 3-3

The principal topics are: transistors—properties of semi-conductors and P-N junctions; transistors as circuit elements; small and large signal transistor circuit characteristics and analysis.

Texts: RCA Staff: Transistor Electronics; Instructors notes.

Prerequisites: Es-214(C) and Ph-730(A).

Es-222(B) Transistor Electronics 3-3

The principal topics are: electrical characteristics of semi-conductors; P-N junctions and their rectification properties; basic transistor action; transistors as circuit elements; transistor circuit analysis.

Texts: RCA Staff: Transistor Electronics; Instructor's notes.

Prerequisites: Es-214(C) and Ph-730(A).

Es-225(B) Electron Tubes 3-3

The tubes treated are those in which operation depends on the motions of electrons under the control of electric and magnetic fields. Some of the tube types studied are picture tubes, beam deflection, storage, and photo tubes. The topic of noise is also included.

Texts: Harman: Fundamentals of Electron Motion; Spangenberg: Vacuum Tubes.

Prerequisite: Es-214(C).

Es-226(A) Microwave Tubes and Techniques 3-3

The principal topics presented are: fundamentals of microwave amplifiers and oscillators, triode and tetrode microwave amplifiers and oscillators, two and three cavity klystrons, reflex klystrons, magnetrons, traveling-wave and double-beam tubes, circuit components, coupling methods, energy transfer, and circuit concepts at microwave frequencies.

Texts: Reich, Ordung, Krause, Skalnik: Microwave Theory and Techniques; Spangenburg: Vacuum Tubes; Harman: Fundamentals of Electron Motion.

Prerequisites: Es-225(B) and Es-623(A).

Es-227(B) Ultra-High Frequency Techniques 3-2

The principles and underlying problems of high-frequency techniques. The principal topics are: limitations of conventional tubes at ultra-high frequencies, transit-time effects, noise problems, electron ballistics, wave guides, cavity resonators, klystrons, magnetrons and traveling-wave tubes. The course emphasizes a descriptive presentation rather than a mathematical one.

Texts: Spangenberg: Vacuum Tubes; Massachusetts Institute of Technology Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-214(C).

Es-261(C) Electron Tubes and Circuits I 3-2

The first term of a two term course in the fundamentals and general applications of electron tubes and circuits, primarily for noncommuncation students. The principal topics are: electron emission, characteristics of vacuum tubes, equivalent circuits, rectifiers and filters, class A amplifiers, feedback circuits, gas filled tubes.

Texts: Corcoran and Price: Electronics; Hill: Electronics in Engineering; Schultz, Anderson and Leger: Experiments in Electronics and Communication Engineering; Varner: The 14 Systems of Units.

Prerequisites: Es-111(C) and Es-112(C).

Es-262(C) Electron Tubes and Circuits II 3-2

Continuation of Es-261(C). The principal topics are: class B and C amplifiers, semi-conductor diodes and transistors, oscillators, multivibrators and pulse circuits, modulation, detection.

Texts: Estman: Fundamentals of Vacuum Tubes; Corcoran and Price: Electronics; Schultz, Anderson and Leger: Experiments in Electronics and Communication Engineering; Varner: the 14 Systems of Units.

Prerequisite: Es-261(C).

Es-267(A) Electron Tubes and Ultra-High Frequency Techniques 3-2

The principal topics are: electron ballistics, noise in electron-tube circuits, ultra-high frequency effects, microwave techniques, i.e., cavity resonators, the klystron, the cavity magnetron and the traveling-wave tube.

Texts: Spangenberg: Vacuum Tubes; M.I.T. Radar School Staff: Principles of Radar (Third Edition); Reich, et al: Microwave Principles.

Prerequisite: Es-262(C) or equivalent.

Es-268(C) Introduction to Microwaves 3-2

The objective of this course is to serve as an introduction to radar. The principal topics are: Wave solutions to the transmission line equations, characteristics of lossless lines, pulse propagation on lossless lines, impedance matching via Smith Charts, lines as resonant circuit elements, discussion of common modes in waveguides and resonators, study of the internal and external characteristics of cathode ray tubes, klystrons, magnetrons, and traveling wave tubes.

Texts: Coates: Principles of Radar; Reich et al: Microwave Principles.

Prerequisite: Es-262(C).

Es-271(C) Electronics I 3-2

This is a series of three courses designed to give the Nuclear Engineering student an appreciation of electronic equipment used in this science. The first course takes the student through the analysis of network circuits and introduces elementary transient concepts.

Texts: Guillemin: Introductory Circuit Theory; Hessler and Carey: Electrical Engineering.

Prerequisite: None.

Es-272(C) Electronics II 3-3

This course includes the common vacuum tube circuits, such as rectifiers, voltage amplifiers, and elementary feedback circuits. Special emphasis is placed on these circuits in regard to transient response, bandwidth, stability, and pulse shaping. Also included is semiconductor diode and transistor theory.

Texts: Hill: Electronics in Engineering; Corcoran and Price: Electronics.

Prerequisite: Es-271(C).

Es-273(C) Electronics III 3-2

This course emphasizes systems of vacuum tube circuits used by the nuclear engineer, such as the cathode-ray oscilliscope, scalers, counters, pulse height analyzers, Geiger counters, and other nuclear energy detecting devices such as Radiac. Detection and measurement of nuclear energy by making use of telemetering systems is also included.

Texts: Seely: Electron Tube Circuits; Elmore and Sands: Electronics.

Prerequisite: Es-272(C).

Es-287(C) Electron Tubes and Circuits 3-2

The principal topics are: high-frequency limitations of tube-circuit operation; microwave technique, i.e., cavity resonators, the klystron, the cavity magnetron and the traveling-wave tube; basic pulse techniques, i.e., clipping circuits, differentiating and integrating circuits, clamping circuits, relaxation oscillators, switching circuits.

Text: M.I.T. Radar School Staff—Principles of Radar, 3rd Edition.

Prerequisites: Es-214(C), Es-116(C).

Es-321(B) Communication Systems I 3-3

The first of a series of five courses designed to give the student the opportunity to coordinate his previous theoretical background in the philosophy, requirements, and synthesis of increasingly complex electronic systems. Class discussion is supported by laboratory projects which include tests for the determination of system characteristics and relative capabilities and limitations. The first course concerns itself primarily with the design of radio transmitters for the medium and high frequency range, together with considerations which lead to a successful system, such as reliability, consideration in human engineering, etc.

Texts: Terman: Radio Engineering Handbook; Federal Telephone and Telegraph Corporation: Reference Data for Radio Engineers; Black: Modulation Theory; Navy Equipment Manuals.

Prerequisites: Es-225(B) and Ma-104(A).

Es-323(B) Missile Guidance Systems 3-0

A study of missile guidance systems. The principal topics are: Fundamental problems of missile guidance, prior and present day missile guidance systems, missile guidance servo requirements, launching transients, simulation and computation of the missile guidance system, radio telemetry.

Texts: Locke: Principles of Guided Missile Design; Instructor's Notes.

Prerequisite: Es-327(B).

Es-326(B) Transmitters and Receivers 4-2

A study of audio-bandwidth communications systems. This course concerns itself heavily with the design of radio transmitters and receivers together with a consideration of diversity and scatter propagation techniques, single sideband generation and reception, frequency modulation.

Texts: Navy Instruction Manuals; Current technical literature; Instructor's notes.

Prerequisite: Es-214(C).

Es-327(B) Electronic Systems 3-3

A continuation of Es-326(B). This course concerns itself with specialized electronic techniques. Topics covered are: automatic telegraphy, image systems, pulse modulation systems, time-division multiplexing.

Texts: Navy Instruction Manuals; Current technical literature; Instructor's notes.

Prerequisite: Es-326(B).

Es-328(B) Transmitters and Receivers 3-3

A study of audio-bandwidth communications systems. This course concerns itself heavily with the design of radio transmitters and receivers together with a consideration of diversity and scatter propagation techniques, single sideband generation and reception, frequency modulation.

Texts: Navy Instruction Manuals; Current technical literature; Instructor's notes.

Prerequisites: Es-262(C) and EE-251(C).

Es-332(B) Communication Systems II 2-3

A study of the considerations involved in the design of communication receivers for ranges from VLF to UHF. The use of propagation prediction data, and the natural division of services and frequency allocations is also covered.

Texts: Sturley: Radio Receiver Design; Wallman and Valley: Vacuum Tube Amplifiers; Terman: Radio Engineering Handbook; Black: Modulation Theory.

Prerequisite: Es-321(B).

Es-333(B) Communication Systems III 3-3

A continuation of the communication systems sequence directed toward the study of recent and advanced methods of establishing a communication link. Considerable emphasis is placed on the information-theoretic viewpoint and use is made of statistical methods in the comparative evaluation of various techniques. Topics covered are: Statistical properties of fading, diversity and scatter propagation techniques, single-sideband systems, wideband systems, e.g., frequency modulation, pulse modulation, time-division multiplexing.

Texts: Black: Modulation Theory; Goldman: Frequency Analysis, Modulation, and Noise; Instructor's notes.

Prerequisite: Es-332(B).

Es-334(B) Communication Systems IV 2-3

A continuation of Es-333(B). This course considers communication systems involving a variety of presentation techniques. Topics covered are: automatic telegraphy, image systems, e.g., facsimile and television.

Texts: Black: Modulation Theory; Current technical literature; Instructor's notes.

Prerequisite: Es-333(B).

Es-335(B) Electronic Systems 3-3

Study in this course is directed toward the philosophy principles, and design of electronic aids to navigation, missile guidance systems and electronic countermeasures. A study of telemetering is included in support of missile guidance systems.

Texts: Navy Instruction Manuals; Instructor's notes.

Prerequisite: Es-334(B).

Es-341(B) Radio Telemetering and Simulation 3-3

A survey of telemetering and missile guidance methods including consideration of time and frequency division multiplexing, pulse modulation techniques, FM/FM telemetry, transducers, data recording devices, analog and digital computation, simulation of the tactical problem, and classroom and laboratory study of existing telemetering and missile guidance systems.

Text: To be assigned.

Prerequisite: Es-423(B).

Es-371(C) Electronics I 4-2

This is the first of a series of two courses designed to give the Naval Science student an introduction to the theory and principles of electronics. Applications in naval electronics systems are developed. Appropriate laboratory demonstrations and exercises are utilized. Topics include: vacuum tubes; gas tubes; transistors, rectifiers; amplifiers; oscillators; modulators; detectors; wave propagation; receivers; transimtters; oscilloscopes; cathode ray tubes; pulse circuits; timing circuits.

Texts: As assigned: Instructor's notes.

Prerequisites: EE-022(C) or equivalent.

Es-372(C) Electronics II 4-2

A continuation of Es-371(C).

Texts: As assigned; Instructor's notes.

Prerequisite: Es-371(C).

Es-376(C) Electronics Fundamentals 4-0

The objective of this course is to cover the fundamentals of electronics with particular emphasis on naval applications for the General Line curriculum. Topics include the following: vacuum tubes, gas tubes, transistors, rectifiers, amplifiers, oscillators, modulators, detectors, receivers and transmitters, oscilloscopes and propagation.

Text: As assigned.

Prerequisite: EE-011(C) or equivalent.

Es-381(C) Systems I (Transmitters, Receivers) 3-3

This course concerns itself in a quantitative way with the theory, characteristics, and design of communication transmitters and receivers. Emphasis is placed on those considerations which lead to a successful communication system. Principal topics are transmitters and receivers, amplitude and frequency modulation, single sideband systems, automatic frequency control and selection.

Texts: Terman: Radio Engineering Handbook; Federal Telephone and Telegraph Corp.; Reference Data for Radio Engineers; Navy Equipment Manuals.

Prerequisite: Es-214(C).

Es-382(B) Systems II (Teletype, Image Systems, Pulse Systems, ECM) 3-3

This course is concerned with the principles and design of systems using coded information. Of particular interest is the effect on information rates and bandwidth when pulse code techniques are used. The electronics principles and characteristics of these systems are studied through the application to frequency shift keying and CW teletype techniques, certain image transmission systems, and multiplexing systems. Possible ECM which may be used against these systems are investigated.

Texts: Navy Equipment Manuals; Instructor's Notes.

Prerequisites: Es-381(C), Es-287(C).

Es-383(B) Systems III (Radar, Navigation, Naval and Air Tactical Data Systems) 3-0

The aim of this course is to consider certain special electronic systems in regard to their principles, characteristics, and capabilities and limitations. The principal systems investigated are radar systems, loran, direction finders, Naval and Air Tactical Data Systems, and electronic countermeasures as applied to these systems.

Texts: Naval Equipment Manuals; Selected Reading; Instructor's Notes.

Prerequisites: Es-383(B), Es-125(B).

Es-421(B) Pulse Techniques 2-3

The principles and underlying problems of pulse techniques. Principal topics are: pulse-shaping, switching, clipping, differentiating and integrating circuits; sweep-circuit generators; pulse transformers; delay lines; transistors.

Text: M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: EE-771(B).

Es-422(B) Radar Systems I 3-3

A study of the fundamental principles of radar. The principal topics are: the theory of operation of radar timing circuits, indicators, modulators, transmitters, r-f systems and receivers, the radar range equation.

Texts: Ridenour: Radar System Engineering; M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-421(B).

Es-423(B) Radar Systems II 3-6

A continuation of Es-422(B). The course contents include a study of representative search, fire-control and IFF systems, including airborne, with particular attention to design features; a study of current radar developments; related laboratory work on current Navy radar equipment.

Text: Ridenour: Radar System Engineering.

Prerequisite: Es-422(B).

Es-424(B) Radar Systems IIA 3-3

Same as Es-423(B).

Es-426(B) Introduction to Radar 3-2

The course treats pulse shaping, clipping, switching, differentiating, integrating circuits, and the fundamental principles of radar such as the range equation, timing circuits, indicators, modulators, transmitters and receivers.

Text: M.I.T. Radar School Staff: Principles of Radar.

Prerequisite: Es-262(C).

Es-431(B) Radar System Engineering I 3-3

A treatment of the fundamental principles of radar. The principal topics are: the theory of operation and design features of radar timing circuits, indicators, modulators, transimtters, r-f systems and receivers.

Texts: Ridenour: Radar System Engineering; M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-127(B).

Es-432(B) Radar System Engineering II 3-6

A continuation of Es-431(B). The course contents include a study of representative search, fire-control and IFF systems, including airborne, with particular attention to design features; a study of current radar developments; related laboratory work on current Navy radar equipment.

Text: Ridenour: Radar System Engineering.

Prerequisite: Es-431(B).

Es-433(B) Radar Data Processing and Computer-Controlled Systems 3-3

A study of advanced applications of computer techniques in systems of importance to the Naval Service. Coding and transmission of radar range data. Reliable digital communication links. Programming of computers for automatic tracking and for generation of weapons control orders. Principles of track-while-scan radar systems. Computer techniques applicable to various types of missile guidance systems.

Texts: Classified Official Publications.

Prerequisites: Es-136(A) and Es-432(B).

Es-446(C) Introduction to Radar 2-2

A study of the radar range equation, i.e., effect of pulse duration, pulse repetition frequency, types of targets, etc., block diagram studies of current fire-control systems, with emphasis on operational limitations, propagation phenomena, types of presentation, and anti-jam techniques; and laboratory work that emphasizes operational techniques of current fire-control systems.

Text: M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-262(C) or equivalent.

Es-447(C) Pulse Techniques 3-0

The basic principles of pulse-shaping circuits, clippers, peakers, gaters, etc., pulse-forming networks and artificial lines. Also, r-f, i-f and video amplifiers are treated from the view point of pulse amplification, distortion tolerances and requirements. The course is directed toward preparing the students for more advanced courses in radar.

Texts: Ridenour: Radar System Engineering; M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-262(C) or equivalent.

Es-456(C) Introduction to Radar (Airborne) 2-2

A study of the radar range equation, i.e., effect of pulse duration, pulse repetition frequency, types of targets, etc., block diagram studies of current airborne systems with emphasis on operational limitations, propagation phenomena, types of presentation, and anti-jam techniques and laboratory work on current airborne radar equipment.

Text: M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-262(C) or equivalent.

Es-461(A) Pulse Techniques 3-3

The principal topics are: clipping circuits, differentiating and integrating circuits, clamping circuits, pulse-coupling circuits, relaxation oscillators, pulse amplifiers, transistor pulse techniques.

Texts: M.I.T. Radar School Staff Principles of Radar (Third Edition); Millman and Taub: Pulse and Digital Circuits.

Prerequisite: Es-267(A).

Es-536(B) Countermeasures 2-3

Principles of radio direction finding; special electronic circuits with particular application to the field of electronic counter-measures; basic principles of electronic counter-measures tactics and operational procedures; passive and active electronic countermeasures equipment.

Texts: Radio Research Laboratory Staff: Very High Frequency Techniques, Vols. I and II; Navy equipment manuals; Instructor's notes.

Prerequisite: None.

Es-537(B) Sonar System Engineering Design and Developments 3-3

Classroom and laboratory study of engineering design problems met in operational and developmental sonar systems.

Texts: Classified Technical Reports; Navy Equipment Instruction Books.

Prerequisite: Ph-423(A).

Es-615(C) Introduction to Electromagnetics 4-0

An elementary study of the fundamental field concepts of electromagnetic theory. This includes a review of vector analysis, and a study of the experimental laws of electromagnetism and their application to electrostatics, electric currents, magnetostatics and electromagnetic induction. Maxwell's equations are formulated and applied to a study of plane waves, Poynting's vector, skin effect phenomena, refraction and reflection of plane waves, elliptical polarization, electromagnetic potentials and dipole radiation, and an introduction to antennas and radio wave propagation.

Text: Skilling: Fundamentals of Electric Waves (Second Edition).

Prerequisites: Es-114(C) and Ma-122(B).

Es-621(C) Electromagnetics I 4-0

An introduction to the concepts utilized in electromagnetic theory. The material covered includes vector analysis, field theorems, the electrostatic field, dielectric materials, electric current, the magnetic field, Maxwell's hypothesis, plane waves, radiation, antennas, wave guides.

Text: Skilling: Fundamentals of Electric Waves (Second Edition).

Prerequisite: Elementary Calculus.

Es-622(B) Electromagnetics II 5-0

Phasor notation; generalized coordinates; rectangular, cylindrical, and spherical harmonics; Bessel functions; Maxwell's equations for time varying fields; displacement current density; retarded potentials; circuit concepts from fields; impedance; skin effect; inductance; Poynting's theorem; propagation of plane waves; phase velocity and Snell's law; pseudo-Brewster angle; waves in imperfect media; guided waves.

Text: Ramo and Whinnery: Fields and Waves in Modern Radio (Second Edition).

Prerequisites: Es-621(C) and Ma-104(A).

Es-623(A) Electromagnetics III 4-0

A continuation of Es-622(B). TEM, TE, TM waves; rectangular and cylindrical wave guides; miscellaneous guiding systems; resonant cavities; fields from dipole antenna; gain; image antenna; field from rhombic antenna; antenna arrays; induced EMF method; psuedo-Maxwell's equations; parabolic reflector; slot antenna; electromagnetic horns; biconical antenna; driving point impedance of cylindrical antenna; receiving antenna.

Text: Ramo and Whinnery: Fields and Waves in Modern Radio (Second Edition).

Prerequisite: Es-622(B).

Es-626(C) Guided Waves and Resonators 2-0

Application of Maxwell's equations to TEM propagation on open wire and coaxial lines, and TE and TM waves in the rectangular guide. Discussion of TE and TM modes in the circular guide and the coaxial line. Cavity resonance and equivalent circuits for resonators.

Text: Skilling: Fundamentals of Electric Waves (Second Edition); Instructor's notes.

Prerequisite: Es-615(C).

Es-627(A) Electromagnetics II 4-0

Applications of Maxwell's equations to the propagation of unguided and guided waves, rectangular and cylindrical wave guides, resonant cavities and radiating systems.

Text: Ramo and Whinnery: Fields and Waves in Modern Radio (Second Edition).

Prerequisites: Es-621(C) and Ma-114(A).

Es-726(B) Antennas, Transmission Lines 3-3

The engineering problems associated with the practical design of antennas, antenna systems, and transmission lines.

Text: Kraus: Antennas.

Prerequisite: Es-623(A).

Es-727(B) Antennas and Feed Systems 3-3

This course is intended to make the student familiar with the more common types of antennas and feed systems. The attack is essentially an engineering approach, applying to practical systems, to as great an extent as practicable, the mathematics and field theory presented in earlier courses. The laboratory work is directed to the measurement of field intensities, antenna patterns, input impedances and feed systems.

Text: Kraus: Antennas.

Prerequisites: Es-615(C) and Es-626(C).

Es-728(C) Lines, Antennas and Propagation 4-3

Derivation and solution of the transmission line equations, properties of travelling waves, use of circle diagrams, use of lines and stubs as transformers and matching devices. Introduction to radiating systems, engineering characteristics of common antennas and feed systems. Characteristics of radio wave propagation throughout the useful spectrum, special emphasis on selecting appropriate frequencies and power levels for reliable communications.

Text: Instructor's notes.

Prerequisite: Es-262(C).

Es-787(B) Antennas and Propagation 3-2

This course is an analytical study of certain elementary antennas used in transmission and reception of radio communications. Emphasis is placed on those antenna systems found aboard ship as well as those used in naval shore installations. Propagation characteristics throughout the communications spectrum are studied with emphasis on proper choice of frequency, power, and time of transmission. Propagation anomalies are studied with the object of maintaining communications regardless of atmospheric or ionospheric conditions. New techniques of transmission are studied such as scatter communications.

Texts: Menzel: Elementary Manual of Radio Propagation; Kraus: Antennas.

Prerequisite: Es-628(C).

Es-821(C) Systems Lectures I 0-1

A series of informational lectures covering recent developments, new publications, and faculty visits to industrial and military research and development laboratories.

Text: None.

Prerequisites: Es-214(C) and Es-114(C).

Es-822(C) Systems Lectures II 0-1

A continuation of Es-821(C).

Text: None.

Prerequisite: Es-821(C).

Es-823(B) Systems Seminar 3-0

Groups of students undertake the overall specification and design of an integrated weapons, countermeasures, navigational, or communications system, under the instructor's consultation and guidance. Emphasis is on the integration of electronic devices and evaluation of system performance.

Texts: Miscellaneous.

Prerequisite: Es-327(B).

Es-836(A) Project Seminar 0-2

In this seminar an oral report is made to the class by each student on his individual development work on a project at an industrial laboratory in electronics. A written engineering report is also required of each student covering his term project in industry.

Text: None.

Prerequisite: None.

GEOLOGY

Ge Courses

Ge-101(C) Physical Geology 3-2

The study of the various geological phenomena. Topics discussed are: rock-forming minerals; igneous, sedimentary, and metamorphic rocks; weathering and erosion; stream sculpture; glaciation; surface and sub-surface waters; volcanism, dynamic processes; structural geology; and interpretation of topographic maps. Frequent reference is made to other than the prescribed textbook. The course stresses those topics of particular interest to the petroleum engineer.

Text: Longwell, Flint: Introduction to Physical Geology.

Prerequisite: Ge-401(C).

Ge-201(C) Physical Geology 3-0

Course content similar to Ge-101, but directed towards the specific needs of the Nuclear Engineering Groups.

Text: Longwell, Flint: Introduction to Physical Geology.

Prerequisite: None.

Ge-241(A) Geology of Petroleum 2-4

Seminars and discussion on the origin, accumulation, and structures which aid in the accumulation of petroleum, its general occurrence, and distribution. The following regions are studied: Eastern United States, Mid-Continent, Gulf Coast, Rocky Mountains, Pacific Coast, North America (except U. S.), West Indies, South America, Europe, Russian, Oceanica and Asia. This course is supplemented by reading assignments in the current petroleum and petroleum geology journals.

Text: Lalicker: Principles of Petroleum Geology.

Prerequisite: Ge-101(C).

Ge-302(C) Determinative Mineralogy 1-4

The lectures are designed to familiarize the student with the principles and techniques involved in determining minerals in the laboratory. The laboratory periods are spent in the determination of some fifty of the more common minerals by blowpipe, chemical, x-ray diffraction and crystallographic methods. The student is also made familiar with the methods employed in the use of chemical microscopy for the determination of certain elements.

Text: Lewis, Hawkins: Determinative Mineralogy; Dana, Ford: Textbook of Mineralogy.

Prerequisite: Cr-301(B) or Cr-311(B).

Ge-401(C) Petrology and Petrography 2-3

A series of lectures on the differentiation of magmas into the various igneous rock series on the basis of physical chemical theories; the characteristics, structures and textures of igneous rocks; the metamorphic rocks, mineral alteration, metamorphism and the resultant rock types. The laboratory work consists of the study of the various rocks in hand specimens, and in thin sections under the petrographic microscope. When practicable, the course is supplemented by trips to nearby localities to study rocks and minerals in the field.

Texts: Pirsson, Knopf: Rocks and Rock Minerals; Grout: Petrography and Petrology.

Prerequisite: Cr-301(B) or Cr-311(B).

NAVAL POSTGRADUATE SCHOOL LECTURE PROGRAM

LP Lecture Program

LP-101(L) NPS Lecture Program I 0-1

A series of weekly lectures to be delivered by authorities in education, government, and management designed to extend the knowledge of the officer students in the fields of world politics, international affairs, economics, and psychology.

Text: None.

Prerequisite: None.

LP-102(L) NPS Lecture Program II 0-1
(Space Technology)

A series of weekly lectures to be delivered by authorities in the scientific fields associated with Space Technology. Topics will be chosen from among the new developments most prominent or promising in the advancing field of outer space exploration for delivery at an appropriate level of technical sophistication.

Text: None.

Prerequisite: None.

MATHEMATICS

Ma Courses

Ma-010(C) Elementary Algebra and Trigonometry 3-0

Review, as needed, of elementary algebraic operations. Logarithms and basic slide rule operations. Solution of equations. Algebra of complex numbers. Definition and basic properties of trigonometric functions. Polar coordinates. Algebra of vectors.

Text: Hart: College Mathematics.

Prerequisite: None.

Ma-011(C) College Algebra and Trigonometry 5-0

Brief review of algebraic fundamentals. Logarithms and the slide rule. Solution of linear and quadratic equations. Algebra of complex numbers. Mathematical induction. Binomial Theorem. Elementary theory of equations. Determinants and solution of systems of equations. Fundamentals of trigonometry.

Text: To be selected.

Prerequisite: None.

Ma-012(C) College Algebra, Trigonometry and Analytic Geometry 5-0

Algebra of complex numbers, Quadratic equations. Determinants and systems of equations. Mathematical Induction. Binomial Theorem. Logarithms and Slide Rule. Elementary Theory of Equations. Trigonometric functions of the general angle. Identities. Radian measure. Elements of analytic geometry, including coordinate representation of functions, graphs.

Text: To be selected.

Prerequisite: Previous college courses in Algebra and Trigonometry.

Ma-050(C) Elements of Calculus 4-0

Elements of plane analytic geometry. Concepts of function, limit, continuity. The derivative. Differentiation of elementary functions. Higher derivatives. Applications of derivative. Differentials. Definite integral with applications. Formal integration. Rolle's Theorem of the mean. Taylors series with a remainder.

Text: Granville, Smith, Longley: Elements of Differential and Integral Calculus.

Prerequisite: Recent course in Algebra and Trigonometry.

Ma-051(C) Calculus and Analytic Geometry I 5-0

Fundamentals of plane and analytic geometry, concepts of function, limit, continuity. The derivative and differentiation of elementary functions with applications. Derivatives of higher order. Differentials. Formal integration of elementary functions.

Text: To be selected.

Prerequisite: Ma-011(C) or its equivalent.

Ma-052(C) Calculus and Analytic Geometry II 5-0

Selected topics from plane analytic geometry. Differentiation of transcendental functions. Parametric equations. Formal integration. Rolle's Theorem and Theorem of the mean. Sequences and Series. Taylor series.

Text: To be selected.

Prerequisite: Ma-051(C).

Ma-053(C) Calculus and Analytical Geometry II 5-0

Elements of solid analytic geometry and fundamentals of vector algebra. Partial derivatives. Chain rule differentiation. Multiple integrals with applications. Introduction to ordinary differential equations.

Text: To be selected.

Prerequisite: Ma-052(C).

Ma-071(C) Calculus I 5-0

The calculus of functions of a single variable with emphasis on basic concepts. Derivatives. Definite integrals. Applications. Formal integration. Sequences and series. Topics from plane analytic geometry to be introduced as necessary.

Text: To be selected.

Prerequisite: Ma-012(C) or its equivalent.

Ma-072(C) Calculus II 5-0

Solid analytic geometry and vector algebra. Partial derivatives. Chain rule differentiation. Multiple integrals with applications. Introduction to ordinary differential equations including linear differential equations of second order.

Text: To be selected.

Prerequisite: Ma-071(C).

Ma-100(C) Vector Algebra and Geometry 2-1

Outline of real number system. Vectors and their algebra. Analytic geometry of space; points, lines, and planes in scalar and vector notation. Determinants and linear systems. Special surfaces. The laboratory periods are devoted to a review of a selection from essential topics in trigonometry and analytic geometry.

Texts: Smith, Gale and Neelley: New Analytic Geometry; Weatherburn: Elementary Vector Analysis; USNPS Notes.

Prerequisite: A former course in plane analytic geometry.

Ma-109(A) Fundamentals of Analysis I 3-0

Development of natural number system and extension to real and complex number systems; the elements of point set theory; basic limit theory; sequences, series; uniform convergence of infinite sequences and series of functions; continuity and differential properties of functions; Riemann integration.

Texts: Landau: Foundations of Analysis; Courant: Differential and Integral Calculus, Volume I; Osgood: Functions of Real Variables; Hardy: Pure Mathematics; Brand: Advanced Calculus.

Prerequisite: A former course in differential and integral calculus.

Ma-110(A) Fundamentals of Analysis II 3-0

A continuation of Ma-109(A). Rigorous development of infinite series. Functions of a real variable. Riemann integral.

Texts: Courant: Differential and Integral Calculus, Volume I; Osgood: Functions of Real Variables; Hardy: Pure Mathematics; Brand: Advanced Calculus; Periodicals.

Prerequisite: Ma-109(A).

Ma-111(C) Introduction to Engineering Mathematics 3-1

Partial differentiation; multiple integrals; hyperbolic functions. The laboratory periods are devoted to a review of selected topics in basic calculus.

Texts: Granville, Smith and Longley: Elements of the Differential and Integral Calculus; Wylie: Advanced Engineering Mathematics.

Prerequisites: A former course in differential and integral calculus and Ma-100(C) or Ma-120(C) to be taken concurrently.

Ma-112(B) Differential Equations and Infinite Series 5-0

A continuation of Ma-111(C). First order ordinary differential equations; ordinary linear differential equations with constant coefficients; power series and power series expansion of functions; power series solution of ordinary differential equations; Fourier series.

Texts: Golomb and Shanks: Ordinary Differential Equations; Granville, Smith and Longley: Elements of the Differential and Integral Calculus; Wylie: Advanced Engineering Mathematics.

Prerequisite: Ma-111(C).

Ma-113(B) Introduction to Partial Differential Equations and Functions of a Complex Variable 4-0

A continuation of Ma-112(B). Solution of partial differential equations by means of series of orthogonal functions; analytic functions of a complex variable; line integrals in the complex plane; infinite series of complex variables; theory of residues.

Text: Wylie: Advanced Engineering Mathematics.

Prerequisite: Ma-112(B).

Ma-114(A) Functions of a Complex Variable and Vector Analysis 3-0

A continuation of Ma-113(B). Conformal mapping and applications; calculus of vectors with geometric applications; differential operators; line, surface and volume integrals involving vector fields; applications to heat flow and potential problems.

Text: Wylie: Advanced Engineering Mathematics.

Prerequisite: Ma-113(B).

Ma-115(A) Differential Equations for Automatic Control 3-0

Phase trajectories for linear and certain non-linear systems; singular points of non-linear equations; graphical solutions; stability investigations. The Laplace Transformation methods as used in ordinary initial value problems and partial differential equations; the inversion integral; calculation of inverse transforms by residues and by the Heaviside rules. Reduction of differential equations to non-dimensional form.

Texts: Minorsky: Introduction to Non-linear Mechanics; Churchill: Modern Operational Mathematics in Engineering; Stoker: Non-linear Vibrations; Thomson: Laplace Transformation.

Prerequisite: Ma-114(A).

Ma-116(A) Matrices and Numerical Methods 3-2

Finite differences, interpolation, numerical differentiation and integration; numerical solution of polynomial equations; numerical methods for initial value and boundary value problems involving ordinary and partial differential equations; solution of systems of linear algebraic equations; elementary properties and types of matrices; matrix algebra; latent roots and characteristic vectors of matrices; numerical methods for inversion of matrices.

Texts: Booth: Numerical Methods; Reprints of articles from scientific journals; Salvadori and Baron: Numerical Methods in Engineering.

Prerequisite: Ma-114(A).

Ma-120(C) Vector Algebra and Geometry 3-1

Real number system. Algebra of complex numbers. Vectors and their algebra. Analytic geometry of space; points, lines, and planes in scalar and vector notation. Determinants, matrices and linear systems; linear dependence. Special surfaces. Laboratory periods devoted to review of essential topics in trigonometry and plane analytic geometry.

Texts: Smith, Gale, Neelley: New Analytic Geometry; Weatherburn: Elementary Vector Analysis; Churchill: Introduction to Complex Variables; USNPS Notes; Phillips: Vector Analysis.

Prerequisite: Former course in plane analytic geometry.

Ma-121(C) Introduction to Engineering Mathematics 3-1

Concepts of function, limit, continuity. Ordinary derivatives and applications. Rolle's theorem and the theorem of the mean. Taylor's series with a remainder. Partial derivatives. Implicit functions. Jacobians. Definite integral. Infinite series; Power series and Fourier series.

Texts: Franklin: Methods of Advanced Calculus; Granville, Smith, Longley: Elements of the Differential and Integral Calculus.

Prerequisites: A former course in differential and integral calculus and Ma-120(C) to be taken concurrently.

Ma-122(B) Differential Equations and Vector Calculus 5-0

Multiple integrals. Line, surface and volume integrals. Divergence theorem. The theorems of Stokes, Green, and Gauss with applications. Vector calculus; intrinsic definition of the curl and divergence, the operator del, and vector formulation of integral theorems. Elementary differential equations. Hyperbolic functions.

Texts: Weatherburn: Advanced Vector Analysis; Phillips: Vector Analysis; Sokolnikoff and Sokolnikoff: Higher Mathematics.

Prerequisite: Ma-121(C).

Ma-123(A) Orthogonal Functions and Partial Differential Equations 5-0

Special functions; elliptic integrals, Gamma and Beta functions. Series solution of differential equations. Orthogonal functions. Elements of Sturm-Liouville Theory. Bessel functions. Legendre polynomials. Partial differential equations and solution of boundary value problems.

Texts: Churchill: Fourier Series and Boundary Value Problems; Franklin: Methods of Advanced Calculus.

Prerequisite: Ma-122(B).

Ma-124(B) Complex Variable 3-0

Analytic functions. Cauchy's theorem and formula. Taylor and Laurent series. Theory of residues. Contour integration. Conformal mapping. Applications.

Texts: Churchill: Introduction to Complex Variable.

Prerequisite: Ma-122(B) or the equivalent (may be taken concurrently).

Ma-125(B) Numerical Methods for Digital Computers 2-2

Numerical methods for solution of systems of linear algebraic equations, polynomial equations, and systems of non-linear algebraic equations; finite differences, numerical interpolation, differentiation, integration; numerical methods for solving initial value and boundary value problems involving ordinary and partial differential equations. The laboratory periods cover sample problems solved on hand-operated keyboard calculators; emphasis is given to the methods which are most useful in large scale automatic digital computers.

Texts: Salvadori and Baron: Numerical Methods in Engineering; Booth: Numerical Methods.

Prerequisite: Ma-113(B) or Ma-123(A) or Ma-183(B).

Ma-131(C) Topics in Engineering Mathematics 5-2

Concepts of function and limit. Fundamentals of sequences and series. Taylor and Maclaurin series.

Operations with series. Solution of algebraic equations. Determinants, matrices and systems of linear equations. Analytic geometry of space and the definition and algebra of vectors. Partial derivatives and multiple integrals. Laboratory periods will be devoted to essential review in analytic geometry and elementary calculus.

Texts: Sokolnikoff and Sokolnikoff: Higher Mathematics; Weatherburn: Elementary Vector Analysis; Granville, Smith and Longley; Elements of the Differential and Integral Calculus; Phillips: Vector Analysis.

Prerequisite: A former course in differential and integral calculus.

Ma-132(B) Vector Analysis and Differential Equations — 5-0

Line, surface and volume integrals. Green's theorem and the divergence and Stoke's theorems. Derivatives of vector functions of one or more scalar variables. The del operator and the intrinsic definitions of divergence and curl. The integral theorems in vector form. Ordinary differential equations of first order. Linear differential equations with constant coefficients. Hyperbolic, Gamma and Beta functions.

Texts: Sokolnikoff and Sokolnikoff: Higher Mathematics; Weatherburn: Advanced Vector Analysis.

Prerequisite: Ma-131(C).

Ma-133(A) Differential Equations and Vector Mechanics — 5-0

Applications of ordinary differential equations. Stability criteria. Total differential equations and systems of differential equations. The vector equations of motion. Irrotational, solenoidal and linear vector fields. Fourier series. Partial differential equations and introduction to solution of boundary value problems in series of orthogonal functions.

Texts: Skolonikoff and Sokolnikoff· Higher Mathematics; Weatherburn: Advanced Vector Analysis.

Prerequisite: Ma-132(B).

Ma-151(C) Differential Equations — 5-0

Review of calculus. Partial derivatives. Polar coordinates and change of variables. Elements of differential equations; first order; linear; and total, with condition of integrability.

Texts: Granville, Smith and Longley: Elements of the Differential and Integral Calculus; Golomb and Shanks: Differential Equations.

Prerequisite: A former course in differential and integral calculus.

Ma-152(B) Infinite Series — 3-0

Convergence of a series, uniform convergence. Taylor series in one and two variables; associated approximation methods. Expansion of function in Fourier series; even and odd functions. Series solution of differential equations, introducting method of Frobenius.

Texts: Granville, Smith and Longley: Elements of the Differential and Integral Calculus; Sokolnikoff and Sokolnikoff: Higher Mathematics for Engineers and Physicists.

Prerequisite: Ma-151(C) or equivalent. (May be taken concurrently.)

Ma-153(B) Vector Analysis — 3-0

Differential and integral relations involving vectors. Gradients, divergence and curl. Normals and tangents to lines and surfaces. Line and surface integrals. Theorems of Gauss, Green, and Stokes, and related integral formulas.

Texts: Phillips: Vector Analysis; Weatherburn: Elementary Vector Analysis; Weatherburn: Advanced Vector Analysis.

Prerequisite: Ma-120(C).

Ma-154(B) Differential Equations for Automatic Control — 3-0

Systems of linear differential equations. Operational mathematics for solving differential and elementary integral equations. Phase-plane relations for non-linear second-order differential equations.

Texts: Golomb and Shanks: Ordinary Differential Equations; Churchill: Modern Operational Mathematics.

Prerequisites: Ma-120(C) and Ma-151(C) or equivalent.

Ma-155(A) Differential Equations for Automatic Control — 3-0

Systems of linear differential equations. Laplace transforms for solving ordinary differential equations. Inversion integral. Phase-plane relations for non-linear differential equations. Stability criteria.

Texts: Golomb and Shanks: Ordinary Differential Equations; Churchill: Modern Operational Mathematics; Stoker: Non-linear Vibrations; Minorsky: Introduction to Non-linear Mechanics.

Prerequisite: Ma-157(B), or equivalent.

Ma-156(A) Partial Differential Equations 3-0

Solution of boundary value problems by separation of variables. Orthogonal functions and introduction to Sturm-Liouville theory. Problems involving expansions in Bessel functions and Legendre polynomials.

Text: Churchill: Fourier Series and Boundary Value Problems.

Prerequisite: Ma-152(B)

Ma-157(B) Complex Variable 4-0

Analytic functions. Cauchy's Theorem and formula. Taylor and Laurent series. Theory of residues. Contour integration. Conformal mapping. Applications.

Texts: Churchill: Introduction to Complex Variable.

Prerequisites: Ma-151(C) and Ma-152(B).

Ma-158(B) Selected Topics for Automatic Control 4-0

Analytic functions; Cauchy's theorem and formula. Taylor and Laurent series residues, contour integration, conformal mapping. The Laplace transform and its use in solving ordinary differential equations; inversion integral. Systems of linear differential equations. Stability criteria.

Texts: Churchill: Introduction to Complex Variables and Applications; Churchill: Modern Operational Mathematics in Engineering.

Prerequisites: Ma-120(C) and Ma-151(C).

Ma-161(C) Algebra, Trigonometry and Analytic Geometry 5-0

Review of elementary algebraic operations. Exponent laws and logarithms. Variables and functions of variables. Coordinate representation of functions; graphs. The trigonometric functions. The straight line and its slope. Simultaneous linear equations. The quadratic equation. Elementary equations of the conics.

Text: Brink: A First Year of College Mathematics.

Prerequisite: None.

Ma-162(C) Introduction to Calculus 5-0

The limit concept. The derivatives of elementary functions. Elementary applications of derivatives. Differentials, higher order derivatives and curvature. The integral as an antiderivative and as an area. Elementary applications of integration.

Text: Granville, Smith and Longley: Elements of the Differential and Integral Calculus.

Prerequisite: Ma-161(C) or satisfactory evidence of competence in analytic geometry.

Ma-163(C) Calculus and Vector Analysis 4-0

Elementary vector operations. Partial derivatives, total derivatives and total differentials with applications. Partial and multiple integrals. Differentiation of vectors; gradient, divergence and curl. Introduction to line integrals.

Texts: Phillips: Vector Analysis; Granville, Smith and Longley: Elements of the Differental and Integral Calculus.

Prerequisite: Ma-162(C) or a recent course in differential and integral calculus.

Ma-181(C) Partial Derivatives and Multiple Integrals 4-1

Review of elementary calculus. Partial and total derivatives. Gradients and their physical interpretations. Line integrals. Double and triple integrals. Introduction to ordinary differential equations. Physical applications.

Texts: Granville, Smith and Longley: Differential and Integral Calculus; Sokolnikoff and Sokolnikoff: Higher Mathematics; Kaplan: Advanced Calculus.

Prerequisites: A former course in differential and integral calculus, and Ma-100(C) or Ma-120(C) to be taken concurrently.

Ma-182(B) Vector Analysis and Differential Equations 5-0

Vector differentiation. Vector integral relations. Physical applications. Ordinary first order differential equations. Higher order linear differential equations. Systems of differential equations. Physical interpretations. Infinite series.

Texts: Sokolnikoff and Sokolnikoff: Higher Mathematics; Phillips: Vector Analysis; Kaplan: Advanced Calculus.

Prerequisites: Ma-100(C) and Ma-181(C).

Ma-183(B) Fourier Series and Complex Variables 5-0

Expansion of functions. Series solution of differential equations. Fourier series and solution of partial differential equations. Algebra of complex numbers. Analytic functions of a complex variable, and the elementary transcendental functions. Conformal maps. Cauchy's Theorem. Residues.

Texts: Sokolnikoff and Sokolnikoff: Higher Mathematics; Churchill: Fourier Series and Boundary Value Problems; Churchill: Complex Variables.

Prerequisite: Ma-182(B).

Ma-184(A) Matrices and Numerical Methods 3-0

Algebra of matrices. Characteristic values of matrices. Application of matrices. Notation of finite differences. Numerical differentiation and numerical integration.

Texts: Sokolnikoff and Sokolnikoff: Higher Mathematics; Margenau and Murphy: Mathematics of Physics and Chemistry; Salvadori and Baron: Numerical Methods in Engineering.

Prerequisite: Ma-183(B).

Ma-194(A) Laplace Transforms, Matrices And Variations 5-0

Definition and properties of Laplace transforms. Solution of ordinary and partial differential equations by Laplace transforms. Algebra of matrices. Characteristic values of matrices and differential operators. Introduction to calculus of variations.

Texts: Churchill: Modern Operational Mathematics; Margenau and Murphy: Mathematics of Physics and Chemistry; Burington and Torrance: Higher Mathematics.

Prerequisite: Ma-183(B).

Ma-195(A) Matrix Theory and Integration Theory 4-0

Algebra of matrices; characteristic value of matrices; Hamilton-Cayley and Sylvester's theorems; matrix methods in the solution of systems of differential equations. Basic concepts in the theories of Riemann, Lebesgue, and Stieltjes integrals with emphasis on the applications of these theories to probability theory.

Texts: Frazer, Duncan and Collar: Elementary Matrices; Munroe: Introduction to Measure and Integration.

Prerequisite: Ma-183(B).

Ma-301(B) Statistics 4-2

Fundamental principles of probability. Probability distributions with special emphasis on the binomial, Poisson and normal distributions. Simple and multiple regressions and correlation. Distribution of mean, chi-square, variance, t, and F. Analysis of variance. Tests of statistical hypotheses.

Texts: Wilkes: Elementary Statistical Analysis; Hoel: Introduction to Mathematical Statistics.

Prerequisite: Ma-123(A) or Ma-113(B). (May be taken concurrently.)

Ma-320(C) Introduction to Statistics and Operations Analysis 4-0

Frequency distributions. Mean value and standard deviation. Basic probability theory for discrete and continuous variables. Basic probability distributions. Applications to kill probability, target analysis, and communication networks. Correlation with applications.

Texts: C. E. Clark: Introduction to Statistics; Wilks: Elementary Statistical Analysis; Granville, Smith and Longley: Differential and Integral Calculus.

Prerequisite: A former course in differential and integral calculus.

Ma-321(B) Probability and Statistics 4-2

Tabulation and graphical presentation of frequency distributions from observational data. Elementary rules for calculation of probabilities with application. Random variables and probability distributions. The binomial, Poisson, and normal distributions. Chi-square, Gosset's t, and variance quotient distributions. Regression and correlation, Estimation and testing of statistical hypotheses. Applications in quality control and acceptance sampling.

Text: Cramer: The Elements of Probability Theory.

Prerequisite: Ma-123(A) or Ma-113(B).

Ma-330(C) Introduction to Statistics 2-0

Preliminary considerations in the analysis of observations. Measures of central tendency and dispersion. Elementary probability. The Poisson, Bernoulli and normal distributions. Some applications to sampling.

Text: Wilks: Elementary Statistical Analysis.

Prerequisite: Ma-121(C) or equivalent.

Ma-331(A) Statistics 4-2

A continuation of Ma-330(C). Definition and laws of probability over an event space. Joint frequency functions. Tests of statistical hypotheses. Large and small sampling theory. Correlation and regression methods in multivariate problems. Introduction to the theory of estimators of population parameters and their distributions. Applications to problems in aerology.

Texts: Hoel: Introduction to Mathematical Statistics (Second Edition); Best and Panofsky: Some Applications of Statistics to Meterology.

Prerequisite: Ma-134(B) or Ma-330(C).

Ma-341(C) Elements of Probability and Statistics for Military Applications 3-0

Basic probability calculations for discrete and continuous chance variables with emphasis on binomial, Poisson, and normal distributions. Applications to computation of detection probabilities and hit probabilities. Properties of estimates of mean and standard deviation. Correlation and curve fitting. Elements of statistical decisions.

Text: To be selected.

Prerequisite: Ma-071(C) or its equivalent.

Ma-351(B) Industrial Statistics I 3-2

Frequency distributions. Elements of the theory of probability. The hypergeometric, binomial, Poisson, and normal probability distributions. Sampling distributions of the mean, variance, and range. Acceptance sampling by attributes.

Texts: Duncan: Quality Control and Industrial Statistics; Bowker and Lieberman: Handbook of Industrial Statistics.

Prerequisite: Ma-113(B).

Ma-352(B) Industrial Statistics II 2-2

Double and sequential acceptance sampling by attributes. Acceptance sampling by variables. Control charts. Statistical tests. Analysis of variance and design of experiments. Regression and correlation. Illustrations from selected ordnance publications.

Texts: Duncan: Quality Control and Industrial Statistics; Bowker and Lieberman: Handbook of Industrial Statistics.

Prerequisite: Ma-351(B).

Ma-361(B) Probability and Statistical Inference for Engineers I 2-1

Definitions of probability and basic rules of computation. Sample space, random variables, discrete and continuous distribution functions. Elementary sampling theory. General principles of testing hypotheses and estimation.

Texts: Hall: Introduction to Mathematical Statistics (Second Edition); Munroe: Theory of Probability.

Prerequisite: Ma-181(C).

Ma-362(B) Probability and Statistical Inference for Engineers II 2-1

Sampling distributions. Regression and correlation. Design of experiments and analysis of variance. Acceptance sampling.

Texts: Hoel: Introduction to Mathematical Statistics (Second Edition); Duncan: Quality Control and Industrial Statistics.

Prerequisite: Ma-361(B).

Ma-371(C) Management Statistics 2-0

The development of intuitive concepts of probability, probability distribution, central tendence, and correlation. Some indications of the general manner in which these concepts permeate all the management sciences.

Text: Sprowls: Elementary Statistics.

Prerequisite: Ma-161(C) or equivalent.

Ma-381(C) Elementary Probability and Statistics 4-2

Frequency distributions. Elements of the theory of probability. The binomial, Poisson and normal probability distributions. Elements of sampling theory and statistical inference with applications. Confidence intervals. Bivariate distributions. Regression lines and simple correlation. Applications in the field of the group.

Texts: Wilks: Elementary Statistical Analysis; Cramer: The Elements of Probability Theory; Best and Panofsky: Applications of Statistics to Meteorology (Aerology groups only); Cramer: The Elements of Probability Theory.

Prerequisite: Ma-163(C) or Ma-181(C).

Ma-391(C) Basic Probability 4-0

Definitions of probability and basic rules of computation. Sample space, random variable, discrete and continuous distribution functions. The common distribution functions. Joint marginal and conditional distribution functions. Limit theorems.

Texts: Munroe: Theory of Probability; Feller: An Introduction to Probability Theory and its Application, Vol. 1, (Second Edition).

Prerequisite: Ma-181(C). (May be taken concurrently).

Ma-392(B) Basic Statistics 3-2

Sampling distributions. Point estimation, properties of point estimators, the theory of testing simple hypotheses, interval estimation, application to the common distributions. Procedures for testing composite hypotheses, power functions. Regression analysis.

Texts: Hoel: Introduction to Mathematical Statistics; Mood: Introduction to the Theory of Statistics.

Prerequisite: Ma-391(C) or the equivalent.

Ma-393(A) Sequential Analysis and Nonparametric Inference 3-2

Sequential method of statistical decisions, probability ratio test, the fundamental identity, simple hypotheses. Estimation and testing when the functional form of the population distribution is unkown, rank order statistics. Tests based on permutations of observations. Nonparametric confidence intervals and tolerance limits.

Texts: Wald: Sequential Analysis; Fraser: Nonparametric Methods in Statistics.

Prerequisite: Ma-392(B) or the equivalent.

Ma-394(A) Analysis and Design of Experiments 3-0

Theory of the general linear hypothesis. Analysis of variance. Randomized blacks and Latin squares. Factorial experiments. Analysis of convariance; confounding and fractional replication. Methods for determining the optimum combination of factor levels.

Texts: Mann: Analysis and Design of Experiments; Davies: Design and Analysis of Industrial Experiments.

Prerequisite: Ma-392(B).

Ma-401(A) Analog Computers 2-2

Elementary analog devices which may be used to perform addition, multiplication, function generation, integration, etc. Combinations of such devices for solution of differential equations, systems of linear equations, algebraic equations, harmonic analysis, etc. Digital differential analyzers.

Texts: W. W. Soroka: Analog Methods in Computation and Simulation; Murray: Theory of Mathematical Machines; Reprints of articles from scientific periodicals.

Prerequisite: Ma-113(B) or Ma-123(A) or equivalent.

Ma-420(A) Digital Computation 2-2

Logical design of digital computers. Programming and coding for general-purpose digital and differential analyzer computers. Laboratory operation of computing machines. Applications.

Texts: Programming Manuals; Booth and Booth: Automatic Digital Calculators; McCracken: Digital Computer Programming.

Prerequisite: Ma-116(B) or Ma-125(B).

Ma-421(A) Digital and Analog Computation 3-2

Logical design of digital and analog computers. Programming and coding for general-purpose digital, differential analyzer, and analog computers. Laboratory operation of computing machines. Applications to problems in engineering, logic and data processing.

Texts: Programming Manuals; McCracken: Digital Computer Programming.

Prerequisite: Ma-116(A) or Ma-125(B).

Ma-441(C) Introduction to Digital Computers 2-0

Description of a general purpose digital computer. Command structure and commands. Flow charts and programming. Applications to problems in science, logic and data processing.

Text: McCracken: Digital Computer Programming.

Prerequisite: Ma-071(C) or its equivalent.

Ma-471(B) Electronic Data-Processing and Management Control 3-2

Study and analysis of intermediate and large-scale electronic digital data-processing machines in the solution of management problems. Scientific approach to management problems. Case studies in inventory control, material accounting, personnel accounting or applications of immediate interest to the group.

Texts: Kozmetsky and Kircher: Electronic Computers and Management Control. Periodicals and literature of government and industrial users of electronic data-processing equipment.

MECHANICAL ENGINEERING

ME Courses

ME-060(C) Engineering Drawing 2-3

Lectures and drawing room practice on solution of problems by graphical methods, orthographic projection, technical sketching, sectioning, tolerances, working drawings, assembly drawings, reproduction of drawings.

Texts: To be assigned.

Prerequisite: None.

ME-111(C) Engineering Thermodynamics 4-2

Stored and transitional energies, their accounting by energy equations in dynamic and chemical processes. Aspects of reversibility, thermodynamic scale of temperature, entropy of energy and the entropy function. Second and Third Laws of thermodynamics, Maxwell relations. Phase rule, thermodynamic properties of liquids and vapors in equilibrial and metastable states, property tables and diagrams, representative reversible and irreversible processes in vapor and liquid phases. Property relations, tables and diagrams for ideal or quasi-ideal gases, representative reversible and irreversible processes with these. Associated problems.

Text: Kiefer, Kinney and Stuart: Engineering Thermodynamics.

Prerequisite: Ma-112(B).

ME-112(B) Engineering Thermodynamics 4-2

Properties of mixtures of quasi-ideal gases, low-pressure gas-vapor mixtures and related indices, representative processes with these, multi- and mono-pressure hygrometric diagrams. Combustion of fuels, material and energy balances, fuel calorimetry, equilibruim and equilibrium constant, rich-mixture and thin-mixture combustion, flame temperatures. As time permits, non-ideal gases and their p-v-T correlation by equation and by compressibility diagrams, residual enthalpy and entropy functions and their determination from compressibility and throttling data, representative processes and generation of thermodynamic diagrams. Associated problems.

Text: Kiefer, Kinney and Stuart: Engineering Thermodynamics.

Prerequisite: ME-111(C).

ME-122(C) Engineering Thermodynamics 3-2

Studies included are as indicated for course ME-112 except for omission of considerations of the thermodynamics properties and property correlations for non-ideal gases. This course is in continuation of ME-111.

Text: Kiefer, Kinney and Stuart: Engineering Thermodynamics.

Prerequisite: ME-111(C).

ME-160(C) Thermodynamics 4-3

The objective of this course is to present the laws of thermodynamics and their applications to the analyses of performance, design, and limitations of heat engines and allied machinery. Laboratory work provides a correlation of actual performance characteristics and theory. Topics include: the general energy equation and the concepts of entropy, enthalpy, internal energy, and specific heat with the related graphical representations; the ideal processes of gases; the various cycles and their practical applications in actual equipment.

Text: To be assigned.

Prerequisites: Ph-012(C) and Ma-053(C).

ME-210(B) Marine Power Plant Equipment 3-2

Thermodynamic aspects of flow of compressible fluids in nozzle, diffuser, compressive shocks, dynamics of the jet and diverted flow. Thermodynamic aspects of the turbine, impulse and reaction types. Power-generation cycles employing condensing fluids, Rankine cycle and variations, binary-vapor cycles. Power generation cycles employing non-condensing fluids, basic internal combustion turbine cycle, variations of basic cycle, air-standard and real-fuel performance.

Text and Supplement: Kiefer, Kinney and Stuart: Engineering Thermodynamics; Keenan and Keyes: Thermodynamic Properties of Steam.

Prerequisite: ME-112(B) or ME-122(C).

ME-211(B) Marine Power Plant Equipment 3-2

Steam power plant cycles, internal combustion power cycles, elementary gas turbine power plant, influences of regenerative pre-heating and of reheating, performance indices. Thermodynamic aspects of the flow of compressible fluids in nozzle, diffuser and duct, compressive shocks, dynamics of jet and diverted flow. Associated problems and laboratory work.

Texts: Kiefer, Kinney and Stuart: Engineering Thermodynamics; miscellaneous supplementary material.

Prerequisite: ME-112(B).

ME-212(B) Marine Power Plant Equipment 3-4

Thermodynamic aspects of the turbine, impulse and reaction types, of the reciprocating engine, the gas compressor and blower. Refrigeration and heat pump cycles, refrigerants, multi-level refrigeration. Air conditioning; requirements and equipment, associated laboratory work.

Texts: Kiefer, Kinney and Stuart: Engineering Thermodynamics; miscellaneous supplementary material.

Prerequisite: ME-211(C).

ME-215(A) Marine Power Plant Analysis and Design 2-4

Studies of the methods and procedures employed in the over-all planning of naval ships from the viewpoint of the power plant engineer, their principal plant components and various practical and military factors which influence the design. Project work includes preliminary methods of estimating for a hypothetical naval ship: the hull, main engine and auxiliary power requirements, inter-relationship of individual equipment items, and computation of various ship and plant performance indices. The time is distributed variously between lectures, student project work, seminar and, upon occasion, lectures by visiting authorities in specialized fields of naval marine engineering.

Texts: Seward: Marine Engineering; Bureau of Ships publications and data; Kiefer, Kinney and Stuart: Engineering Thermodynamics.

Prerequisites: ME-212(B), ME-310(B), and ME-411(C).

ME-216(A) Marine Power Plant Analysis and Design 2-4

This course, in continuation of ME-215(A), carries to completion the project work of the latter, as required, with additional project work in preliminary design investigation of main propulsion turbines and other major equipment items. The time is distributed variously between lectures, student project work, seminar and, upon occasion, lectures by visiting authorities in specialezd fields of naval marine engineering.

Texts: Seward: Marine Engineering; Labberton: Marine Engineering; Church: Steam Turbines; Bureau of Ships publications and data; Kiefer, Kinney and Stuart: Engineering Thermodynamics.

Prerequisite: ME-215(A).

ME-217(C) Internal Combustion Engines 3-2

Analysis of basic spark-ignition and compression ignition cycles, real-fuel cycles and effects of dissociation, combustion processes, effects of detonation, variations of real engine performance from ideal performance, supercharged and throttled cycles. Spark-ignition engine combustion chambers, carburetion, inlet and exhaust systems, effects of ignition timing. Compression-ignition engine combustion chambers, injection systems, analysis of injection phenomena and variables affecting performance. Laboratory work includes engine tests to determine speed-torque characteristics, fuel consumption rates, effect of injection systems variables upon engine performance, volumetric efficiencies, etc.

Texts: Lichty: Internal Combustion Engines: Taylor and Taylor: Internal Combustion Engines.

Prerequisite: ME-112(B) or ME-122(C).

ME-220(A) Marine Power Plant Analysis 3-2

Preliminary methods of estimating for a hypothetical naval ship the main engine and auxiliary power requirements, inter-relationship of individual equipment items, and computation of various plant and ship performance indices. Preliminary design investigation of main propulsion turbines and other power plant equipment. Heat balance and flow diagrams.

Texts: Labberton: Marine Engineering; Church: Steam Turbines.

Prerequisites: ME-210(B) and ME-421(C) or ME-411(C).

ME-221(C) Marine Power Plant Equipment 3-2

Steam power plant cycles, influences of regenerative feed heating and of reheating, performance indices. Internal combustion power cycles, elementary gas turbine power plant, influence of regenerative preheating and of reheating, performance indices. Thermodynamic aspects of flow of compressible fluids in nozzle, diffuser and duct, dynamics of jet and of diverted flow. Elements of heat transmission. Associated problems and laboratory work.

Texts: Kiefer, Kinney and Stuart: Engineering Thermodynamics; miscellaneous supplementary material.

Prerequisite: ME-122(C).

ME-222(C) Marine Power Plant Equipment 3-4

Thermodynamic aspects of the turbine, impulse and reaction types, of the reciprocating engine, the gas compressor and blower. Refrigeration and heat pump cycles, refrigerants, multi-level refrigeration, air conditioning requirements and equipment. Associated laboratory work.

Texts: Kiefer, Kinney and Stuart: Engineering Thermodynamics; miscellaneous supplementary material.

Prerequisite: ME-221(C).

ME-223(B) Marine Power Plant Analysis 2-4

Preliminary methods of estimating for a hypothetical naval ship the hull, main engine and auxiliary power requirements, inter-relationship of individual equipment items, and computation of various plant and ship performance indices. Preliminary design investigation of main propulsion turbines and other power plant equipment. Heat balance and flow diagrams.

Texts: Seward: Marine Engineering; Labberton: Marine Engineering; Church: Steam Turbines; Bureau of Ships publications and data.

Prerequisites: ME-222(C) and ME-421(C) or ME-411(C).

ME-240(B) Nuclear Power Plants 4-0

A general survey of nuclear power with emphasis on the relation of the reactor to power sources, present and future. Nuclear particles, energies and properties. Nuclear reactions, radioactivity, decay. Scattering and diffusion of neutrons. Nuclear reactor principles, types. Problems of power removal and utilization. Reactor core considerations. Elements of reactor economics, feasibility. Shielding problems. Discussion of world future energy source.

Text: Murray: Introduction to Nuclear Engineering.

Prerequisites: ME-111(C) and Ph-610(B).

ME-241(A) Nuclear Power Plants 3-2

The first of a two-term series, ME-241 and ME-242, covering engineering aspects of nuclear power reactors. Reactor types, properties and criteria for selection. History and organization of atomic energy effort. Advanced heat transfer and thermodynamics of characteristic cycles. Elementary nuclear and thermal core and plant design. Shielding. Economics of nuclear plants.

Texts: Murray: Introduction to Nuclear Engineering; Glasstone and Edlund: Elements of Nuclear Reactor Theory; USGPO: Liquid Metals Handbook.

Prerequisites: ME-310(B) and Ph-642(B).

ME-242(A) Nuclear Power Plants 3-2

Reactor control methods and programs. Plant stability, kinetic behavior, poisoning. Detailed studies of existing naval reactor plants. Material in this course will be partly of a classified nature.

Texts: Murray: Introduction to Nuclear Engineering; Glasstone and Edlund: Elements of Nuclear Reactor Theory; USGPO: Liquid Metals Handbook.

Prerequisite: ME-241(A).

ME-247(C) Nuclear Power Plant Survey 1-0

A general survey of nuclear power plants for students in fields other than mechanical engineering. Familiarization with basic concepts in nuclear reactor physics, shielding, and materials. General description of types of plants and equipment peculiar to nuclear plants.

Prerequisite: None.

ME-250(A) Nuclear Reactor Laboratory 0-4

Laboratory experiments using the AGN-201 Reactor covering reactor operation, monitoring the reactor, control rod calibration, measurement of the effect of absorption reactivity, measurement of thermal cross-sections and danger coefficient tests, relative calibration of foils, temperature of reactor by foil measurement, measurement of reactor core buckling and power level calibration, measurement of diffusion length and age in water and shielding evaluation. Experiments on a reactor simulator investigating reactor behavior and control during normal operation and under unusual conditions.

Texts: Hughes: Pile Neutron Research; Glasstone and Edlund: Elements of Nuclear Reactor Theory; Glasstone: Principles of Nuclear Reactor Engineering.

Prerequisite: ME-241(A).

ME-310(B) Heat Transfer 4-2

General manners of energy transition by temperature potential, characteristic thermal circuits, concepts and correlation of individual and overall heat transfer coefficients. Fourier's general law of conduction, applications to representative steady-state situations and unsteady-state condition, Schmidt and relaxation methods of approximation. Convection phases of thermal circuits, free and forced, and ones involving vaporization and condensation. Heat radiation. Associated problems and laboratory work.

Texts: Jakob and Hawkins: Elements of Heat Transfer and Insulation; McAdams: Heat Transmission; W. H. Giedt: Principles of Engineering Heat Transfer.

Prerequisites: Ma-114(A) and ME-112(B).

ME-320(B) Heat Transfer 3-2

Basic concepts of heat transfer mechanisms are treated by classical boundary value problem techniques, numerical methods, analogue methods, "lumped parameter" and thermal circuit analyses and presentation and application of experimental data. Primary emphasis is upon conduction and convection for both steady state and un-steady state behavior.

Texts: W. H. Giedt: Principles of Engineering Heat Transfer; W. H. McAdams: Heat Transmission, 3rd Edition; M. Jakob: Heat Transfer, Volume I.

Prerequisites: Ma-114(A) and ME-112(B).

ME-350(B) Heat Transfer 2-2

General survey of the manners of energy transition by temperature potential with major emphasis on its transfer by radiation and conduction under steady and unsteady-state conditions.

Texts: McAdams: Heat Transmission; Jakob: Heat Transfer, Vol. I; Jakob and Hawkins: Elements of Heat Transfer and Insulation.

Prerequisite: Ma-182(C).

ME-410(B) Hydromechanics 3-2

Brief coverage of hydrostatics, energy aspects of flow, momentum principle, and applications of dimensional analysis. Resistance to flow through and about bodies. Two dimensional potential flow theory and examples. Two dimensional viscous, incompressible fluid flow, with application to hydrodynamic lubrication. Associated laboratory exercises and problem work.

Texts: Departmental notes: Engineering Fluid Mechanics; Streeter: Fluid Dynamics.

Prerequisite: Ma-113(B).

ME-411(C) Hydromechanics 3-2

The mechanical properties of liquids, hydrostatic pressures and forces, buoyancy and ship stability. Energy aspects of fluid flow, fluid flow in pipes, flow metering and control. Dynamic forces associated with flow, impulse-momentum principles, analysis of hydro-machinery. Dimensional analysis and similitude are developed and applied extensively. Elementary potential flow, vortex motion, viscous motion, boundary layer, and lubrication theory are introduced, associated laboratory experiments and problem work.

Text: Hunsaker and Rightmire: Engineering Applications of Fluid Mechanics.

Prerequisite: Ma-113(B).

ME-412(A) Hydromechanics 4-2

Continuation of ME-411. Basic concepts of kinematics of ideal, incompressible fluids. Stream and velocity potential functions, elementary flow patterns and the synthesis of combined flows, graphically and mathematically. Basic concepts in vector notation, use of the complex variable leading to the theory and application of conformal transformations. Kutta-Joukowski and Blasius theorems. Theory of hydrodynamic lubrication.

Texts: Departmental notes: Engineering Fluid Mechanics; Streeter: Fluid Dynamics.

Prerequisites: ME-411(C) and Ma-114(A).

ME-421(C) Hydromechanics 3-2

The course is the first of a sequence of ME-421 and ME-422. The content parallels that of ME-411, but proceeds at a slower rate.

Text: Departmental notes: Engineering Fluid Mechanics.

Prerequisite: Ma-111(C).

ME-422(B) Hydromechanics 2-2

Dynamic forces in fluid flow, centrifugal pumps, couplings and torque converters, jet propulsion. Introduction to the kinematics of ideal-fluid flow, primary flow patterns and their synthesis by graphical techniques. Elements of hydrodynamic lubrication.

Text: Departmental notes: Engineering Fluid Mechanics.

Prerequisites: Ma-113(B) and ME-421(C).

ME-460(C) Mechanics of Fluids 4-0

This courses covers the laws of mechanics as they apply to liquids, vapors and gases. Particular attention is directed to the fluid phenomena affecting the performance of ships, aircraft, and propelled weapons. Topics include: fluid statics, steady flow processes, viscosity, incompressible and compressible fluids, dynamic lift, dynamics of compressible flow, lubrication, fluid couplings, fluid power systems.

Text: Binder: Fluid Mechanics.

Prerequisites: ME-562(C).

ME-500(C) Strength of Materials 3-0

Elements of the mechanics of elastic bodies; tensile and compressive stresses, shearing stress, Hooke's law, thin-walled cylinders, combined stresses, torsion of circular-sectioned members, elementary beam theory, combined loadings and columns.

Text: Timoshenko and MacCullough: Elements of Strength of Materials.

Prerequisites: Ma-111(C) and Mc-101(C) or ME-501(C).

ME-501(C) Statics 2-2

Laws of statics. Force systems, equilibrium. Simple structures, distributed forces, friction, virtual work.

Text: Meriam: Mechanics, Part I.

Prerequisite: Ma-100(C) or Ma-120(C) (may be taken concurrently).

ME-502(C) Dynamics 2-2

Kinematics, Newton's laws, kinetics of particles. Work and energy, impulse and momentum. Kinetics of rigid bodies in plane motion, periodic motion, moments of inertia.

Text: Meriam: Mechanics, Part II.

Prerequisites: ME-501(C), and differential equations (may be taken concurrently).

ME-503(A) Advanced Dynamics 2-2

Restatement of laws of mechanics. Simple pendulum for large amplitudes, effects of earth's rotation. The inertia tensor, general motion of a rigid body, spinning tops, gyroscopes. Numerical procedures. Lagrange's equations.

Text: Synge and Griffith: Principles of Mechanics.

Prerequisite: ME-502(C).

ME-511(C) Strength of Materials 5-0

Topics in elastic-body mechanics, including tensile and compressive stress, shearing stress, Hooke's law, thin-walled cylinders, combined stresses, torsion of circular-sectioned members, elementary beam theory, statically indeterminate problems in bending, combined loading, columns, and beams on elastic foundations.

Text: Timoshenko and MacCullough: Elements of Strength of Materials.

Prerequisites: Ma-111(C) and ME-501(C).

ME-512(A) Strength of Materials 5-0

Beam columns, strain energy, shear center, thin plates, buckling of bars and plates, problems having radial symmetry, behavior beyond the elastic limit.

Text: Timoshenko: Strength of Materials, Vols. I and II.

Prerequisite: ME-511(C).

ME-513(A) Theory of Elasticity 3-0

Plane-stress considerations, differential equations of equilibrium and compatibility, the Airy stress function, curvilinear coordinates, problems in plane stress and plane strain, three-dimensional stress systems, St.-Venant theory of torsion, energy methods.

Text: Timoshenko and Goodier: Theory of Elasticity.

Prerequisite: ME-512(A).

ME-522(B) Strength of Materials 4-0

Beam columns, strain energy, shear center, thick cylinders, rotating disks, torsion of non-circular sections.

Text: Seeley and Smith: Advanced Mechanics of Materials.

Prerequisite ME-511(C).

ME-550(B) Elements of Dynamic Structural Analysis 5-0

Elastic and plastic analysis of structural elements. Structural types and nomenclature. Elastic and plastic analysis of statically determinate and indeterminate structures. Behavior of materials under suddenly applied loads. Engineering idealizations of loads imposed by blasts. Exact solutions for dynamic response of simple elements to suddenly applied loads. Introduction to the general problem of dynamic analysis of structures, through elastic and plastic phases. Numerical analysis of simple cases.

Texts: Timoshenko and MacCullough: Elements of Strength of Materials; Atomic Energy Commission: The Effects of Atomic Weapons; current reports.

Prerequisites: Mc-311(A) and ME-500(C).

ME-561(C) Engineering Mechanics I (Statics) 4-0

Forces and force systems, moments and couples, resultants, equilibrants, free body diagrams, equilibrium of a free body, two force members, trusses, many force members, friction, cables, first and second moments, centroids.

Text: To be assigned.

Prerequisite: Ma-052(C).

ME-562(C) Engineering Mechanics II (Dynamics) 4-0

Kinematics of a particle, force, mass and acceleration, Newton's laws of motion, d'Alembert's principle for a particle, systems of particles, motion of the mass center, translation and rotation, plane motion, work and energy, impulse and momentum.

Text: To be assigned.

Prerequisites: ME-561(C) and Ma-053(C).

ME-570(C) Mechanics of Materials 4-0

Stress, uniform normal stress, deformation, strain, Hooke's law, simple statically indeterminate loadings, thin shells, shear, connections, torsion, shear and bending moment in beams, stresses and deflections of beams; complex loadings and combined stresses, columns.

Text: Timoshenko and MacCullough: Elements of Strength of Materials.

Prerequisite: ME-562(C).

ME-601(C) Materials Testing Laboratory 0-2

Performance and analysis of standard tests used in determining the mechanical properties of engineering materials, including tests in tension, compression, torsion, shear, transverse bending, impact and hardness.

Texts: Muhlenbruch: Testing of Engineering Materials; A.S.T.M. Student Standards.

Prerequisite: Subsequent to or concurrent with ME-500(C) or Ae-211.

ME-611(C) Mechanical Properties of Engineering Materials 2-2

Study of the theories of failure, the evaluation of experimental error and experiments in the determination of the mechanical properties of engineering materials. These tests include: tension, compression, torsion, shear, transverse bending, impact, hardness, fatigue and column action.

Texts: Seely and Smith: Advanced Mechanics of Materials; Davis, et al: Testing and Inspection of Engineering Materials.

Prerequisite: ME-511(C).

ME-612(A) Experimental Stress Analysis 3-2

The course includes: dimensional analysis, strain gage techniques, photoelasticity, brittle lacquer method, membrane analogy, miscellaneous methods in experimental stress analysis. Diversified labortory projects are assigned, offering an opportunity to apply the methods of experimental stress analysis to the solution of both static and dynamic problems.

Text: Lee: An Introduction to Experimental Stress Analysis.

Prerequisites: ME-513(A) and ME-611(C).

ME-622(B) Experimental Stress Analysis 2-2

Theory and application of the wire resistance strain gage for finding static and dynamic stresses in machines and structures. Brief survey of other techniques including brittle lacquer, photo-elasticity, and analog methods. Laboratory experiments cover both static and dynamic stress studies with the resistance gage and a variety of auxiliary instrumentation.

Text: Perry and Lissner: Strain Gage Primer.

Prerequisites: ME-522(B) and ME-611(C).

ME-710(B) Mechanics of Machinery 4-2

Velocity and acceleration of machine parts, static and dynamic forces on machine members, kinematic analysis of cams and gears, balancing of solid rotors, basic vibration problems in machines.

Texts: Ham and Crane: Mechanics of Machinery; Thomson: Mechanical Vibrations.

Prerequisite: ME-502(C).

ME-711(B) Mechanics of Machinery 4-2

Emphasis is placed on velocities and accelerations of machine parts. An analysis is made of static and inertia forces on machine members. Practical dynamic analysis of cams is included . The kinematics of gears are studied including spur, bevel, helical and worm gears. This course is the first of a coordinated sequence of ME-711 and ME-712.

Text: Ham and Crane: Mechanics of Machinery.

Prerequisite: ME-502(C).

ME-712(A) Dynamics of Machinery 3-2

Studies are made of the following topics: Balancing of solid rotors and reciprocating machines, free and forced vibrations without and with damping for one, two or many degrees of freedom, vibration isolation, vibration absorbers, torsional vibration including the Holzer methods, vibration of beams including Rayleigh's method for transverse vibrations, nonlinear systems. Laboratory work includes the following experiments: balancing a solid rotor on a mechanical as well as an electrical balancing machine, rate of decay in the transverse vibration of beams, calibration of velocity and acceleration pickups.

Texts: Den Hartog: Mechanical Vibrations; Thomson: Mechanical Vibrations.

Prerequisites: Ma-114(B), ME-711(B) and ME-511(C).

ME-713(A) Advanced Dynamics of Machinery 3-0

Several topics are studied from a theoretical as well as a practical point of view. These include: Shock and vibration mounts, torsional vibrations of crank shafts with emphasis on the design of tuned vibration absorbers, special bearings, gear tooth lubrication, sleeve bearings with pulsating loads, oil film whirl, turbine blade vibration, non-linear vibration problems, design and calibration of a velocity and an acceleration pick-up as carried out in the dynamics labortory.

Texts: Den Hartog: Mechanical Vibrations; Thomson: Mechanical Vibrations; Karman and Biot: Mathematical Methods in Engineering.

Prerequisites: ME-712(A) and ME-812(B).

ME-730(A) Vibrations 3-2

Studies are made of the following topics: Balancing of solid rotors and reciprocating machines, free and forced vibrations without and with damping for one, two or many degrees of freedom, vibration isolation, vibration absorbers, torsional vibration including the Holzer method, vibration of beams including Rayleigh's method for transverse vibrations, non-linear systems. Laboratory work includes balancing a solid rotor, experimental study of transverse vibration of beams, study of free and forced vibrations using an analogue computer, and calibration of vibration transducers.

Texts: Den Hartog: Mechanical Vibrations; Thomson: Mechanical Vibrations.

Prerequisites: Ma-114(B), ME-500(C), and ME-502(C).

ME-760(C) Basic Mechanisms 3-2

Lectures and drawing room practice on solution of problems related to various mechanisms by graphical methods. Topics include displacement, velocity and acceleration of machine parts, such as links, cams, and gears.

Text: To be assigned.

Prerequisites: ME-060(C) and Ma-051(C).

ME-811(C) Machine Design 3-2

Review of strength of materials, selections of materials, stress-concentration, bearings, fits and tolerances. Several short design projects as follows: tabulation of tolerances for shafts and holes for the various classes of fits, accumulation of tolerances in machines, design of an armature shaft, spring design, screw fastening design, design of a power screw and the design of a set of gears. Studies of belt and chain drives, brakes, clutches, cams and thin and thick cylinders.

Text: Vallance and Doughtie: Design of Machine Members.

Prerequisites: ME-511(C) and ME-711(B).

ME-812(B) Machine Design 3-4

Several practical design projects will be completed on the drawing board. The projects will give the students an opportunity to combine theory with practice. The drawings involved in the projects will be completely dimensioned; proper materials selected; correct base references, surfaces for machining and inspecting will be chosen; proper fits and tolerances will be chosen for interchangeable manfacture. The objective is to create designs which may actually be fabricated.

Text: Departmental Notes.

Prerequisite: ME-811(C).

ME-820(C) Machine Design 2-4

Short review of strength of materials. Stress-concentration, factors of safety. Fits and tolerances. Several short design projects which illustrate the application of the principles of stress, strain, deflection, fits, and tolerances, vibrations, etc. General design information on bearings, springs, shafting, screw fastenings, gears, clutches, brakes, cams and thick and thin cylinders.

Text: Departmental notes.

Reference: Vallance and Doughtie: Design of Machine Members.

Prerequisite: ME-711(B).

ME-840(C) Manufacturing Engineering 3-2

The following topics are studied: the principles of interchangeable manufacture, the selection of and use of the proper machine tools to fulfill a specific requirement, the details of gage design and inspection methods with reference to proper fits and tolerances. Several industrial plants will be visited, where lectures on the use of machines will be provided.

Text: Buckingham: Interchangeable Manufacturing.

Prerequisite: ME-811(C).

ME-900(A) Special Problems in Mechanical Engineering 3-0

Advanced topics to meet special entrance requirements at other institutions. Analytic theory of heat conduction. Thermal stresses in plates, rods, and pressure vessels.

Texts: Jakob: Heat Transfer; Timoshenko and Goodier: Theory of Elasticity.

Prerequisites: ME-310(B) and ME-512(A) or equivalent.

MECHANICS

Mc Courses

Mc-101(C) Engineering Mechanics I 2-2

Review of statics; free-body diagrams; distributed forces; centroids; moments and products of inertia of areas; hydrostatics; friction, general principles of dynamics; dimensional analysis; kinematics of a particle; relative and absolute time rate of change of a vector; Coriolis acceleration.

Text: Housner and Hudson: Applied Mechanics.

Prerequisite: A previous course in mechanics is desirable. Ma-100(C) or Ma-120(C) to be taken concurrently.

Mc-102(C) Engineering Mechanics II 2-2

Dynamics of a particle; impulse and momentum; work and energy; potential; conservation of energy; vibrating systems, free and forced, with and without damping; impact; dynamics of rigid bodies; moments and products of inertia; principal axes of inertia; the gyroscope.

Text: Housner and Hudson: Applied Mechanics.

Prerequisite: Mc-101(C).

Mc-201(A) Methods in Dynamics 2-2

The principles of linear momentum, angular momentum, work and energy, power and energy, conservation of energy, virtual work, and d'Alembert are developed and discussed in detail. This work is followed by a development and interpretation of Lagrange's equations of motion. Application of these various principles to obtain the differential equations of motion of dynamical systems is given particular attention. Numerous exercises in the writing of differential equations of motion are assigned; some of these are designed to furnish practice in the formulation of the differential equations for systems of variable mass.

Texts: Synge and Griffith: Principles of Mechanics; Timoshenko and Young: Advanced Dynamics.

Prerequisite: Mc-102(C).

Mc-311(A) Vibrations 3-2

Kinematics of vibrations; free and forced vibrations of systems with one degree of freedom; theory of vibration measuring instruments and of vibration insulation; systems with many degrees of freedom; normal modes of vibration; computation of fastest and slowest modes by matrix methods; vibrations of strings, beams, shafts and membranes; Rayleigh's method; Stodola's method; critical speeds; self-excited vibrations; effect of impact on elastic structures.

Texts: Thomson: Mechanical Vibrations (2nd edition); Den Hartog: Mechanical Vibrations (3rd edition); Frankland: Effects of Impact on Simple Elastic Structures (TMB Report 481).

Prerequisites: Ma-114(A) and Mc-102(C).

Mc-402(A) Mechanics of Gyroscopic Instruments 3-0

Review of the vector kinematics and dynamics involved in the angular motion of rigid bodies; steady, free and forced precession and general motion of a gyro; stability of a free gyro; the gyrocompass and gyro pendulum; gyro angular velocity indicator; the stable platform; Shuler tuning of inertial guidance instruments.

Texts: Synge and Griffith: Principles of Mechanics (Second Edition); Timoshenko and Young: Advanced Dynamics; Klass: Inertial Guidance; Wrigley: Shuler Tuning Characteristics in Navigational Instruments.

Prerequisite: Mc-102(C).

Mc-403(A) Kinematics of Guidance 3-0

Kinematics and geometry of guidance and interception systems; special coordinates; inertial reference frames; accelerometers; inertial guidance; introduction to autopilots; introduction to optimum rocket trajectories.

Texts: Locke: Guidance; USNPS Notes.

Prerequisite: Mc-402(A).

Mc-404(A) Missile Mechanics 3-0

A survey of ballistic missile dynamics including discussions of atmospheric structure; standard conditions; drag; stability derivatives; equations of yawing, swerving and angular motion; electronic digital integration of equations of motion; effects of variations from standard conditions; rocket motor thrust and torque; tricyclic motion; aeroballistic range measurements of stability derivatives; contributions of aerodynamic jump and drift to dispersion; dynamic wind tunnel tests; dynamic stability; resonance instability.

Text: Bleick: Dynamics of Ballistic Missiles.

Prerequisite: Mc-402(A).

Mc-421(A) Interior Ballastics 2-0

Basic thermodynamics of interior ballistics including methods of determining the adiabatic flame temperature, specific heat and number of moles of powder gas. These basic topics are followed by a detailed study (including computational exercises) of the linear system of interior ballistics of Hirschfelder developed under NDRC auspices.

Texts: Hirschfelder and Sherman: Simple Caculation of Thermochemical Properties for Use in Ballistics (OSRD Report 935); Curtiss and Wrench: Interior Ballistics (OSRD Report 6468).

Prerequisites: Ma-111(C), Mc-102(C) and Ch-631(A).

METALLURGY

Mt Courses

Mt-101(C) Production Metallurgy 2-0

An introduction to the study of metallurgy and is essentially descriptive in nature. Subjects treated include the occurrence and classification of metal-bearing raw materials; the fundamental processes of extractive metallurgy; refractories, fuels, fluxes, slags and equipment; a brief summary of steel-making and the production of copper and zinc.

Text: Stoughton, Butt: Engineering Metallurgy (1938).

Prerequisite: Ch-101(C) or Ch-121(B), or concurrently with either.

Mt-102(C) Production of Steel 3-0

The subject matter includes such topics as the occurrence and composition of various iron ores, blast furnace products. The various methods of steel production and the production of grey, white and malleable cast iron.

Text: Bray: Ferrous Production Metallurgy.

Prerequisite: Ch-101(C) or Ch-121(B).

Mt-103(C) Production of Non-Ferrous Metals 3-0

A discussion of the sources, the strategic importance of, and the methods of production of the following metals; copper, zinc, lead, tin, aluminum, magnesium, and other metals of technical interest.

Text: Bray: Non-Ferrous Production Metallurgy.

Prerequisite: Ch-101(C) or Ch-121(B).

Mt-104(C) Production Metallurgy 4-0

An introduction to the study of production metallurgy. Subjects treated include the occurrence of metal bearing raw materials, the fundamental processes of extractive metallurgy, refractories, fuels, fluxes. Production of steel, cast iron, copper, zinc, lead, tin, nickel, aluminum and magnesium.

Texts: Bray: Ferrous Production Metallurgy; Bray: Non-Ferrous Production Metallurgy.

Prerequisite: Ch-101(C) or equivalent.

Mt-201(C) Introductory Physical Metallurgy 3-2

An introduction to physical metallurgy. Subjects treated include: (a) the nature, characteristics and properties of metals; (b) the application of the phase rule to binary and ternary alloy systems and characteristic phase diagrams; (c) the correlation of microstructure, mechanical properties and corrosion resistance of alloys, with phase diagrams; (d) mechanical deformation and heat treatment of alloys; (e) descriptions of representative non-ferrous alloys of commercial importance. The subject matter is illustrated by reference to technically important alloy systems in which the phenomena are commonly observed.

The laboratory experiments are designed to introduce to the student the methods available to the metallurgist for the study of metals and alloys. These include the construction of equilibrium diagrams and metallographic studies of fundamental structures, brass, bronze, bearings, etc.

Texts: Coonan: Principles of Physical Metallurgy: Clark and Varney: Physical Metallurgy for Engineers.

Prerequisite: None.

Mt-202(C) Ferrous Physical Metallurgy 3-2

Continues the presentation of subject matter introduced in Metals, Mt-201, with emphasis on the alloys of iron. Subjects treated include (a) the iron-carbon alloys, (b) effects of various heat treatments and cooling rates on the structure and properties of steel, (c) isothermal reaction rates and the hardenability of steel, (d) surface hardening methods, (e) characteristics and properties of plain carbon and alloy cast irons, (f) the effect of other alloying elements on steel, (g) tool steels.

The laboratory work includes experiments in the heat treatment of steel, mechanical testing and metallographic examination of common ferrous alloys.

Texts: Coonan: Principles of Physical Metallurgy; Clark and Varney: Physical Metallurgy for Engineers.

Prerequisite: Mt-201(C).

Mt-203(B) Physical Metallurgy (Special Topics) 2-2

A continuation of material presented in Mt-201 and Mt-202. The subject matter includes a discussion of the theories of corrosion, factors in corrosion, corrosion prevention, corrosion resistant metals and alloys, powder metallurgy, metallurgical aspects of welding and casting, fatigue and fatigue failures, creep of metals, properties of metals at low temperatures, and surveys of the alloys of aluminum and magnesium and of certain alloys having characteristics suitable for special applications.

Texts: Coonan: Principles of Physical Metallurgy; Heyer: Engineering Physical Metallurgy; Woldman: Metal Process Engineering; Clark and Varney: Physical Metallurgy for Engineers; Reynolds Metals Company: Aluminum Heat Treating.

Prerequisite: Mt-202(C).

Mt-204(A) Non-Ferrous Metallography 3-3

An expansion of material introduced in Mt-201, Mt-202 and Mt-203 with greater emphasis on the intrinsic properties of specific nonferrous metals and alloys. Metals and alloys of importance in engineering and technical applications are discussed in considerable detail with respect to their physical and mechanical properties, microstructures, response to mechanical deformation and heat treatment, advantages and disadvantages for technical applications and unique characteristics leading to specific applications.

Text: None.

Prerequisites: Mt-201(C) and Mt-202(C).

Mt-205(A) Advanced Physical Metallurgy 3-4

The subject matter includes a discussion of equilibrium in alloy systems, structure of metals and alloys, phase transformations and diffusion.

Texts: Barrett: Structure of Metals; Rhines: Phase Diagrams in Metallurgy; Smoluchowski: Phase Transformations in Solids.

Prerequisite: Mt-202(C).

Mt-206(A) Advanced Physical Metallurgy 3-4

The subject matter is an extension of that offered in Mt-205(A) and includes such topics as plastic deformation, theories of slip, recrystallization, preferred orientation, age hardening, etc.

Texts: Barrett: Structures of Metals; Chalmers: Progress in Metal Physics; Cottrell: Dislocations and Plastic Flow in Crystals; Shockley: Imperfections in Nearly Perfect Crystals.

Prerequisite: Mt-205(A).

Mt-207(B) Physics of Solids 3-0

A course for engineers intended as an introduction to the physics of solids. Topics discussed include introductory statistical mechanics, atomic structure and spectra, introductory quantum mechanics, binding and energy bands, crystal structure, and imperfections in crystals.

Text: Sproull: Modern Physics.

Prerequisite: Mt-202(C).

Mt-208(C) Physical and Production Metallurgy 4-2

This course covers the same material as Mt-202 and includes in addition the production of iron and steel. One period each week is devoted to this latter topic.

Texts: Coonan: Principles of Physical Metallurgy; Clark and Varney: Physical Metallurgy for Engineers; Stoughton and Butts: Engineering Metallurgy.

Prerequisite: Mt-201(C).

Mt-301(A) High Temperature Materials 3-0

A course concerned with the effect of elevated temperatures on the properties of metals; of heat problems, creep, surface and structural stability, etc. in reaction motors; turbines, air frames and allied components, guided missiles, rockets, etc. Methods of evaluating behavior of materials at high temperatures and the factors to consider in their selection. Development of alloys for high temperature service; refractory metals. The use of ceramics and developments in cermets and refractory coatings.

Text: Coonan: High Temperature Materials.

Prerequisite: Mt-202(C).

Mt-302(A) Alloy Steels 3-3

The subject matter covered includes a thorough study of the effects of the alloying elements, including carbon, commonly used in steel making on the characteristics of steels in the annealed, the hardened and the hardened and tempered conditions. The principles elucidated are subsequently applied to studies of the classes of steels used for structural purposes, machinery (S.A.E. and A.I.S.I. grades), electrical purposes, tools, and corrosion resisting purposes.

Text: E. C. Bain: The Alloying Elements in Steel; references and reading assignments in other books and current literature.

Prerequisite: Mt-202(C).

Mt-303(A) Metallurgy Seminar

Hours to be arranged

Papers from current technical journals will be reported on and discussed by students.

Text: None.

Prerequisite: Mt-203(B) or Mt-205(A).

Mt-304(C) Non-Destructive Testing 2-2

An introduction to the methods and procedures available for the non-destructive determination of quality characteristics of metals and metal objects. Types of procedures to be discussed may include x-ray and gamma ray radiography, magnetic and electro-magnetic methods, sonic methods, fluorescent liquid and powder methods, spot tests, spark tests, etc.

Text: None.

Prerequisite: Mt-202(C).

Mt-305(B) Corrosion and Corrosion Protection 3-0

Designed for Engineering Materials Curriculum. Corrosion theories and methods of corrosion protection.

Text: None.

Prerequisites: Mt-202 and Ch-101 or equivalent.

Mt-306(B) Advanced Analytical Techniques 3-3

Designed for Engineering Materials Curriculum. Engineering measurements, to include X-ray diffraction, concentration measurements, pH meters, etc. Density measurements and radio tracer techniques, activation analysis, infra-red techniques.

Text: None

Prerequisites: Mt-202 and Physical Chemistry.

Mt-401(A) Physics of Metals 3-0

A discussion of crystal chemistry and modern theories of the solid state. Topics considered are the wave nature of electrons, the electron theory of metals, reaction kinetics, free energy of alloy phases, order-disorder transformations, etc.

Texts: Cottrell: Theoretical Structure Metallurgy; Kittell: Solid State Physics; selected references.

Prerequisites: Mt-205(A) and either Ph-610(B) or Ph-640(B).

Mt-402(B) Nuclear Reactor Materials—Effects of Radiation 4-0

A course designed for students in nuclear engineering. Includes a study of materials of reactor construction; factors in materials selection; commercially available materials; liquid metal coolants; nature of radiation damage on materials.

Texts: The Reactor Handbook—General Properties Materials; Finniston and Howe: Metallurgy and Fuels.

Prerequisite: Mt-202(C), Mt-207(B), or equivalent.

Mt-501(A) Welding Metallurgy 3-3

This course is designed to study in considerable detail the various materials, equipment, and processes employed for joining metals by both the plastic and the fusion welding methods, and to correlate the mechanical, electrical, and metallurgical factors essential to successful welding. Topics covered include heat sources, welding machines, manual and automatic processes, fluxes and slags, evaluation of materials, examination and testing of welded structures, metallurgy of weld deposits and heat-affected parent metals, weldability, underwater welding and cutting, corrosion of welds and welded structures, and the origin and control of defects in welding.

The laboratory exercises are designed to familiarize the student with the more common welding processes and to permit verification of certain aspects of the subject matter.

Texts: None. References from handbooks, periodicals and manufacturers' literature.

Prerequisite: Mt-203(B).

OCEANOGRAPHY

Oc Courses

Oc-110(C) Introduction to Oceanography 3-0

A descriptive course which provides background for later courses in oceanography; it may be taken by students in all curricula. Topics include the physical and chemical properties of sea water, marine biology, and submarine geology; the heat budget of the oceans; water masses and the general circulation; currents, waves, and tides.

Texts: Sverdrup: Oceanography for Meteorologists; Shepard: Submarine Geology; NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare.

Prerequisite: None.

Oc-210(B) Physical Oceanography 3-0

The physics of ocean currents, mixing, and boundary-layer flow; electromagnetic radiation and visibility in the sea; the properties of simple waves; tides and seiches; the nature of estuarine circulations.

Texts: Sverdrup, Johnson, and Fleming: The Oceans; NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare; departmental notes.

Prerequisites: Oc-110(C) or equivalent, Ma-163(C) or equivalent, and Ph-196(C) or Ph-191(C).

Oc-212(B) Tides and Tidal Currents 3-0

Theories of the astronomical tides; the tide-producing forces; tidal oscillations in ocean basins; geographical variation of the tides; analysis and prediction of tides; tidal datum planes. Meteorological tide. Seiches. Tidal currents.

Texts: Marmer: The Tide; Marmer: Tidal Datum Planes.

Prerequisites: Ma-111(C) and Ph-142(B) or their equivalents.

Oc-213(B) Shallow-Water Oceanography 3-0

Types and characteristics of continental shelves, coasts, and beaches; surf, breaking waves, littoral currents, and other shallow-water phenomena, and their influence upon amphibious operations; storm-tides.

Text: Departmental notes.

Prerequisites: Oc-110(C) and Mr-611(B).

Oc-220(B) Ocean Currents and Diffusion 3-0

Dynamics of ocean currents; advection and diffusion of various substances and properties in the ocean, including the natural flushing of contaminants from harbors and estuaries; boundary-layer flow in the ocean.

Texts: Sverdrup, Johnson, and Fleming: The Oceans; Shepard: Submarine Geology; NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare.

Prerequisites: Oc-110(C), and Ma-163(C) and Ph-196(C) or their equivalents.

Oc-230(A) Wave Phenomena in the Sea 3-0

The mechanics of simple water waves, ocean-wave spectra, statistical properties of ocean waves, wave forces, and wave pressures; the movement of ships in irregular seas; tides, tidal currents, and the forces associated with them; sea-water transparency and underwater visibility.

Texts: Sverdrup, Johnson, and Fleming: The Oceans; H.O. 603: Practical Methods for Observing and Forecasting Ocean Waves; departmental notes.

Prerequisites: Oc-110(C), Ma-152(B), and Ma-321(B) or equivalent.

Oc-310(B) Geological Oceanography 3-0

General physiography of the ocean basins; topographic features of the sea floor, especially seamounts, the continental slope and shelf, submarine canyons, and coral reefs; marine processes that have shaped the ocean basins and coasts; character of marine sediments; geographical and vertical distribution of sediment types; rates of deposition; origin of the ocean basins.

Texts: Kuenen: Marine Geology; Shepard: Submarine Geology.

Prerequisite: Oc-110(C) or equivalent. Ge-101(C) is desirable but not necessary.

Oc-330(A) Marine Geology and Geophysics 3-0

Physical and engineering properties of marine sediments, load-bearing capacity of sediments; deposition and erosion on the ocean floor, current scour around objects on the bottom; types of continental shelves and harbors; geographical distribution of marine sediments; acoustical and electrical characteristics of sediments; biological fouling organisms, distribution of foulers, rates of fouling; sources of oceanographic data.

Texts: Terzaghi and Peck: Soil Mechanics in Engineering Practice; Shepard: Submarine Geology; United States Naval Institute: Marine Fouling and its Prevention; selected publications.

Prerequisite: Oc-110(C).

Oc-400(C) General Oceanography and Marine Biology 3-0

The first half of the course deals briefly with the physical and chemical properties of sea water; currents, waves, and tides; general circulation of the oceans; and submarine geology. The second half treats the biology of the oceans, followed by study of the organisms that are responsible for noise making, sound scattering, bioluminescense, fouling, and boring.

Texts: Sverdrup, Johnson, and Fleming: The Oceans; selected publications.

Prerequisites: None.

Oc-410(B) Biological Oceanography 3-1

Plants and animal groups in the oceans; marine biological environments; character of the plankton, nekton, and benthos; ecology of marine organisms; oceanographic factors influencing populations; the effect of organisms on the physical-chemical properties of sea water; organisms responsible for boring, fouling, sound and light production, and sound scattering.

Text: Sverdrup, Johnson, and Fleming: The Oceans..

Prerequisite: Oc-110(C) or equivalent.

Oc-510(B) Chemical Oceanography 3-2

Chemical composition of sea water; total salinity and density; dissolved gases with emphasis on the carbon-dioxide system; plant nutrients; organic and inorganic agencies affecting the composition; the observed distribution of salts, dissolved gases, and nutrients; sea ice; geochemistry of the oceans; the production of fresh water from sea water. The laboratory includes chemical determination of the salinity and oxygen content of sea-water samples, and sea-water density computations.

Texts: Harvey: Recent Advances in the Biological Chemistry and Physics of Sea Water; Sverdrup, Johnson, and Fleming: The Oceans.

Prerequisites: Ch-101(C) or equivalent, and Oc-110(C) or equivalent.

Oc-620(B) Oceanographic Factors in Underwater Sound I 3-0

The oceanographic factors involved in sound ranging, including thermal gradients, sound absorption properties of sea water, sound scattering and reflection characteristics of the sea surface and sea floor, scattering properties of marine organisms, and ambient noise arising in the sea.

Texts: NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare; departmental notes.

Prerequisites: Oc-110(C) and Ph-196(C) or equivalent.

Oc-621(B) Oceanographic Factors in Underwater Sound II 1-2

A continuation of Oc-620(B). Diurnal and seasonal thermoclines and their variations; forecasting vertical thermal gradients, surface scattering coefficients, etc.; use of data sources for mean thermal structures, ambient noise levels, and sea-floor reverberation.

Text: H.O. Misc. 15360: Effects of Weather upon the Thermal Structure of the Ocean.

Prerequisite: Oc-620(B).

Oc-630(A) Engineering Aspects of Oceanography 3-0

Engineering application of oceanographic information, including the motion of ships in a seaway; the effect of harbor surging on moored ships; wave forces on breakwaters, pilings, mines, etc.; permanent and mobile breakwaters; the influence of piers, breakwaters, and seawalls on coastline erosion; shoreline protection from marine erosion; harbor design and maintenance; and hydraulic models.

Texts: Departmental notes and selected publications.

Prerequisites: Oc-210(B) and Mr-610(B) or equivalent.

OPERATIONS ANALYSIS

Oa Courses

Oa-121(A) Survey of Operations Analysis 4-2

The nature, origin, and contemporary status of operations analysis; fundamental concepts with special emphasis on applications in the field of evaluating radar and sonar; introduction to game theory, linear programming, and other advanced techniques.

Texts: Operations Evaluation Group: Report No. 54, Methods of Operations Research; classified official publications; notes from MIT Summer Course on Operations Research, 1953; McClosky and Trefethen: Operations Research for Management. Vols. I and II.

Prerequisite: Ma-321(B).

Oa-141(B) Fundamentals of Operations Analysis 4-0

The role of operations analysis in the solution of military problems. Measures of effectiveness and the selection of optimal weapon systems. Special techniques such as game theory, linear programming, detection theory, and reliability theory.

Texts: McCloskey and Trefethen: Operations Research for Management, Vols. I and II; Koopmans: Activity Analysis of Production and Allocation; classified official publications; instructor's notes.

Prerequisite: Ma-321(B).

Oa-151(B) Survey of Weapons Evaluation 3-0

Review of probability theory with military interpretations. Sources of firing errors and their relative contributions to the over-all errors. Damage probabilities. Selection of optimal weapon systems. Introduction to game theory and its application.

Texts: Operations Evaluation Group: Report No. 54, Methods of Operations Research; classified official publications.

Prerequisites: Ma-113(B) and Ma-301(B).

Oa-152(C) Measures of Effectiveness of Mines 3-0

Review of probability theory with military interpretations. Introduction to operations analysis. Errors in mine laying. Probability of damage. Theory of mine field operation.

Texts: Classified official publications.

Prerequisite: Ma-381(C).

Oa-153(B) Game Theory and Its Applications to Mine Fields 3-0

A continuation of Oa-152(C). Introduction to game theory. Operation of a mine field according to game theory. Analysis of countermeasures.

Texts: Classified official publications.

Prerequisite: Oa-152(C).

Oa-171(C) Operations Analysis for Navy Management 3-0

The nature, origin and contemporary status of operations analysis; fundamental concepts with special emphasis on applications in the fields of transportation, inventory control and personnel management. Introduction to game theory, linear programming and queueing theory.

Texts: McClosky and Trefethen: Operations Research for Management, Vols. I and II; Notes from MIT Summer Course on Operations Research, 1953; Koopmans: Activity Analysis of Production and Allocation; Instructor's Notes.

Prerequisite: Ma-371(C).

Oa-201(A) Logistics Analysis 3-2

Mathematical methods in logistics, with major emphasis on applications of linear programming to problems of transportation and scheduling of interdependent activities. Theory of inventory control. Dynamic programming. Laboratory work on computation of optimal solutions of linear programs.

Texts: Koopmans: Activity Analysis of Production and Allocation; Project RAND Paper P-189, Optimal Inventory Policy; Project RAND Report R-245, An Introduction to the Theory of Dynamic Programming.

Prerequisites: Oa-391(A) and Ma-195(A).

Oa-202(A) Econometrics 3-0

A continuation of Oa-201(A). Inter-industry analysis; mathematical economic theory; review of current theoretical investigations of relationships between military programs and the national economy.

Texts: Koopmans: Activity Analysis of Production and Allocation; Project RAND Report R-245, An Introduction to the Theory of Dynamic Programming; Morgenstern: Economic Activity Analysis; Conolly: Interdiction Considerations in Leontieff—Type Models of Land Logistic Networks, USNPS Thesis.

Prerequisites: Oa-201(A) and Ma-195(A).

Oa-291(C) Introduction to Operations Analysis 4-0

Development of fundamental concepts and methods of operations analysis as illustrated in the field of submarine and anti-submarine warfare. Over-all measures of effectiveness of a submarine as a weapon systems. Determinaton of effectiveness as a product of measure of detection, attack, and kill capabilities.

Texts: Operations Evaluation Group: Report No. 54, Methods of Operations Research; Classified official publications; McCloskey and Trefethen: Operations Research for Management, Vols. I and II; Tucker: Submarine Firing Phase Decisions, USNPS Thesis.

Prerequisite: Ma-391(C) and Ma-182(C). (The latter may be taken concurrently).

Oa-292(B) Methods of Operations Analysis 4-0

Classification of areas and problems of Operations Analysis. Classification of methods of attack. Analysis of measures of effectiveness. Critique of assumptions and results.

Texts: Merrill: Operations Research; Churchman, Ackoff, Arnoff: Introduction to Operations Research; Classified official publications.

Prerequisites: Ma-391(C) and Oa-291(C).

Oa-293(B) Search Theory and Air Defense 4-0

Theory of radar detection. Evaluation of the operational performance of search radars. Search theory. The design of screens and barrier patrols. Evaluation of fleet air defense. Applications of operations analysis to the problem of continental air defense.

Texts: Classified official publications.

Prerequisites: Oa-292(B) and Ma-392(B).

Oa-294(A) Special Topics in Operations Analysis 3-0

General formulation of the decision problem. Special types of decision problems, including game theory. Military applications of game theory. General concept of utility and its measurement. Group decisions. Scales of measurement. The broad scope of Operations Analysis.

Texts: Luce and Raifa: Game Theory and Decisions; Thrall: Decision Processes; Classified official publications.

Prerequisite: Oa-292(B).

Oa-295(A) Analysis of Weapon Systems 3-0

Selection of optimum weapon systems. Special weapons. The effects of system complexity on system reliability.

Texts: Classified official publications.

Prerequisite: Oa-294(A).

Oa-296(A) Design of Weapon Systems 3-0

The areas of application of the various techniques of operations analysis which the student has learned are reviewed and placed in perspective relative to the procedure for evolving new weapons systems. Emphasis is placed upon the role of operations research in formulating operational requirements, developing prototype systems, and determining military specifications for selected systems and the role of operations analysis in various phases of operational testing of the system. The contributions of operations analysis to the coordination of the functions of those segments of the military establishment concerned with weapons systems development are analyzed.

Texts: Classified official publications and instructor's notes.

Prerequisites: Oa-295(A) and Oa-392(A).

Oa-391(A) Games of Strategy 3-2

Rectangular games. Games in normal and extensive forms. Relation between linear programming and games. Methods of solving linear programs and games. Continuous games. Minimax theorem. Applications of games of strategy.

Texts: Dresher: Theory and Applications of Games of Strategy; McKinsey: Introduction to the Theory of Games.

Prerequisite: Ma-391(C) or the equivalent; Ma-195(A). (The latter may be taken concurrently).

Oa-392(A) Decision Theory 3-0

Basic concepts. Relation of statistical decision functions to the theory of games. Applications in the planning of operational evaluation trials.

Texts: Wald: Statistical Decision Functions; Tucker: Introduction to Statistical Decision Functions, USNPS Thesis; Smith; Application of Statistical Methods to Naval Operational Testing, USNPS Thesis.

Prerequisites: Ma-392(B) and Oa-391(A). (The latter may be taken concurrently).

Oa-401(A) Theory of Information Communication 3-0

Markov chains: surprisal of events and uncertainty of distributions; characterization of uncertainty; noise and rate of information transmission; limit distributions connected with sequences from an ergodic Markov chain; Shannan-Fano coding; detection.

Texts: Shannon and Weaver: The Mathematical Theory of Communication; W. Feller: Probability Theory and its Applications; A. Feinstein: Foundations of Information Theory; R. M. Fano: The Transmission of Information; MIT Technical Reports 65 and 149.

Prerequisites: Ma-195(A) and Ma-391(C) or equivalent.

Oa-491(A) Automatic Computers and Systems Analysis 3-2

Programming and coding of stored program digital computers. Automatic computers and their application to computation, control, simulation and monitoring within large-scale-systems.

Texts: Goode and Machol: System Engineering; McCracken: Digital Computer Programming.

Prerequisites: Ma-391(A) or the equivalent and Ma-125(B).

Oa-891(B) Seminar 1-0

Presentation, evaluation and critique of experiences and results of summer field trips.

Text: None.

Prerequisite: Participation in summer field trip.

Oa-892(L) Orientation Seminar 0-1

Audition of Oa-891(B) for guidance in later work.

Text: None.

Prerequisite: None.

Oa-893(A) Seminar 2-2

Opportunity is given to students to prepare original material, or to choose current publications for study, and to present reports of this work as a phase of Operations Analysis.

Text: None.

Prerequisite: A background of advanced work in Operations Analysis.

ORDNANCE

Or Courses

Or-105(C) Underwater Ordnance 1-2

Underwater ordnance used in offensive anti-submarine or anti-surface action. Research and development programs for torpedoes, depth charges, mines and underwater rockets. Laboratory periods are devoted to the presentation of reports by students on pertinent weapons systems.

Text: Classified Official Publications.

Prerequisite: None.

Or-191(C) Mines and Mine Mechanisms 2-0

Present U. S. mines, mine handling, mine storage, explosives, surveillance. Foreign types. Mine firing mechanisms, representative types. Preparation and test.

Text: Classified official publications.

Prerequisite: None.

Or-241(C) Guided Missiles I 2-0

General concepts and theoretical problems involved in guidance, launching, propulsion, warhead design, stabilization, and simulation of guided missiles. Tactical problems and limitations of guidance systems. Organization of guided missile program. Test ranges and instrumentation. Practical application as exemplified by the BAT.

Text: Classified official publications.

Prerequisite: None.

Or-242(B) Guided Missiles II 2-0

Continuation of Or-241(C). Concepts of FM-CW and droppler radar; types of servos; the ballistic trajectory as applied to guided missiles. Application of guided missiles principles and uses as exemplified by V-2, Loon, Terrier, Talos, Zeus, and Regulus. The Kingfisher-Petrel program.

Text: Classified official publications.

Prerequisite: Or-241(C).

Or-291(C) Mine Countermeasures I 3-0

Sweeper characteristics. Sweeping techniques. Countermeasures for specific influence mine types. Practical sweeping of influence mines. Passive countermeasures.

Text: Classified official publications.

Prerequisite: None.

Or-292(C) Mine Countermeasures II 1-2

Continuation of Or-291(C). Theory of various countermeasures techniques. Laboratory periods are devoted to problem working and student presentations of reports on advanced countermeasures theories.

Text: Classified official publications.

Prerequisite: Or-291(C).

Or-293(C) Mine Countermeasures III 2-0

Continuation of Or-292(C). Mine detection and destruction. Statistical minesweeping theory. New developments.

Text: Classified official publications.

Prerequisite: Or-292(C).

Or-294(A) Mine Warfare Seminar 2-0

Investigation and reports by students on assigned mine warfare topics. Occasional presentations and discussions by field representatives of mine warfare activities.

Text: None.

Prerequisite: Or-292(C).

Or-392(B) Minefield Planning 2-0

Theory of tactical and strategic mining. Limitations of current planning doctrine. New approaches to minefield design.

Text: Classified official publications.

Prerequisite: Or-191(C) and a previous course in mine countermeasures.

PHYSICS

Ph Courses

General Physics I	Ph-011(C)
General Physics II	Ph-012(C)
General Physics III	Ph-013(C)
General Physics IV	Ph-014(C)
Dynamics	Ph-113(B)
Analytical Mechanics	Ph-141(B)
Analytical Mechanics	Ph-142(B)
Analytical Mechanics	Ph-144(A)
Hydrodynamics	Ph-161(A)
Survey of Physics I	Ph-190(C)
Survey of Physics II	Ph-191(C)
Review of General Physics	Ph-196(C)
Radiation	Ph-220(B)
Optics and Spectra	Ph-240(C)
Radiation	Ph-241(C)
Electrostatics and Magnetostatics	Ph-311(B)
Applied Electromagnetics	Ph-312(A)
Electricity and Magnetism	Ph-341(C)
Electromagnetism	Ph-361(A)
Electromagnetic Waves	Ph-362(A)
Fundamental Acoustics	Ph-421(B)
Underwater Acoustics	Ph-425(A)
Underwater Acoustics and Sonar Systems	Ph-428(A)
Fundamental Acoustics	Ph-431(B)
Underwater Acoustics and Sonar Systems	Ph-432(A)
Propagation of Waves in Fluids	Ph-433(A)
Shock Waves in Fluids	Ph-441(A)
Shock Waves in Fluids	Ph-442(A)
Underwater Acoustics	Ph-450(B)
Transducer Theory and Design	Ph-461(A)
Acoustics Research	Ph-471(A)
Acoustics Seminar	Ph-480(A)
Thermodynamics	Ph-530(B)
Kinetic Theory and Statistical Mechanics	Ph-541(B)
Survey of Atomic and Nuclear Physics	Ph-610(C)
Atomic Physics	Ph-620(B)
Atomic Physics	Ph-631 B)
Atomic Physics	Ph-640(B)
Atomic Physics Laboratory	Ph-641(B)
Nuclear Physics	Ph-642(B)
Nuclear Physics Laboratory	Ph-643(B)
Advanced Nuclear Physics	Ph-644(A)
Advanced Nuclear Physics Laboratory	Ph-645(A)
Gaseous Discharges and Nuclear Instruments	Ph-650(A)
Reactor Theory	Ph-651(A)
Atomic Physics	Ph-660(B)
Modern Physics Laboratory	Ph-661(B)
Physics of the Solid State	Ph-710(B)
Introductory Quantum Mechanics	Ph-721(A)
Physics of the Solid State	Ph-723(A)
Physics of the Solid State	Ph-730(A)
Theoretical Physics	Ph-731(A)
Physics Seminar	Ph-750(L)

Ph-011(C) General Physics I 4-3

Mechanics—This course is designed to provide a knowledge of the principles of physics and to provide a scientific background for the study of engineering. It consists of lectures, recitations, problem sessions, and laboratory work dealing with force, motion, energy, momentum, elasticity, and hydrodynamics.

Text: Sears and Zemansky: University Physics.

Prerequisite: One term of calculus.

Ph-012(C) General Physics II 4-3

Heat, Sound, and Light—This is a continuation of General Physics I and deals with molecular mechanics, behavior of gases, thermal expansion, calorimetry, the laws of thermodynamics, wave motion, vibrating bodies, reflection and refraction of light, dispersion, interference and diffraction and optical instruments.

Text: Sears and Zemansky: University Physics.

Prerequisite: Ph-011(C).

Ph-013(C) General Physics III 3-3

Electricity and Magnetism—This is a continuation of General Physics I and II and deals with the fundamental principles of electrostatics, electromagnetism, electrochemistry, direct and alternating currents.

Text: Sears and Zemansky: University Physics.

Prerequisites: Ph-011(C) and Ph-012(C).

Ph-014(C) General Physics IV 4-1

Nucleonics—The objective of this course is to provide an understanding of nuclear physics with emphasis on military applications and unclassified developments. Topics include: structure of matter; atomic and nuclear structure; nuclear transformation; high energy particles; fission of uranium; isotope separation; reactor principles; fusion; fission and fusion weapon principles; applications of radioactive isotopies; and instrumentation. Pertinent laboratory demonstrations and exercises are included.

Texts: Heisenberg: Nuclear Physics; S.W.T.G. Sandia Base: Principles of Nuclear Physics; Hoisington: Nucleonics Fundamentals.

Prerequisites: Ph-011(C), Ph-012(C), Ph-013(C) and College Algebra and Trigonometry.

Ph-113(B) Dynamics 4-0

Fundamental dynamical concepts, oscillator theory, motion of a particle in two and three dimensions, motion in central fields with emphasis on atomic structure, motion of a system of particles, center of mass coordinates, wave motion, Lagrange's and Hamilton's methods.

Text: Symon: Mechanics.

Prerequisite: None.

Ph-141(B) Analytical Mechanics 4-0

Fundamental dynamical concepts, oscillator theory, curvilinear motion in a plane, energy concepts, statics and dynamics of a rigid body. Both analytical and vector methods are used.

Text: Symon: Mechanics.

Prerequisite: Ma-182(C). (May be taken concurrently.)

Ph-142(B) Analytical Mechanics 4-0

Wave motion, fluid mechanics, constrained motion, Hamilton's principle, Lagrange's equations.

Text: Symon: Mechanics.

Prerequisites: Ma-183(B) (may be taken concurrently) and Ph-141(B).

Ph-144(A) Analytical Mechanics 4-0

The linear oscillator, central force motion, Lagrange's and Hamilton's equations. Kinematics of rigid bodies. Canonical transformations. Coupled systems and normal coordinates.

Text: Goldstein: Classical Mechanics; lecture notes.

Prerequisite: Ph-142(B) or equivalent.

Ph-161(A) Hydrodynamics 3-0

Equilibrium conditions for liquids; liquids under gravity and Coriolis forces; Eulerian and Lagrangean motion; Bernoulli equation; two-dimensional flow, Schwarz-Christoffel transformations; three-dimensional flow; vorticity, viscous flow; analogue to magnetic-statics; hydrofoils; surface waves.

Texts: Streeter: Fluid Dynamics; Lecture Notes.

Prerequisites: Ae-100(C); Ae-121(C); Ma-114(A).

Ph-190(C) Survey of Physics I 3-0

Elementary concepts and laws of statics and dynamics. Introduction to the statics and dynamics of fluids. Temperature, heat, radiation, kinetic theory and the gas laws. Fundamentals of vector representation and notation.

Text: Sears and Zemansky: College Physics.

Prerequisite: None.

Ph-191(C) Survey of Physics II 3-0

A continuation of Ph-190(C). A survey of wave propagation, sound, electricity and magnetism, atomic structure, the properties of light, and other electromagnetic wave phenomena.

Text: Sears and Zemansky: College Physics.

Prerequisite: Ph-190(C) or equivalent.

Ph-196(C) Review of General Physics 5-0

A review of statics and dynamics. A survey of temperature, heat, kinetic theory, electricity and magnetism, wave motion and sound, and selected topics in light as time permits.

Text: Sears and Zemansky: University Physics.

Prerequisite: Ph-191(C) or equivalent.

Ph-220(B) Radiation 3-3

Reflection and refraction of light, optical instruments. Fundamentals of wave phenomena, interference, diffraction, dispersing polarization. Propagation of electromagnetic waves, the radar equation. Thermal radiation, the photoelectric effect, the Bohr atom, visibility and photometry.

Texts: Sears: Optics; Jenkins & White: Fundamentals of Optics.

Prerequisite: None.

Ph-240(C) Optics and Spectra 3-3

Reflection and refraction of light, optical systems, dispersion, interference, diffraction, polarization.

Basic atomic structure, photoelectric effect, radiation from atoms, molecules and solids.

Texts: Sears: Optics; Jenkins and White Fundamentals of Optics.

Prerequisite: None.

Ph-241(C) Radiation 3-3

Fundamentals of geometric and physical optics. Wave phenomena and wave propagation. Origin of the quantum theory, photoelectric effect, radiation from atoms, molecules and solids.

Texts: Sears: Optics; Jenkins and White: Fundamentals of Optics.

Prerequisite: None.

Ph-311(B) Electrostatics and Magnetostatics 3-0

Coulomb's law, Gauss' law, dipoles, dielectric theory, polarization, solutions of Laplace's equation, electrical images, magnetic dipoles and shells, Ampere's law, magnetic field of current, magnetic theory. Both analytical and vector methods are used.

Texts: Slater and Frank: Electromagnetism; Whitmer: Electromagnetics.

Prerequisites: Ma-156(B); Es-112(C).

Ph-312(A) Applied Electromagnetics 3-0

A continuation of Ph-311 with particular emphasis on magnetic fields of significance to mine warfare. Propagation of induction and radiation fields of electromagnetic waves.

Texts: Slater and Frank Electromagnetism; Whitmer: Electromagnetics.

Prerequisite: Ph-311(A).

Ph-341(C) Electricity and Magnetism 4-2

DC and AC circuits, elementary electrostatics, vacuum tubes, coupled circuits, filters, lines, vacuum tube circuits. The treatment emphasizes the physical aspects of these phenomena.

Texts: Winch: Electricity and Magnetism; lecture notes.

Prerequisite: Ma-182(C). (May be taken concurrently.)

Ph-361(A) Electromagnetism 3-0

Electromagnetic field theory; electrostatics, dielectrics, magnetic fields of currents; vector potential; magnetic materials; magnetomotive force; electromagnetic induction; Maxwell's equations.

Text: Slater and Frank: Electromagnetism.

Prerequisites: Ma-183(C) and EE-272(B), or equivalent.

Ph-362(A) Electromagnetic Waves 3-0

A continuation of Ph-361(A). Propagation, reflection and refraction of electromagnetic waves; wave guides; cavity resonators; electromagnetic radiation.

Text: Slater and Frank: Electromagnetism.

Prerequisite: Ph-361(A).

Ph-421(B) Fundamental Acoustics 3-0

An analytical study of the dynamics of free, forced, and damped simple harmonic oscillators, strings, bars, and membranes. Development of, and solutions to, the acoustic wave equation. Propagation of plane waves through pipes and between different media. Propagation of spherical waves including acoustic output and beam patterns from a circular piston. Absorption of sound in fluids. Electro-acoustic transducers.

Text: Kinsler and Frey: Fundamentals of Acoustics.

Prerequisite: Ma-113(B) or equivalent.

Ph-425(A) Underwater Acoustics 3-2

A continuation of Ph-421(B). An analytic treatment of the propagation of underwater acoustic waves as influenced by boundary conditions, refraction, reverberation, and attenuation. Physical characteristics of sonar transducers. Psychoacoustics, shock waves, sonar systems and developments, experimental measurements in underwater acoustics. Laboratory includes experiments in underwater acoustic measurements, sonar beam pattern, and operational characteristics of sonar equipment.

Texts: Kinsler, Frey: Fundamentals of Acoustics; NDRC Technical Summary: Principles of Underwater Sound; NDRC Technical Summary: Physics of Sound in the Sea.

Prerequisite: Ph-421(B) or 431(B).

Ph-428(A) Underwater Acoustics and Sonar Systems 3-3

A continuation of Ph-421(B). Microphone and sonar transducer theory and design. Transmission of sound in sea water, including problems of refraction, attenuation, reverberation, and channel propagation. Physical principles, detection systems used in design and operation of current sonar equipment. New developments in sonar. Experiments in acoustical measurements, transducer measurements, sound beam and sonar equipment measurements, and noise analysis.

Texts: Kinsler and Frey: Fundamentals of Acoustics; NDRC Technical Summary: Principles of Underwater Sound.

Prerequisite: Ph-421(B).

Ph-431(B) Fundamental Acoustics 4-0

An analytical study of the dynamics of free, forced, and damped simple harmonic oscillators, strings, bars and membranes. Development of, and solutions to, the acoustic wave equation. Propagation of plane waves through pipes and between different media. Acoustic filters. Beam patterns and directivity of acoustic radiation from a piston. Radiation reaction. Loudspeaker. Classical and molecular absorption of sound in free space and in tubes.

Text: Kinsler and Frey: Fundamentals of Acoustics.

Prerequisite: Ma-113(B) or equivalent.

Ph-432(A) Underwater Acoustics and Sonar Systems 4-3

A continuation of Ph-431(B). Microphone and sonar transducer theory and design. Transmission of sound in sea water, including problems of refraction, attenuation, reverberation, and channel propagation. Physical principles, electronic circuits, detection systems used in design and operation of current sonar equipment. New developments in sonar. Experiments in acoustical measurements, transducer measurements, sound beam and sonar equipment measurements, and noise analysis.

Texts: Kinsler and Frey: Fundamentals of Acoustics: NDRC Technical Summary: Principles of Underwater Sound.

Prerequisite: Ph-431(B).

Ph-433(A) Propagation of Waves in Fluids 2-0

A theoretical treatment of the propagation of acoustic waves in fluids including both ray and wave propagation characteristics as well as second order effects.

Text: Instructor's notes.

Prerequisite: Ph-421(B) or Ph-431(B).

Ph-441(A) Shock Waves in Fluids 4-0

Simple Oscillator. Hydrodynamics. Longitudinal wave equation. Propagation of acoustic waves in fluids. Propagation of explosive shock waves in fluids. Shock waves propagated from atomic explosions.

Texts: Kinsler, Frey: Fundamentals of Acoustics; Cole: Underwater Explosions; AFSWP-Hirschfeller: The Effects of Atomic Weapons.

Prerequisites: Ma-183(B) and Ph-142(B).

Ph-442(A) Shock Waves in Fluids 3-0

Finite amplitude waves. Theory of propagation of explosive shock waves in fluids, Rankine-Hugoniot equation of shock front, scaling laws, experimental measurements of shock waves in water. Shock waves propagated from atomic explosions.

Text: Cole: Underwater Explosions.

Prerequisite: Ph-421(B) or Ph-431(B).

Ph-450(B) Underwater Acoustics 3-2

An analytic treatment of the fundamentals of acoustics, with particular emphasis on sound radiation and transmission problems encountered in underwater acoustics.

Texts: Kinsler, Frey: Fundamentals of Acoustics; NDRC Technical Summary: Principles of Underwater Sound; NDRC Technical Summary; Physics of Sound in the Sea.

Prerequisite: Ma-102(C).

Ph-461(A) Transducer Theory and Design 3-3

A theoretical treatment of the fundamental phenomena inherent to the design of crystal, magnetostrictive, and ceramic sonar transducers. Characteristics and parameters of various sonar transducer systems are studied in the laboratory.

Texts: Hueter, Bolt: Sonics; NDRC Technical Summary: Crystal Transducers; instructor's notes.

Ph-471(A) Acoustics Research 0-3

Advanced laboratory work in acoustics.

Text: None.

Prerequisite: Ph-432(A) or equivalent.

Ph-480(A) Acoustics Seminar 2-0

Survey of current classified and unclassified acoustic literature in preparation for the student's thesis.

Text: None.

Prerequisite: None.

Ph-530(B) Thermodynamics 3-0

Fundamental theory of thermodynamics and application to physical problems. First and second laws of thermodynamics, entropy, free energy, the phase rule. Gaseous reactions, thermodynamics of dilute solutions, specific heats of gases, the Nernst heat theorem.

Text: Sears: Thermodynamics.

Prerequisites: Ph-113(B) or Ph-142(B), and Ma-156(B) or Ma-183(B).

Ph-541(B) Kinetic Theory and Statistical Mechanics 4-0

Maxwell-Boltzman distribution, collision cross-sections, introduction to classical and quantum statistics, with application to radiant energy.

Texts: Kennard: Kinetic Theory; Sears: Thermodynamics.

Prerequisites: Ma-183(B) and Ph-142(B).

Ph-610(B) Survey of Atomic and Nuclear Physics 3-0

An introductory course in atomic and nuclear physics. Elementary charged particles, photoelectricity, x-rays, radioactivity, atomic structure, nuclear reactions, nuclear fission.

Text: Semat: Atomic Physics.

Prerequisite: None.

Ph-620(B) Atomic Physics 3-0

The atom and kinetic theory, electrons as particles and waves, elementary quantum mechanics, atomic structure and spectra, molecular structure, introduction to fundamental nuclear particles and structure of nuclei, behavior of atoms in solids.

Text: Sproull: Modern Physics.

Prerequisites: Ph-240(C), Ph-113(B).

Ph-631(B) Atomic Physics 4-0

Dynamics of elementary charged particles, Rutherford's model of the atom and the scattering of alpha particles, special theory of relativity, Bohr model of the atom, Schroedinger wave equation, dipole radiation, optical spectra, Zeeman effect, magnetic moments, Pauli's principle, x-rays, photoelectric effect, natural radioactivity, the nucleus, artifical radioactivity.

Text: Richtmeyer and Kennard: Introduction to Modern Physics.

Prerequisite: Ph-361(A) or equivalent.

Ph-640(B) Atomic Physics 3-0

Elementary charged particles, photoelectricity, Bohr model of the hydrogen atom, optical and x-ray spectra, Zeeman effect, Compton effect, electron diffraction, special theory of relativity, Schroedinger's wave equation.

Texts: Finkelnburg: Atomic Physics; Semat: Atomic Physics.

Prerequisites: Ph-142(B) and Ph-240(C).

Ph-641(B) Atomic Physics Laboratory 0-3

An experimental study of the phenomena, observational methods, and instruments used in atomic physics.

Text: Laboratory notes.

Prerequisite: Ph-640(B). (To be taken concurrently.)

Ph-642(B) Nuclear Physics 4-0

Nuclear structure, radioactivity, nuclear reactions and nuclear fission.

Texts: Halliday: Introductory Nuclear Physics; Kaplan: Nuclear Physics.

Prerequisite: Ph-640(B).

Ph-643(B) Nuclear Physics Laboratory 0-3

An experimental study of the phenomena, observational methods, and instruments used in nuclear physics.

Text: Bleuler, Goldsmith: Experimental Nucleonics.

Prerequisite: Ph-642(B).

Ph-644(A) Advanced Nuclear Physics 4-0

A continuation of Ph-642(B). Nuclear forces; general theory of nuclear reactions. Application of theory to experiments.

Texts: Blatt and Weisskopf: Theoretical Nuclear Physics; lecture notes.

Prerequisites: Ph-642(B) or equivalent, Ph-721(A).

Ph-645(A) Advanced Nuclear Physics Laboratory 0-3

Nuclear bombardment experiments; research techniques in nuclear physics.

Texts: Bleuler, Goldsmith: Experimental Nucleonics; laboratory notes.

Prerequisite: Ph-644(A). (To be taken concurrently.)

Ph-650(A) Gaseous Discharges and Nuclear Instruments 4-0

Basic phenomena in gaseous discharges and infrared spectroscopy; theory of particle accelerators, spectrometers and detectors for nuclear reactions.

Texts: Von Engel: Ionized Gases; Richtmeyer and Kennard: Introduction to Modern Physics; Halliday: Introductory Nuclear Physics; Lecture Notes.

Prerequisite: Ph-642(B).

Ph-651(A) Reactor Theory 3-0

Nuclear fission, the diffusion and slowing down of neutrons, homogenous thermal reactors.

Text: Glasstone and Edlund: The Elements of Nuclear Reactor Theory.

Prerequisite: Ph-640(B) or Ph-660(B).

Ph-660(B) Atomic Physics 4-0

Diffraction phenomena, charged particles, Rutherford's model of the atom and scattering of alpha particles, special theory of relativity, photoelectricity, Compton effect, Bohr model of the atom, optical spectra, Zeeman effects, x-rays, Moseley's Law.

Text: Semat: Atomic Physics.

Prerequisite: Ph-113(B) or equivalent.

Ph-661(B) Modern Physics Laboratory 0-3

Laboratory exercises involving phenomena studied in Ph-660(B).

Text: Laboratory Notes.

Prerequisite: Ph-660(B). (To be taken concurrently).

Ph-710(B) Physics of the Solid State 4-0

Crystal, classes, quantum theory of crystal lattices, electron theory of solids, conductivity, semiconductor phenomena, magnetic properties of solids, superconductivity, strength and mechanical properties of solids on the basis of dislocation theory.

Text: None.

Prerequisite: Ph-610(B).

Ph-721(A) Introductory Quantum Mechanics 4-0

This course is designed to familiarize the student with the postulates and methods of Schroedinger's quantum mechanics, with application to such problems as the free particle, particle in a potential well, potential barriers, natural radioactivity, harmonic oscillator, free rotator, hydrogen atom and the one-dimensional potential lattice for the solid state.

Text: Rojansky: Introductory Quantum Mechanics.

Prerequisite: Ph-640(B) or equivalent.

Ph-723(A) Physics of the Solid State 4-0

Crystal classes, interference phenomena. Quantum theory of crystal lattices, binding energies. Statistics of electrons in solids, band theory of solids, Brillouin zones, Hume-Rothery rule, electron negative mass and the "hole" concept. Conductivity, insulators and semiconductors, electron trapping, fluorescence, junction rectification, transistor action. Superconductivity, properties to liquid helium II. Magnetic properties of solids. Dislocations, strength and plastic flow.

Texts: Kittel: Introduction to Solid State Physics; Seitz: Modern Theory of Solids; Read: Dislocations in Crystals.

Prerequisite: Ph-631(B) or Ph-640(B).

Ph-730(A) Physics of the Solid State 3-3

Statistics of of electrons in solids, band theory of solids, Brillouin zones, thermionic, photoelectric, and field emission, "hole" concept, conductivity, insulators and semi-conductors, photoconductivity, fluorescence, phosphorescence, junction rectification, transistor action. Magnetic and electric properties of solids, superconductivity.

Text: Kittel: Introduction to Solid State Physics.

Prerequisite: Ph-721(A).

Ph-731(A) Theoretical Physics 3-0

Topics in theoretical physics selected to meet the needs of the student.

Text: None.

Prerequisite: Consent of instructor.

Ph-750(L) Physics Seminar 0-1

Discussion of special topics of current interest in the field of physics and student thesis reports.

Text: None.

Prerequisite: Consent of instructor.

SECTION III

GENERAL LINE AND NAVAL SCIENCE SCHOOL

Director

Albert Peyton COFFIN, Captain, U. S. Navy
B.S., USNA, 1934
Air War College, Maxwell AFB, Alabama, 1954

Prospective Director

Robert Park BEEBE, Captain, U. S. Navy
B.S., USNA, 1931
Naval War College, 1958

Assistant Director

Jefferson David PARKER, Captain, U. S. Navy
B.S., USNA, 1935
Armed Forces Staff College, 1952; Naval War College, 1956

Academic Chairman

Frank Emilio LA CAUZA (1929)*
B.S., Harvard Univ., 1923
M.S., 1924; A.M., 1929
Captain, USNR

Assistant to Director for Women

Elizabeth Spencer HARRISON, Lieutenant Commander, U. S. Navy
A.B., Western Maryland College, 1937
M.Ed., 1947

Administrative Officer

Richard Michael PALKOVIC, Lieutenant Commander, U. S. Navy

Scheduling Officer

Wayne LeRoy JENSEN, Lieutenant, U. S. Navy
B.S., USNA, 1950

NAVAL STAFF AND CIVILIAN FACULTY

DEPARTMENT OF NAVAL WARFARE

Oliver Walton BAGBY
Captain, U. S. Navy
Head of Department
B.S., USNA, 1938; Naval War College, 1950

Joseph Edward HART
Captain, U. S. Navy
Prospective Head of Department
Naval War College, 1953

LeRoy Philip HUNT, Jr.
Lieutenant Colonel, U. S. Marine Corps
Marine Corps Representative and Instructor in Amphibious Operations
A.B., Colgate Univ., 1939; Marine Corps Schools, 1955

Charles Koll HOLZER
Commander, U. S. Navy
Instructor in Advanced Tactics
B.S., California Maritime Academy, 1939

*The year of joining the Postgraduate School faculty is indicated in parenthesis.

George Hale GOLDSMITH
Commander, U. S. Navy
Prospective Instructor in Naval Aviation
A.B., Univ., of Alabama
Air Command and Staff School

Bernard Norman GOCKEL
Commander, U. S. Navy
Instructor in Naval Aviation and Tactics
B.S., Univ., of Tennessee, 1940

Lee George MILLS
Commander, U. S. Navy
Instructor in Naval Ordnance and Fire Control

Joseph Brennan DRACHNIK
Commander, U. S. Navy
Instructor in Operational Planning
B.S., USNA, 1943

Charles Eugene STASTNY
Commander, U. S. Navy
Instructor in ASW
B.S., USNA, 1943

Curtis D. McGAHA
Commander, U. S. Navy
Instructor in Tactics and CIC

Robert Joseph NELSON
Commander, U. S. Navy
Instructor in Restricted Weapons

Frederick Ernest FRANCIS
Commander, U. S. Navy
Instructor in Operational Planning
A.B., Whittier College, 1939; USNPS, Applied Communications, 1950; Armed Forces Staff College, 1954

Edward Gooding GRANT
Commander, U. S. Navy
Instructor in Amphibious Operations
A.B., San Jose State College, 1940

Donald Marchand MILLER
Commander, U. S. Navy
Prospective Instructor in ASW
B.S., USNA, 1944; Naval War College

John T. LYONS
Lieutenant Commander, U. S. Navy
Instructor in Communications
USNPS, Command Communications, 1953

Marvin Jay COOPER
Lieutenant Commander, U. S. Navy
Prospective Instructor in Restricted Weapons

Rue Wayne WHITE
Lieutenant Commander, U. S. Navy
Instructor in Restricted Weapons

Robert Carl MAY
Lieutenant Commander, U. S. Navy
Instructor in Tactics and CIC
B.S., Brown Univ., 1945

Mitchell Joseph KARLOWICZ
Lieutenant Commander, U. S. Navy
Instructor in ASW
B.S., USNA, 1946

John Douglass CALLAWAY, Jr.
Lieutenant Commander, U. S. Navy
Instructor in Mine Warfare and Harbor Defense
B.S., USNA, 1946

George Edward YOUNG, Jr.
Lieutenant, U. S. Navy
Instructor in Communications
B.N.S., Holy Cross College, 1946

James Creighton WILSON
Lieutenant, U. S. Navy
Instructor in ASW
B.S., USNA, 1949

Frederick Charles JOHNSON
Lieutenant, U. S. Navy
Instructor in Naval Ordnance and Fire Control
B.S., USNA, 1952

Norbert Walter O'NEILL
Lieutenant, U. S. Navy
Instructor in Guided Missiles

Samuel Saul PEARLMAN
Lieutenant, U. S. Navy
Instructor in Tactics and CIC
A.B., Rutgers Univ., 1953

DEPARTMENT OF SEAMANSHIP AND ADMINISTRATION

Delbert Massey MINNER
Captain, U. S. Navy
Head of Department
A.B., Univ. of Delaware, 1935; A.M., George Washington Univ., 1950; Armed Forces Staff College, 1947

Harold Naylor HEISEL
Commander, U. S. Navy
Instructor in Management and Administration
A.B., Texas Western, 1936

Hartsel Dale ALLEN
Commander, U. S. Navy
Instructor in Navigation
B.S., Univ. of West Virginia, 1939

Verne Elmer GEISSINGER
Commander, U. S. Navy
Instructor in Management and Administration
A.B., Univ. of Nebraska, 1940

Richard Scott GARVEY
Commander, U. S. Navy
Prospective Instructor in Management and Administration

Richard RODRIGUEZ
Commander, U. S. Navy
Instructor in Navigation

Thomas Carey FARRELL
Commander, Supply Corps, U. S. Navy
Instructor in Logistics and Naval Supply
A.B., Tufts College, 1939

Alton Printess ADAMS
Commander, U. S. Navy
Instructor in Management and Administration

Thomas Howard HARDY
Commander, U. S. Navy
Instructor in Personal Affairs

William Louis BALESTRI
Commander, U. S. Navy
Instructor in Aerology
B.S., USNPS, 1954

Joseph Ogden COLLINS
Lieutenant Commander, U. S. Navy
Instructor in Naval Justice

Daniel Donald McLEOD
Lieutenant Commander, U. S. Navy
Instructor in Naval Justice
LL.B., Univ. of Arkansas, 1936

Robert James AGNESS
Lieutenant Commander, U. S. Navy
Instructor in Seamanship

Frank C. DANIEL
Lieutenant Commander, U. S. Navy
Instructor in Seamanship

Gerald Chatham EDWARDS
Lieutenant, U. S. Navy
Instructor in Naval Intelligence
A.B., Univ. of Southern California, 1948

DEPARTMENT OF APPLIED ENGINEERING

John Vernon WILSON
Commander, U. S. Navy
Prospective Head of Department
B.S., USN, 1939; USNPS, Ordnance Engineering

Kenneth Frederick SHIFFER
Commander, U. S. Navy
Senior Marine Engineering Instructor, and Acting Head of Department
B.S., M.S., USNPS, 1954

Laurence Griffith BROOKS
Lieutenant Commander, U. S. Navy
Instructor in Marine Engineering

William Edwin WALKUP
Lieutenant Commander, U. S. Navy
Instructor in Damage Control

Donald Walter WILKINSON
Lieutenant Commander, U. S. Navy
Instructor in Materials of Engineering
B.S., Univ. of Michigan; M.S., Massachusetts Institute of Technology

Charles Hamlin BLACK
Lieutenant, U. S. Navy
Instructor in Marine Nuclear Propulsion

Craig COMSTOCK
Lieutenant, Junior Grade, U. S. Navy
Instructor in Mathematics

Kenneth Ted WALLENIUS
Lieutenant Junior Grade, U. S. Navy
Instructor in Mathematics
M.A., Univ. of Southern California, 1955

DEPARTMENT OF HUMANITIES

Robert Edward PAIGE
Commander, U. S. Navy
Head of Department
B.S., USNA, 1939

Frank Wilson AVILA
Commander, U. S. Naval Reserve
Instructor in International Relations
B.S., UCLA, 1939

Fordyce Raymond DOWNS, Jr.
Commander, U. S. Navy
Instructor in International Law
LL.B, Boston Univ., 1943

Emmett F. O'NEILL
Commander, U. S. Naval Reserve
Instructor in International Relations and National Security

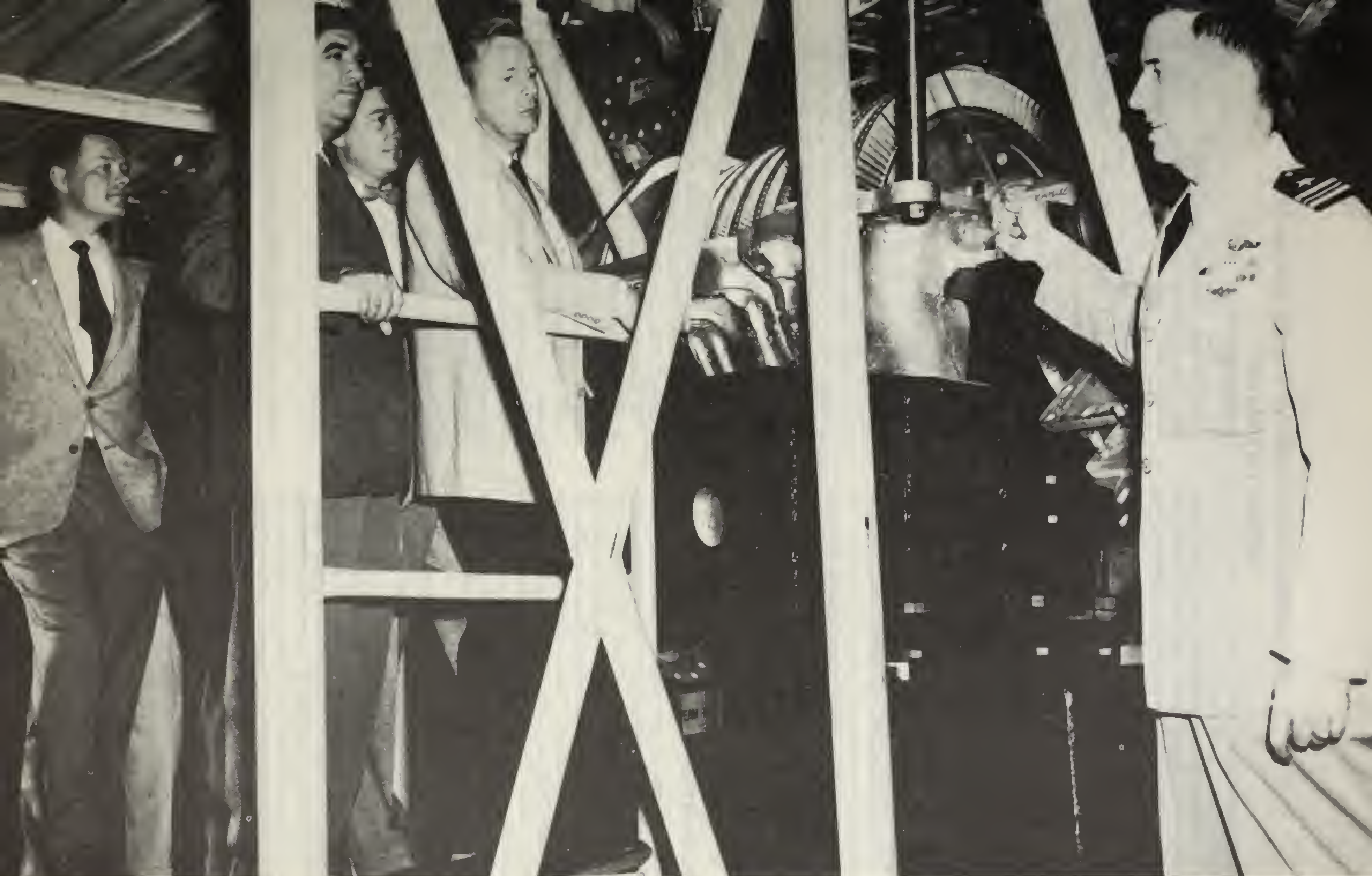
Loftur L. BJARNASON
Professor of English Literature (1958)
A.B., Univ. of Utah, 1934; M.A., 1936;
A.M., Harvard Univ., 1939;
Ph.D. Stanford Univ., 1951

Burton MacLynn SMITH
Associate Professor of Speech and
Lecturer in Leadership Psychology (1955)
A.B., Univ. of Wisconsin, 1936; A.M., 1937

William C. BOGGESS
Associate Professor of Speech (1956)
B.S., Univ. of Southern California, 1953;
M.S., 1945
Captain, USAFR

Boyd Francis HUFF
Associate Professor of History (1958)
A.B., Univ. of Washington, 1938; A.M., Brown Univ., 1940; Ph.D. Univ. of California, 1945

General Line and Naval Science School. Practical work in celestial navigation



General Line and Naval Science School. Instructor demonstrates turbine components.

THE GENERAL LINE AND NAVAL SCIENCE SCHOOL

GENERAL INFORMATION

MISSION

The mission of the General Line and Naval Science School is to raise the educational level, broaden the mental outlook, and increase the professional and scientific knowledge of line officers in order that they may better perform the duties and meet the responsibilities of higher rank.

TASKS

The tasks for the General Line and Naval Science School are:

To provide instruction of about two-and-one-half years' duration leading to a Bachelor of Science Degree, no major designated, to meet the educational and career requirements of "transferee" and "integrated" officers who do not have a baccalaureate degree.

To provide instruction of about nine-and-one-half months duration which will prepare line officers with about 5 to 7 years commissioned service for more responsible duties in the operating forces.

To provide special programs of instruction as may be directed for women officers, legal officers, public information officers, and foreign naval officers.

ORGANIZATION

The Director of the General Line and Naval Science School is responsible to the Superintendent, U. S. Naval Postgraduate School for all phases of administration of the General Line and Naval Science School. The Director's staff includes his administrative assistants, the Assistant Director, the Academic Chairman of the General Line and Naval Science School, the four heads of academic departments, the civilian faculty, and officer instructors.

The four academic departments, each of which is headed by an appropriately qualified officer, are:

Department of Naval Warfare

Department of Seamanship and Administration

Department of Applied Engineering

Department of Humanities

The Academic Chairman of the General Line and Naval Science School provides academic supervision of instruction given in all departments of the school.

Officer students enrolled in the General Line and Naval Science School are divided into sections for administrative purposes. The senior officer of each section is designated section leader with certain administrative responsibilities for the officers in his section. Each section has a member of the school staff assigned as its section advisor. The section advisor serves in the capacity of student counselor and provide a convenient link between the students and the school administration.

CALENDAR

The General Line and Naval Science School utilizes the Postgraduate School calendar which is based on five terms of ten weeks each and a two week Christmas leave period in a calendar year. The tenth week of each term is used as necessary for examinations and administrative transition to the next term.

BACHELOR OF SCIENCE CURRICULUM

The Bachelor of Science Curriculum includes the Naval-Professional courses of the General Line Curriculum (described below) and, in addition, sufficient coverage in the Social-Humanistic and Scientific-Engineering areas to adequately support a Bachelor of Science degree.

To be eligible for enrollment an officer must have acceptable advance standing of 75 term credit hours (equivalent to 45 semester hours) which can be applied toward completion of the prescribed course of study. Up to 2½ calendar years is allowed for those enrolled to complete the program. One term (approximately in the middle) is used for leave, field trips, and temporary duty in combatant ships, leaving 11 terms available for academic work.

Students pursuing this curriculum will carry an average load of 17 credit hours. The total of class hours and laboratory hours should average about 20 hours per week. Scheduling procedures are similar to those for the General Line Curriculum.

The Bachelor of Science Degree will be awarded by the Superintendent, U. S. Naval Postgraduate School to those officer students who successfully complete the curriculum with a minimum average quality point rating of 1.0 (see below for grading system). A minimum of at least 210 term credit hours (equivalent to 126 semester hours), representing college level course credit earned at the General Line and Naval Science School or through accepted advance standing, is required. A minimum of 4 terms in residence at the General Line and Naval Science School is also required.

All officers who have applied for the Five-Term College Program are considered. Careful consideration is given to previous academic records, service experience, and apparent promotion potential in order that the best qualified officers may be enrolled.

NINE-AND-ONE-HALF MONTH GENERAL

The Nine-and-one-half Month General Line Curriculum extends over four terms and may be taken separately or as a component of the Bachelor of Science curriculum. Prescribed courses totaling 774 classrooms and laboratory hours, chiefly in the Naval-Professional area, comprise the curriculum. An officer student enrolled in this program must take each of these courses or establish his qualifications for exemptions. All courses offered by the General Line and Naval Science School are available as electives if the student has the prerequisites and scheduling permits.

Exemptions for each officer student are determined on the basis of information obtained from a "Pre-Registration Questionnaire", prior college record, and personal interview by staff members. In some cases examinations are given to determine qualifications in specific areas. Students pursuing this curriculum are expected to carry an average load of 21 class and laboratory hours, some of which may be electives.

SPECIAL PROGRAMS

The courses offered by the General Line and Naval Science School are also utilized in special programs individually designed to meet the needs of women officers, legal officers, public information officers, and foreign naval officers who are ordered to the school for instruction. In most cases special programs extend over four terms, except that women officers are usually limited to two terms.

GRADING SYSTEM

The quality of a student officer's work is reported by grades assigned in accordance with the following schedule:

Performance	Letter Grade	Quality Point Number
Outstanding	A	3.0
Excellent	B	2.0
Satisfactory	C	1.0
Barely Passing	D	0.0
Failure	X	—1.0

When the value of a course in term credit hours is multiplied by the quality point number corresponding to the grade assigned, the total quality points for that course are obtained. When this is totaled for all courses taken and divided by the total credit hours, a numerical evaluation of the various grades is obtained which is called the quality point rating (or QPR). A QPR of 2.0 would indicate a B average for all the courses taken.

EXEMPTIONS FROM PROMOTION EXAMINATIONS

Satisfactory completion (grade "C" or higher) of certain courses offered by the General Line and Naval Science School (General Line Curriculum) is the basis for promotion examination exemptions, subject to the provision of BuPers Instruction 1416.1C. In scheduling officer students, the meeting of promotion examination requirements is **not**, however, a governing consideration. Primary emphasis is placed on officers pursuing courses which are most essential to their professional growth. BuPers Instruction 1416.1C or its successor may be consulted for detailed information on exemptions from promotion examinations.

TABULATION OF COURSE OFFERINGS AND COURSE DESCRIPTIONS

The remainder of this section provides a tabulation of the courses offered by the four academic departments of the General Line and Naval Science School and describes each course. Many of the courses included in the Bachelor of Science Curriculum will not be offered until such time as they are required for the initial enrollment in that program, and therefore may not actually be given during the academic year 1958-59.

TABULATION OF COURSE OFFERINGS BY DEPARTMENTS

DEPARTMENT OF NAVAL WARFARE

	Hours Class	Per Week	Week Credit
Tactics and Combat Information Center	4	2	5
Communications	5	0	5
Communications I (W)	2	0	2
Communications II (W)	2	0	2
Naval Aviation	3	0	3
Operational Planning	3	0	3
Amphibious Operations	3	0	3
Anti-Submarine Warfare	4	0	4
Advanced Tactics	3	0	3
Naval Ordnance and Fire Control	4	0	4
Mine Warfare	3	0	3
Restricted Weapons	3	0	3
Missiles and Space Operations	6	0	6
Harbor Defense	2	0	2

DEPARTMENT OF SEAMANSHIP AND ADMINISTRATION

Seamanship	3	0	3
Navigation I	2	2	3
Navigation II	2	2	3
Aerology	3	0	3
Management and Administration	4	2	5
Naval Justice I	3	0	3
Naval Justice II	3	0	3
Logistics and Naval Supply	2	0	2
Naval Intelligence	3	0	3
Personal Affairs	3	0	3

TABULATION OF COURSE OFFERINGS BY DEPARTMENTS

DEPARTMENT OF APPLIED ENGINEERING

	Hours Class	Per Lab	Week Credit
*College Algebra and Trigonometry	5	0	5
*Analytic Geometry and Calculus I	5	0	5
*Analytic Geometry and Calculus II	5	0	5
*Analytic Geometry and Calculus III	5	0	5
*Engineering Mechanics I	4	0	4
*Engineering Mechanics II	4	0	4
*General Chemistry I	4	3	5½
*General Chemistry II	3	3	4½
*General Chemistry III	3	3	4½
*Engineering Physics I	4	3	5½
*Engineering Physics II	4	3	5½
*Engineering Physics III	3	3	4½
*Nucleonics	4	1	4½
*Electrical Circuits and Machinery I	5	3	6½
*Electrical Circuits and Machinery II	5	3	6½
*Electronics I	4	2	5
*Electronics II	4	2	5
*Basic Mathematics	3	0	3
*Mathematics Refresher	3	0	3
*Nucleonics Fundamentals	3	0	3
*Electrical Fundamentals	4	0	4
*Electronics Fundamentals	4	0	4
*Calculus	4	0	4
*Electrical Machinery	4	1	4½
*Engineering Drawing	2	3	3½
*Basic Mechanisms	3	2	4
*Thermodynamics	4	3	5½
*Mechanics of Materials	4	0	4
*Mechanics of Fluids	4	0	4
*Materials of Engineering	4	3	5½
*Materials of Engineering	4	0	4
Marine Engineering	5	0	5
Marine Nuclear Propulsion	2	0	2
Damage Control and Atomic, Biological Chemical Warfare Defense	5	0	5
Aircraft Propulsion	3	0	3
Aircraft Performance Evaluation	3	0	3

* Denotes course to be taught by Engineering School instructors for General Line and Naval Science School.

DEPARTMENT OF HUMANITIES

	Hours Class	Per Lab	Week Credit
English and Composition I	3	0	3
English and Composition II	3	0	3
Literature I	3	0	3
Literature II	3	0	3
European History	4	0	4
American History	4	0	4
Naval History	3	0	3
Psychology	3	0	3
Economics	3	0	3
Group Precedures and Written Communications	3	0	3
Speech	3	0	3
Art of Presentation	See Course Description		
International Relations and National Security	3	0	3
International Law	5	0	5

OTC Tactics and Combat Information Center 4-2

Included in Bachelor of Science and General Line Curricula.

The objective of this course is to acquaint the officer-student with the fundamental shipboard tactical doctrine and procedures, including the functions and organization of Combat Information Center. The main topics included are: maneuvering board indoctrination; organization and command definitions; formations, dispositions, stationing, and altering course; screening; scouting; sortie and entry; evasive steering; measures to prevent mutual interference; CIC functions and organization; capabilities and limitations of radar; CIC communications and information handling; fleet air defense; and electronic warfare. The course also includes approximately ten hours of practical work in the CIC mock-up.

Prerequisites: None.

Usual Basis for Exemptions: Instructor or student at a CIC School (4 weeks or longer); or suitable operational experience as OOD and/or CIC officer of a combatant ship.

OCM Communications 5-0

Included in Bachelor of Science and General Line Curricula.

The objective of this course is to acquaint the officer-student with the doctrine, policies and principles governing fleet operational communications, emphasizing capabilities, limitations, procedures, and responsibilities. Topics included are: the communications organization; functions of the Naval Communication System; instructions and procedures for radio and visual communications; command responsibilities with respect to communications; the Allied Naval Signal Book; Naval Postal Administration; the Registered Publication System; Communication Security; and Communications and Frequency Plans.

Prerequisites: None.

Usual Basis for Exemptions: Have served as Communications Officer in a DD or larger ship or completion of correspondence courses "General Communications (NavPers 10916)" and "Shipboard Communications (NavPers 10918)"; or completion of "Communication Officer's Short Course" at Newport or Monterey; or completion of "Command Communications Curriculum".

OCA(W) Communications I(W) 2-0

Special course for women officers.

The objective of this course is to acquaint the woman officer-student with the duties, responsibilities and procedures of the Naval Communication System which she would encounter in a shore communication billet. Topics included are: the communication organization; functions of the Naval Communication System; instructions and procedures regarding reporting systems, communication station organization and files, message drafting and preparation for transmission, postal affiairs, security of classified matter.

Prerequisites: None.

Usual Basis for Exemptions: Appropriate experience in communication duties.

OCB(W) Communications II(W) 2-0

Special course for women officers.

The objective of this course is to further acquaint the woman officer-student with the duties, responsibilities and procedures of the Naval Communication System which she would encounter in a shore communication billet. Topics included are: the duties and responsibilties of a registered publications custodian, communication planner and cryptographer; and familiarization with the basic publications required in such billets.

Prerequisites: Completion of "Communications I (W)" or have qualified for exemption from that course.

Usual Basis for Exemptions: Appropriate experience in communication duties.

OAV Naval Aviation 3-0

Included in Bachelor of Science and General Line Curricula.

Recommended for woman officers.

Foreign officers are excluded from the regular course but a special modified course is offered for them.

The objective of this course is to provide the officer-student with a current and comprehensive knowledge of U. S. Naval Aviation. The course covers advanced information on all phases of naval aviation operations. Emphasis is placed on the coordination of aviation responsibility between the Shore Establishment and the Operating Forces. The discussions specifically concerning the Operating Forces are based on the latest material available on missions, tasks, and tactical employment of naval aircraft, ships, and their inter-related weapons-system.

Prerequisites: None.

Usual Basis for Exemptions: Extensive aviation duty; determined by personal interview.

OOP Operational Planning 3-0

Included in Bachelor of Science and General Line Curricula.

Recommended for women officers.

The objective of this course is to acquaint the officer-student with the principles and processes inherent in naval planning in order that he may understand planning procedures and properly carry out military directives. Topics include: staff organization; principles of planning, the planning process, analysis of the military directive; format, content and uses of annexes, appendices and tabs.

Prerequisites: None.

Usual Basis for Exemptions: Completion of the Naval War College Correspondence Course "Operational Planning and Staff Organization", or completion of the first four assignments (Part I) of the Naval War College Correspondence Course "Strategy and Tactics".

OAO Amphibious Operations 3-0

Included in Bachelor of Science and General Line Curricula.

The objective of this course is to provide the officer-student with an understanding of the doctrinal amphibious operation, including landing force operations of significance to the naval officer. Subject matter includes the fundamentals, operational and tactical procedures, and basic planning considerations of the following as they apply to amphibious operations: the assault; naval and troop organization; the functions of operational units; coordination of supporting arms; troop scheme of maneuver; capabilities of ships, craft and equipment; current trends as derived from reports of fleet exercises and operations.

Prerequisites: Completion of "Operational Planning" or have qualified for exemption from that course.

Usual Basis for Exemptions: Completion since 1953 of "Amphibious Warfare Indoctrination" course given by the Amphibious Training Commands.

OAS Anti-Submarine Warfare 4-0

Included in Bachelor of Science and General Line Curricula.

Foreign officers are excluded from the regular course but a special modified course is offered for them.

The objective of this course is to familiarize the officer-student with Anti-Submarine Warfare doctrine, procedures and weapons systems, with emphasis on coordinated anti-submarine operations. The first phase of the course covers the study of the design, operating characteristics, defensive tactics, offensive tactics and weapons of submarines. The second phase deals with anti-submarine search and detection (surface, air, sub-surface), anti-submarine attack direction systems and weapons, and attack procedures employed against submarines. The final phase is a study of coordinated anti-submarine actions designed to search for and destroy enemy submarines.

Prerequisites: Completion of "Tactics and CIC" or have qualified for exemption from that course.

Usual Basis for Exemptions: Completion in 1953 or later of any of the following courses:
CO/XO A/S Course, Fleet Sonar School
ASW Officer Course, Fleet Sonar School
Coordinated ASW course, Londonderry, Halifax, Norfolk, or San Diego.

OAT Advanced Tactics 3-0

Included in Bachelor of Science Curriculum.

Recommended elective for General Line Curriculum.

Foreign officers are excluded from this course.

The objective of this course is to familiarize the officer-student with advanced tactical concepts and the problems attending them in order to stimulate his thinking and prepare him for broader duties in the operating forces. This course consists of a brief survey of the status of fleet readiness in various tactical fields, followed by student committee study and seminars on selected Atlantic and Pacific Fleet and Intertype Exercises.

Prerequisites: Completion of "Tactics and CIC" or have qualified for exemption from that course.

OFC Naval Ordnance and Fire Control 4-0

Included in Bachelor of Science and General Line Curricula.

Foreign officers are excluded from the regular course but a modified course is offered for them.

The objective of this course is to provide the officer-student with a knowledge of the principles of naval ordnance and fire control, their capabilities, limitations, and the trend of new developments in these fields; to stimulate the thinking and broaden the mental outlook of officers in these subjects. The course includes presentation of the principles of naval ordnance and fire control (with the exception of torpedoes and ASW weapons systems) and the application of these principles to equipment which is currently installed or under development. The fields of shipboard and aircraft armament systems, unguided rockets, bombs and bombing, lethal devices, and naval gunfire support are treated. Consideraations are presented relative to military requirements, capabilities, limitations and cost effectiveness.

Prerequisites: None.

Usual Basis for Exemptions: Completion of USNA, NROTC, or equivalent courses in naval ordnance and fire control and service experience with both shipboard and aircraft armament systems.

OMW Mine Warfare 3-0

Included in Bachelor of Science and General Line Curricula.

The objective of this course is to appraise the officer-student of the importance of mine warfare and to provide the knowledge necessary for its conduct both offensively and defensively. The course includes minefield characteristics and planning principles; capabilities and limitations of mine countermeasures equipment and craft; mine countermeasures planning; and new developments in mine warfare.

Prerequisites: None.

Usual Basis for Exemptions: Completion of a formal course of instruction at the U. S. Naval School, Mine Warfare, Yorktown (3 weeks or longer); or staff duty in a mine warfare or mining billet.

ORW Restricted Weapons 3-0

Included in Bachelor of Science and General Line Curricula.

Foreign officers are excluded from this course.

The objective of this course is to acquaint the officer-student with the family of special weapons available and those under development, together with their capabilities and limitations. The course includes a presentation of the characteristics of the current special weapons and those under development with a discussion of the naval problems incident to their offensive employment. Support of fleet units with special weapons is covered briefly. In addition, the offensive phase of bacteriological and chemical warfare may be presented in general terms for indoctrinational purposes.

Prerequisites: None.

Usual Basis for Exemptions: Attendance within the previous two years at a one-week special weapons orientation course given by AFSWP, SWUPAC, or SWULANT; or, attendance within the previous three years at a planning or employment course given by one of the above commands.

OGM Missiles and Space Operations 6-0

Included in Bachelor of Science and General Line Curricula.

Foreign officers are excluded from this course.

The objective of this course is to develop in the officer student an understanding of the principles, capabilities, and limitations of guided missiles. The course includes a survey of propulsion systems and guidance systems used in guided missiles, discussion of specific missiles being developed for naval use, and the special considerations arising from the employment of these weapons in naval warfare. The course will present a survey of the field of operations outside the earth's atmosphere and develop an understanding of the problems and possibilities involved in satellites and space travel. A brief overview of missiles being developed by Air Force and Army is included.

Prerequisites: None.

Usual Basis for Exemptions: Consideration is given to appropriate experience and/or education.

OHD Harbor Defense 2-0

Recommended elective for all curricula and women officers.

The objective of this course is to acquaint the officer-student with the principles and methods of defending a harbor. The course includes the development, mission, organization, equipments, tactical subdivisions, and planning of harbor defense, operations of the Harbor Defense Command Center and port control, and harbor defense systems evaluation. A series of practical problems in a Harbor Defense Command Center Trainer is included.

Prerequisites: None.

SMN Seamanship 3-0

Included in Bachelor of Science and General Line Curricula.

The objective of this course is to review the fundamentals of seamanship, with emphasis on the duties and responsibilities of a naval line officer as conning officer and as an officer of the deck underway and in port. Topics include: the duties of an officer of the deck both underway and in port; maintenance of the deck log; conning a ship alongside and away from a pier, in narrow channels and in "man overboard" procedures; use of anchors and methods of anchoring; mooring (ordinary, flying, to a buoy, Mediterranean); replenishment at sea; cargo handling and stowage; Rules of the Nautical Road, both international and inland.

Prerequisites: None.

Usual Basis for Exemptions: Successful completion of USNA or equivalent NROTC course in Seamanship or the correspondence course "Seamanship (NavPers 10923)" and qualification as an OOD underway in a DD, SS or larger ship. Experience as the First Lieutenant of a Ship will be given consideration as a possible equivalent to qualification as an OOD underway.

SNA Navigation I 2-2

Included in Bachelor of Science and General Line Curricula.

The objective of this course is to provide the officer-student with a working knowledge of the duties of a ship's Navigator, including marine piloting, radar and loran navigation. Topics included in the course are: charts, buoys, navigation lights, tides and currents, magnetic and gyro compasses, the navigator's records, the deck log, voyage planning, electronic navigation devices. Practical works are given which require the use of hydrographic publications and the actual performance of chart work.

Prerequisites: None.

Usual Basis for Exemptions: Successful completion of USNA or NROTC or equivalent courses in navigation and have had some practical experience in marine piloting; or have served as navigator (assistant navigator of a large ship) of a ship for one year.

SNB Navigation II 2-2

Included in Bachelor of Science Curriculum.

Priority elective for General Line Curriculum.

The objective of this course is to provide the officer-student with a basic working knowledge of celestial navigation. This course includes: an introduction to astronomy; the practical use of navigation publications used in connection with celestial navigation; and the various phases of celestial navigation used by the navigator at sea. Practical works include the entire navigator's day's work at sea with the exception of the actual taking of observations.

Prerequisites: Navigation I, or have qualified for exemption from that course.

Usual Basis for Exemptions: Successful completion of USNA, NROTC, or equivalent courses in celestial navigation and have had some practical experience in celestial navigation; or have served as navigator of a ship for one year. Although this course is not included in the General Line Curriculum proper, it will normally be scheduled for any officer who has never had a formal course in celestial navigation.

SAE Aerology 3-0

Included in Bachelor of Science Curriculum.

Priority elective for General Line Curriculum.

Recommended for women officers.

The objective of this course is to present the principles of Aerology and the effects of weather phenomena on naval operations. Topics presented include: the structure of the atmosphere; the weather elements; the station model; pressure and winds; theory of air masses and fronts; tropical storms; sources of weather information; sea and surf conditions; climatology; and the principles of weather map analysis and forecasting.

Prerequisite: None.

Usual Basis for Exemption: Graduate of a USNPS Aerology Curriculum. Officer-students who feel that other experience and training (such as All Weather Flight School) has qualified them for exemption will be given a brief practical examination to determine eligibility for exemption. Although this course is not included in the General Line Curriculum proper, it will normally be scheduled for any officer without and adequate background in the subject matter.

SMA Management and Administration 4-2

Included in Bachelor of Science and General Line Curricula.

Recommended for women officers.

The objective of this course is to improve the line officer's executive ability by broadening his knowledge and understanding of management principles and practical leadership; and to develop administrative techniques involved in and required for the effective and economical employment of the collective efforts of individuals—officer, enlisted, and civilian—in accomplishing those tasks which constitute the mission of the Navy. The course includes: (1) A consideration of the philosophy of military authority and responsibility and the influence of these concepts on the executive or leadership role of the naval line officer. Included is a review of the elements of human behavior and basic group relations. (2) A study of the overall principles of management and the application of the analytical approach to management problems. (3) A study of methods and techniques of personnel administration and leadership derived from these principles and based on Navy Department policies and procedures. The instruction methods employed emphasize individual study projects, group study and discussion projects, including case study, analysis and problem solving.

Prerequisites: None.

SLO Logistics and Naval Supply 2-0

Included in Bachelor of Science and General Line Curricula.

Recommended for women officers.

The objective of this course is to give the officer-student an understanding of the government agencies responsible for the mobilization planning of the United States; to present the problems involved in the mobilization of industry and manpower in the logistic support of the armed forces from a national government level; and to insure that the officer-student is aware of the magnitude and importance of the logistic functions as a command responsibility. The elements of national mobilization and logistic support are presented, including: concept of logistics; organizational responsibilities as appropriate under the National Security Act of 1947; civilian and military manpower requirements; international and national petroleum aspects; transportation requirements for National Defense; U. S. Naval Logistic organization; Navy Supply distribution and fiscal responsibilities; and theatre logistics.

Prerequisites: None.

SJA Naval Justice I 3-0

Included in Bachelor of Science Curriculum.

Priority elective for General Line Curriculum.

Recommended for women officers.

The objective of this course is to provide an understanding of the fundamentals of naval justice as set forth in the Uniform Code of Military Justice and the Manual for Courts-Martial (including the Naval Supplement thereto) and their application to military duties in order that the administration of justice may function more effectively. The course includes: jurisdiction of courts-martial, analysis and preparation of charges and specifications; punitive articles, including analysis of elements of all the usual naval offenses tried by summary and special courts-martial; and the rules of evidence.

Prerequisites: None.

Usual Basis for Exemptions: Already possess the prerequisites for Naval Justice II.

SJB Naval Justice II 3-0

Included in Bachelor of Science and General Line Curricula.

Recommended for women officers.

The objective of this course is to present advanced problems in naval justice and their solution with special emphasis on procedures, problems and solutions of interest to the more senior officer of the executive/commanding officer level (i.e., problems of naval justice requiring command decisions and action). The course includes: application of the fundamentals presented in Naval Justice I; initiation of charges; apprehension, arrest, and confinement; accuser concept; applicability of enlisted and officer administrative discharge procedures for disciplinary and other reasons; fact-finding bodies (formal and informal investigations, including pre-trial investigations, courts of inquiry, etc.); non-judicial punishment; convening of summary and special courts-martial (composition, qualifications of members, etc.); moot court trial; findings and sentences; action of convening and higher reviewing authorities; and discussions of miscellaneous disciplinary problems confronting the commanding officer.

Prerequisites: Completion of the "Naval School of Justice," or correspondence course "Military Justice in the Navy (NavPers 10993)," or extensive practical experience in court-martial work under UCMJ. Completion of "Naval Justice I" will be required of officer-students who lack all of these.

Usual Basis for Exemptions: Completion of "Naval School of Justice" since May 1951; possess a Degree in Law; completion of correspondence course "Military Justice in the Navy (NavPers 10993)" and have had extensive practical experience in the processing and solution of disciplinary cases under UCMJ.

SNI Naval Intelligence 3-0

Included in Bachelor of Science Curriculum.

Recommended elective for General Line Curriculum.

Recommended for women officers.

Foreign officers are excluded from this course.

The objective of this course is to give the officer-student a comprehensive understanding of naval intelligence and the means by which the line officer may assist in intelligence functions. This course covers the major aspects of naval intelligence and its relationship to naval operations. The first part of the course is applicable to the strategic relationship of the United States to other countries, and how naval intelligence is associated with national strategic planning. There is limited coverage of intelligence matters applicable to psychological warfare. The second part of the course concerns the intelligence cycle and emphasizes the subsequent benefits to operational commanders at all levels.

Prerequisites: None.

SAF Personal Affairs 3-0

Included in the Bachelor of Science Curriculum.

Recommended elective for General Line Curriculum.

Recommended for women officers.

The objective of this course is to acquaint the officer-student with the fundamentals of sound career and estate planning. Topics covered include: career planning; retirement and separation; selection and promotion; courtesies and protocol; government benefits; government and commercial life insurance; insurance programming; liability, auto and casualty insurance; uniformed services contingency option act; wills and related legal matters; real estate financing; estate planning; and investments.

Prerequisites: None.

EME I Engineering Mechanics I 4-0

Included in Bachelor of Science Curriculum.

EME II Engineering Mechanics II 4-0

Included in Bachelor of Science Curriculum.

This series of courses extends over two consecutive terms. It covers the fundamental principles of statics and the applications of these principles to structural and mechanical problems; the fundamental principles of dynamics and the application of these principles to typical mechanical problems. The dynamics portion is restricted mainly to rigid bodies.

Prerequisites: Analytic Geometry and Calculus; mechanics portion of Engineering Physics.

ECH I General Chemistry I 4-3

Included in Bachelor of Science Curriculum.

ECH II General Chemistry II 3-3

Included in Bachelor of Science Curriculum.

ECH III General Chemistry III 3-3

Included in Bachelor of Science Curriculum.

This series of courses extends over 3 consecutive terms. It covers the fundamental concepts of chemical theory and the properties of metals and non-metals, together with appropriate laboratory experiments. Practical applications of importance to the Navy (such as corrosion, fuels and combustion, water treatment, electrochemistry, and explosives) are given special emphasis.

Prerequisites: None.

EAT College Algebra and Trigonometry 5-0

Included in Bachelor of Science Curriculum.

This course includes the fundamental operations of algebra, linear and quadratic equations; exponents and logarithms; variations; progressions; the binomial theorems; slide rule; trigonometric functions; trigonometric identities and equations; oblique triangles; radian measure; and polar coordinates.

Prerequisites: None.

Remarks: Prior satisfactory completion of an equivalent course will be a prerequisite for enrollment in the Bachelor of Science Curriculum during the academic year 1958-59.

EAG I Analytic Geometry and Calculus I 5-0

Included in Bachelor of Science Curriculum.

EAG II Analytic Geometry and Calculus II 5-0

Included in Bachelor of Science Curriculum.

EAG III Analytic Geometry and Calculus III 5-0

Included in Bachelor of Science Curriculum.

This series of courses extends over 3 consecutive terms. It is a unified development of analytic geometry, differential and integral calculus. The first term presents an introduction to plane analytic geometry and calculus including functions, limits, differentiation and integration, with simple applications such as maxima and minima; and relates rates, areas, and moments of areas. Subsequent terms proceed through transcendental functions, techniques of integration, vector and parametric equations, solid analytic geometry and vectors, partial derivatives, multiple integrals, infinite series, and an introduction to ordinary differential equations.

Prerequisites: College Algebra and Trigonometry.

EPD I Engineering Physics I 4-3

Included in Bachelor of Science Curriculum.

EPD II Engineering Physics II 4-3

Included in Bachelor of Science Curriculum.

EPD III Engineering Physics III 3-3

Included in Bachelor of Science Curriculum.

This series of courses extends over 3 consecutive terms. It provides basic training in the fundamental laws and concepts of mechanics, heat, electricity, sound, and light. (Nuclear physics is covered in a separate course which immediately follows this series). Appropriate laboratory experiments are performed to demonstrate the principles and provide training in scientific methods.

Prerequisites: One term of Analytic Geometry and Calculus.

ENN Nucleonics 4-1

Included in Bachelor of Science Curriculum.

Recommended elective for General Line Curriculum.

The objective of this course is to provide an understanding of nuclear physics with emphasis on military applications and unclassified developments. Topics include: structure of matter; structure of the atom; nuclear structure; nuclear transformations including radioactivity and the equivalence of mass and energy; high energy particles; fission of uranium; isotope separation; reactor principles; fusion; fission and fusion weapon principles; applications of radioactive isotopes; and instrumentation. Pertinent laboratory demonstrations and exercises are included.

Prerequisites: Engineering Physics, College Algebra and Trigonometry.

EEA Electrical Circuits and Machinery I 5-3

Included in Bachelor of Science Curriculum.

EEB Electrical Circuits and Machinery II 5-3

Included in Bachelor of Science Curriculum.

This series of courses extends over 2 consecutive terms and provides a thorough grounding in the theory and operation of electrical equipment. Laboratory work is correlated with subject matter throughout. Topics include: general circuit theory including circuit parameters; direct current circuits; alternating current circuits; magnetic circuits; theory and application of transformers; direct current motors and generators; alternating current motors and generators; control systems; servo mechanisms.

Prerequisites: Engineering Physics; Analytic Geometry and Calculus.

EEC I Electronics I 4-2

Included in Bachelor of Science Curriculum.

EEC II Electronics II 4-2

Included in Bachelor of Science Curriculum.

This series of courses extends over 2 consecutive terms and covers the theory and principles of electronics. Applications in naval electronics systems are developed. Appropriate laboratory demonstrations and exercises are utilized. Topics include: vacuum tubes; gas tubes; transistors; rectifiers; amplifiers; oscillators; modulators; detectors; wave propagation; receivers; transmitters; oscilloscopes; cathode ray tubes; pulse circuits; timing circuits.

Prerequisites: Electrical Circuits and Machinery.

EMA Basic Mathematics 3-0

Included in General Line Curriculum.

The objective of the course is to present adequately those principles of Algebra and Trigonometry necessary for the other courses in the General Line School curriculum. Topics covered are: elementary topics of algebra; laws of exponents; basic slide rule; square root; algebraic multiplication and division; special products and factoring; fractions; equations; graphs; exponents and radicals; quadratics; ratio and proportion; basic trigonometric functions; and vectors.

Prerequisites: None.

Usual Basis for Exemptions: Recent completion of a course in College Mathematics through Algebra and Trigonometry.

Remarks: It is planned to discontinue this course after the College Algebra and Trigonometry course for the Bachelor of Science Curriculum has been instituted.

EMR Mathematics Refresher 3-0

Elective for General Line Curriculum.

The objective of this course is to present a brief review of mathematics including Algebra and Trigonometry. The course includes the following topics: exponents; logarithms; slide rule operations; factoring; fractions; equations; graphic solutions; complex numbers; vectors; proportions; angles; trigonometric functions; radian measure; trigonometric identities and equations; oblique triangles; and polar coordinates.

Prerequisite: Successful completion at some time of a course in College Mathematics through Algebra and Trigonometry.

Remarks: This course will be scheduled concurrently with "Basic Mathematics" to permit the segregation of those officer-students who require a review of mathematics from those who have never taken college mathematics.

ENF Nucleonics Fundamentals 3-0

Included in General Line Curriculum.

Recommended for women officers.

The objective of this course is to acquaint the officer-student with the basic theory of the nuclear field needed for later study of nuclear propulsion and atomic warfare. Topics include: atomic structure and theory, spectroscopy, absorption of gamma rays, nuclear structure, nuclear energy, natural and artificial radioactivity, induced nuclear transmutations, neutron cross sections, nuclear fission, the chain reaction, power density, fission product poisoning, conversion of nuclear fuel, principles of nuclear reactors, nuclear fusion, principles of radiation instrumentation.

Prerequisites: Working knowledge of Algebra and Trigonometry.

Remarks: Students enrolled in the General Line Curriculum who elect to take Nucleonics will receive an exemption from this course.

EEF Electrical Fundamentals 4-0

Included in General Line Curriculum

The object of this course is to acquaint the officer-student with the basic elements of the electrical field. Topics include the following: resistance, voltage, current, magnetism, inductance, capacitance, resonance, three-phase systems, power problems, instruments, and transformers. Pertinent laboratory exercises are performed.

Prerequisites: Knowledge of Algebra and Trigonometry.

Usual Basis for Exemptions: Graduate of U. S. Naval Academy, or, possess an Electrical Engineering Degree; or, have completed a one-year Navy Electronics School.

Remarks: This course may be discontinued after the Engineering Physics and Electrical Circuits and Machinery courses have been instituted for the Bachelor of Science Curriculum.

ERF Electronics Fundamentals 4-0

Included in General Line Curriculum.

The objective of this course is to cover the fundamentals of electronics with particular emphasis on naval applications. Topics include the following: vacuum tubes, gas tubes, transistors, rectifiers, amplifiers, oscillators, modulators, detectors, receivers and transmitters, oscilloscopes, and propagation.

Prerequisites: Completion of "Electrical Fundamentals" or have qualified for exemption from that course.

Usual Basis for Exemptions: Possess an Electrical Engineering Degree, or, have completed a one-year Navy Electronics School.

Remarks: This course may be discontinued after the Engineering Physics and Electronics courses have been instituted for the Bachelor of Science Curriculum.

ECA Calculus 4-0

Elective for General Line Curriculum.

The objective of this course is to present the basic principles and some applications of the Differential and Integral Calculus. The course includes the following topics: variables, functions and limits; differentiation of algebraic functions; differentiation of implicit, inverse, logarithmic, exponential, and trigonometric functions; applications; successive differentiation; differentials; theorem of mean value; integration; definite integrals; formal integration; centroids; fluid pressure, and other applications.

Prerequisites: Recent successful completion of a course in Algebra and Trigonometry.

Remarks: This course will probably be discontinued after the Analytic Geometry and Calculus course has been instituted for the Bachelor of Science Curriculum.

EEM Electrical Machinery 4-1

Elective for General Line Curriculum

The objective of this course is to cover the fundamentals and important applications of DC and AC Machinery, especially the naval aspects. Topics include the following: fundamental characteristics of shunt and compound generators; shunt, series, and compound motors; alternators; synchronous and induction motors. Laboratory exercise and demonstrations are utilized.

Prerequisites: Completion of "Electrical Fundamentals" or have qualified for exemption from that course.

Remarks: This course will probably be discontinued after the Engineering Physics and Electrical Circuits and Machinery courses have been instituted for the Bachelor of Science Curriculum.

EED Engineering Drawing 2-3

Included in Bachelor of Science Curriculum

The object of this course is to provide training in drafting technique and procedure as applied to the production of drawings used in building or manufacturing. Topics include: drafting equipment and materials; lettering; orthographic projection, types and choice of views; layout technique; dimensioning; professional methods and standards.

Prerequisites: None.

Remarks: Prior satisfactory completion of an equivalent course will be a prerequisite for enrollment in the Bachelor of Science Curriculum during the academic year 1958-59.

EBM Basic Mechanisms 3-2

Included in Bachelor of Science Curriculum.

This course covers the principles of graphical mechanics and the relative motions of machine parts including levers, linkages, cams, toothed gears, beltings, chains, and ratchets.

Prerequisites: Engineering Drawing, College Algebra and Trigonometry.

ETH Thermodynamics 4-3

Included in Bachelor of Science Curriculum.

The objective of this course is to present the laws of thermodynamics and their applications to the analyses of performance, design and limitations of heat engines and allied machinery. Laboratory work provides a correlation of actual performance characteristics and theory. Topics include: the general energy equation and the concepts of entropy, enthalpy, internal energy, and specific heat with the related graphical representations; the ideal processes of gases; the various cycles and their practical applications in actual equipment.

Prerequisites: Heat portion of Engineering Physics, Analytic Geometry and Calculus.

EMM Mechanics of Materials 4-0

Included in Bachelor of Science Curriculum.

This course covers the analysis of stresses and strains encountered in various materials and structural members subjected to various combinations of forces. It provides an understanding of factors influencing the design and proper handling of structures and machines. Marine and aviation aspects are stressed. Topics include: strength and elastic properties of the ordinary materials of engineering construction, normal stresses, thin cylinders, torsion, shaft coupling and power transmitted by shafts, shearing, bending, elastic curve, deflection of beams, columns, combined stresses, dynamic loading.

Prerequisites: Engineering Mechanics.

EMF Mechanics of Fluids 4-0

Included in Bachelor of Science Curriculum

This course covers the laws of mechanics as they apply to liquids, vapors and gases. Particular attention is directed to the fluid phenomena affecting the performance of ships, aircraft, and propelled weapons. Topics include: fluid statics, steady flow processes. viscosity, incompressible and compressible fluids, dynamic lift, dynamics of compressible flow, lubrication, fluid couplings, fluid power systems.

Prerequisites: Engineering Mechanics.

EEN Materials of Engineering 4-3

Included in Bachelor of Science Curriculum.

The objective of this course is to provide an appreciation of the physical characteristics and engineering applications of metals, plastics, and petroleum products. Concurrent laboratory exercises also serve to demonstrate the validity of some of the computations performed in the Mechanics of Materials course. Topics include: principles of physical metallurgy including equilibrium diagrams and changes in the solid state, alloys of iron and carbon, non-ferrous alloys, high temperature and corrosion problems, synthetic fibers and synthetic elastic materials, lubricants, petroleum and exotic fuels.

Prerequisites: Chemistry, Mechanics of Materials.

EEG Materials of Engineering 4-0

Elective for General Line Curriculum.

The objective of this course is to give the officer-student an appreciation of the physical characteristics and naval applications of metals, plastics, and petroleum products with specific attention to new delevopments. The course includes the following topics: in metal—principles of physical metallurgy including equilibrium diagrams and changes in the solid state, alloys of iron and carbon, non-ferrous alloys, high temperature and corrosion problems; in plastics—the new types of synthetic fibers and elastic materials; in the petroleum industry—the advances in lubricants, diesel fuels and high octane gasolines. Laboratory demonstrations are employed as appropriate.

Prerequisites: None.

Remarks: This course may be discontinued after the Materials of Engineering course described above has been instituted for the Bachelor of Science Curriculum.

EGM Marine Engineering 5-0

Included in Bachelor of Science and General Line Curricula.

The objective of this course is to insure that the officer-student has an adequate understanding of marine engineering principles, the capabilities and proper operation of naval machinery, the organization and responsibilities of a shipboard Engineering Department. The course includes the following topics: basic engineering thermodynamic principles; the steam main propulsion plant and its auxiliaries; gas turbines; diesel engines; shipboard electrical power generation and distribution; miscellaneous naval auxiliary machinery; and the organization and administration of a shipboard Engineering Department. Recent advances which are being incorporated in new construction and the associated advantages and problems are discussed at the appropriate points. (NOTE: The classified details of the Navy's nuclear propulsion program are covered in the elective course "Marine Nuclear Propulsion".)

Prerequisite: None.

Usual Basis for Exemptions: Qualification as Engineering Officer of the Watch of a steam propelled ship.

ENP Marine Nuclear Propulsion 2-0

Included in Bachelor of Science Curriculum.

Recommended elective for General Line Curriculum.

Foreign officers are excluded from this course.

The objective of this course is to acquaint the officer-student with marine nuclear propulsion plants. The course includes the following subjects: reactor fuels and materials; reactor operation and control; application of reactors to shipboard propulsion plants; and a description of the installations currently in use and under development for naval use.

Prerequisites: Completion of "Marine Engineering" course or have qualified for exemption from that course. Completion of "Nucleonics Fundamentals" or "Nucleonics".

EDC Damage Control and Atomic, Biological, Chemical Warfare Defense 5-0

Included in Bachelor of Science and General Line Curricula.

ABC Defense portion is recommended for women officers.

The objective of the Damage Control portion of the course is to give the officer-student a thorough grounding in basic principles of Damage Control, with emphasis on ship stability, Damage Control organization and administration. The objective of the ABC Defense portion is to briefly review the effects of ABC weapons upon personnel and material; to present the methods, means and organization for minimizing these effects to the naval unit. Major topics in chronological order include: fundamentals of ship construction and stability; stability calculations and analysis using the general stability curve and general stability data sheet; Damage Control organization, records and reports; Damage Control piping and communication systems; repair of damage; effects of ABC weapons including similarities and unique effects as they bear on detection and defensive effort; Passive Defense Organization Ashore (OpNav Inst 3440.6); ABC detection, recording and plotting; control of traffic in contaminated areas; personnel and material decontamination and protection.

Prerequisites: Completion of "Nucleonics Fundamentals" or "Nucleonics".

Usual Basis for Exemptions: Completion of 10 week "Officers Basic Damage Control" Course; or completion of correspondence courses "Practical Damage Control (NavPers 10936)", "Theoretical Damage Control (NavPers 10937)", and "Radiological Defense, (NavPers 10771)". Other schooling and experience will be given consideration as possibly equivalent.

EAP Aircraft Propulsion 3-0

Included in Bachelor of Science Curriculum.

The objective of this course is to present the theory, operation, and comparative advantages of propulsion units used in manned and unmanned flight vehicles. Topics include: Piston engines, jet engines, turbo-prop engines, pulse jet engines, ram jet engines, and rocket motors.

Prerequisites: Thermodynamics.

EPE Aircraft Performance Evaluation 3-0

Included in Bachelor of Science Curriculum.

The object of this course is to give an appreciation of the problems and factors involved in arriving at an optimum aircraft configuration and in obtaining maximum operating efficiency from an existing aircraft. Topics include: fundamentals of technical aerodynamics; aircraft aerodynamic characteristics; performance analysis and propulsion characteristics; operational analysis of aircraft in fuel consumption, range, and performance.

Prerequisites: Mechanics of Fluids, Aircraft Propulsion.

Mr. Harold F. Smiddy, Vice President, Management Consultant Services, General Electric Company, addresses Management School students as a part of the Friday afternoon luncheon guest speaker series.

HCA English and Composition I 3-0

Included in Bachelor of Science Curriculum.

HCB English and Composition II 3-0

Included in Bachelor of Science Curriculum.

This series of courses extends over two consecutive terms. It covers the following topics: English grammer, punctuation, and diction, with emphasis on sentence structure; unity coherence and emphasis in writing, primarily with respect to the paragraph; research and theme writing emphasizing analysis, logical organization, and criticism.

Prerequisites: None.

Remarks: Prior satisfactory completion of an equivalent course will be a prerequisite for enrollment in the Bachelor of Science curriculum during the academic year 1958-59.

HLA Literature I 3-0

Included in Bachelor of Science Curriculum.

HLB Literature II 3-0

Included in Bachelor of Science Curriculum.

This series of courses extends over two consecutive terms. It is primarily a study of selections from the best in world literature. Selections are designed to:

(1) Acquaint the students with the various types of literature and with various writing techniques.

(2) Point out the major themes so frequently developed in important literature and give an appreciation of the continuity of thought in the literature of the Western World.

Prerequisites: None.

HEH European History 4-0

Included in Bachelor of Science Curriculum.

This course is intended to provide a knowledge of the social, economic, and political institutions of modern Europe to assist in understanding current problems in Europe and the World. It is a general survey of the political, economic, social, and cultural history of Europe from 1500 to the end of World War II.

Prerequisites: None.

HAH American History 4-0

Included in Bachelor of Science Curriculum.

This course is a survey of American social, political, and economic development from 1607 to the present. Particular attention is given to the basic concepts of American Democracy.

Prerequisites: None.

HNH Naval History 3-0

Included in Bachelor of Science Curriculum.

This course studies the nature and significance of sea power through its historical development successively in the Mediterranean, Atlantic, and Pacific regions. The influence of changing technology upon naval forces, tactics, and strategy is stressed. The development since 1900 of our present surface, subsurface, and air components and their employment in World War II are studied.

Prerequisites: None.

HSY Psychology 3-0

Included in Bachelor of Science Curriculum.

This course is designed to give an understanding of the principles underlying human behavior with emphasis on the application of these principles to human relations. Topics include: the nature of scientific psychology and its methods, motivation, intelligent behavior, emotional behavoir, personality, the measurement of aptitudes, learning, social problems, and problems of adjustment.

Prerequisites: None.

HEC Economics 3-0

Included in Bachelor of Science Curriculum.

This course covers the basic laws of economic behavior and compares the various economic systems (e.g., capitalism, socialism, and communism). The structure of the American economy together with the roles and interdependence of its various segments is studied. The facts and principles of international economic relations are also studied.

Prerequisites: None.

HCS Group Procedures and Written Communications 3-0

Included in Bachelor of Science and General Line Curricula.

Recommended for women officers.

This course is designed to increase the student's ability to express himself clearly and efficiently in written communications, and to understand and use proven techniques from the fields of group dynamics and conference procedures. The course consists of two units: (1) A survey of techniques of clear, informative writing, and exercises to improve skill in preparing written reports, notices and directives; (2) A survey of the theory and practices of group procedures, with student conference sessions devoted to assigned problems.

Prerequisites: None.

Usual Basis for Exemptions: Satisfactory grade on an objective written examination demonstrating writing skill plus knowledge and practical experience in group procedures.

HSP Speech 3-0

Included in Bachelor of Science Curriculum.
Recommended elective for General Line Curriculum.
Recommended for women officers.
The objective of this course is to improve the officer-student's ability to organize and express information and thought orally before military and civilian groups. The course includes a study of effective techniques for planning and delivering speeches, a speech clinic to analyze each student's problems, and opportunities to present speeches of varying length and subject before the group.

Prerequisites: Normal ability to express self in conversational English.

Art of Presentation 3-0

Summer session course offered Engineering School students.
The objective of this course is to develop an understanding of the principles of presentation, oral and visual; and to develop ability to use presentation techniques. The course includes assignments requiring preparation of complete presentations and their delivery in specific speaker-audience situations.

Prerequisites: None.

HNS International Relations and National Security 3-0

Included in Bachelor of Science and General Line Curricula.

Recommended for women officers.

The objective of this course is to present the role of the United States in world affairs, including the collective security organizations to which the United States belongs; and to emphasize the inter-relationship of various governmental agencies in the execution of national policy and the guarantee of national security. The course includes: the Constitutional development of the National Security Act of 1947; the Departments of State and Defense; treaty organizations; military and economic aid programs; the relationship of all the various cabinet level departments in the over-all scheme of National Security.

Prerequisites: None.

Remarks: Students enrolled in the General Line Curriculum who elect to take International Law can obtain an exemption from this course.

HIL International Law 5-0

Included in Bachelor of Science Curriculum.

Recommended elective for General Line Curriculum.

Recommended for women officers.

The objective of this course is to present the fundamental principles of International Law with special emphasis on those phases that govern the activities and problems of the naval officer at sea and in foreign territory. The course covers: historical background of international law, its scope and sources; "international persons" with special reference to the United Nations and Collective Security; treaty-making powers of the President and his constitutional authority as Commander-in-Chief; jurisdiction over territory, marginal seas, airspaces and territorial waters, gulfs, straits, and special bodies of waters; the high seas; international treaties; rules of land, aerial and maritime warfare; rules relative to prisoners of war; relations of belligerents and neutrals; military government; war crimes; solution of theoretical problems; problem discussions.

Prerequisites: None.

SECTION IV

THE MANAGEMENT SCHOOL

DIRECTOR

John Adrian HACK, Captain, U. S. Navy
B.S., USNA, 1935; B.M.E., Rensselaer Polytechnic Institute, 1950;
U. S. Naval War College, 1957.

ASSISTANT DIRECTOR

Thomas Louis CONROY, Captain, U. S. Navy
B.S., Rhode Island State College, 1937;
M.B.A., George Washington Univ., 1955.

ADMINISTRATIVE OFFICER

Kathryn DOUGHERTY, Commander, U. S. Navy
A.B., Iowa State Teachers College, 1932;
A.M., Stanford Univ., 1952.

ACADEMIC CHAIRMAN

William Howard CHURCH, (1956)*
A.B., Whittier College, 1933;
M.S.P.A., Univ. of Southern California, 1941.

Applied Management Department

William Howard CHURCH
Head of Department, Professor of Applied Management (1956)
A.B., Whittier College, 1933;
M.S.P.A., Univ. of Southern California, 1941.

Joseph David BLACOW
Professor of Applied Management (1957)
A.B., San Jose State College, 1936;
A.M., 1937; Ed.D., Stanford Univ., 1946.

Financial Management Department

Alfred Paul BOILEAU
Commander, SC, U. S. Navy
Head of Department
B.S., Pennsylvania State Univ., 1941;
A.M., George Washington Univ., 1954.

J. Hugh JACKSON, Jr., (1957)*
Associate Professor of Business Management
A.B., 1939; M.B.A., Stanford Univ., 1947.

Industrial Management Department

John Bernard WILLIAMS, Jr.
Commander, U. S. Navy, Head of Department
B.A., USNA, 1939; M.B.A., George Washington Univ., 1957.

John David SENGER, (1957)*
Associate Professor of Industrial Management
B.S., 1945; M.S., Univ. of Illinois, 1948.

Materiel Management Department

Henry S. NISBET
Commander, SC, U. S. Navy, Head of Department
B.S., Univ. of California, 1941.

Hunter Williamson STEWART
Commander, SC, U. S. Navy, Instructor
B.S., Georgia Institute of Tech., 1941;
Staff, Navy Supply Corps School, 1948-1950.

Paul ECKER, (1957)*
Associate Professor of Business Management
A.B., Pomona College, 1948; A.M., Claremont Graduate School, 1949.

*Indicates year of joining the Postgraduate School faculty.

THE MANAGEMENT SCHOOL
GENERAL INFORMATION

FUNCTION

The function of the Management School is to provide executive development training at the postgraduate level for Naval Officers in order that they may function more effectively in the performance of their assigned duties. The broadening of the mental outlook and resultant increase in professional knowledge will enable the officers to better meet the duties, responsibilities and complexities of higher rank, thereby improving the efficiency and combat effectiveness of the Navy.

The basic mission is accomplished in a five month course of education in a procedure of analysis which will lead to sound decisions and improved administrative achievement. This is done by providing a common basis of knowledge with emphasis upon the guiding principles and procedures characterizing successfully managed organizations, thereby fostering individual growth, problem solving ability, and initiative through the application of sound management techniques, methods, principles and doctrine. The knowledge and experience of the officer students is fully utilized in accomplishing this task.

ORGANIZATION

The Management School is organized under its director, who is assisted by a staff of especially qualified military and civilian educators. Under the Superintendent, the Director is responsible for all phases of the Management School.

The staff is organized into an Administrative Department and four academic departments representing the four areas of management:

Applied Management (people)

Financial Management (money)

Materiel Management (materiel)

Industrial Management (facilities)

As a general rule each department is staffed by both civilian and military educators in order that the operation of the Navy may be analyzed in an objective manner and compared with the principles and methods evolved by successfully managed organizations in American business. This interlocking of the civilian and military educators is expected to facilitate the broadening of the mental outlook of the officer while maintaining the focus of attention upon problems of the Naval Establishment.

Residents courses of instruction are provided by these four departments, with opportunities for elective courses within the Engineering School and General Line and Naval Science School offered where practicable. Certain non-resident programs are administered by the Management School faculty.

Officer students of the Management School are divided into sections for the purpose of administration and classroom assignments. The senior officer of each section is designated as section leader with responsibility for exercising administrative control over the officers in his section. Each section has a member of the staff assigned as the section advisor to provide the administrative liaison between school administration and the officer students.

FACILITIES

The offices and classrooms of the Management School are located in Root Hall. At special times, facilities of the Postgraduate School in other locations are utilized.

CURRICULUM

The Management School presents two five-month courses (convening in August and January) and a six-week course during the summer.

The program of the five-month course consists of twenty weeks of instruction under the direction of specially selected military and civilian faculty. Officers are exposed to the experiences of American business and industry as a partial basis for solving the specific problems of the Navy. The course consists of approximately 306 hours of classroom discussion supplemented by field trips to Naval and civilian activities, and by lectures by outstanding military and civilian authorities.

The course of instruction is divided into four basic areas required of all officers: (a) Applied Management, (b) Financial Management, (c) Industrial Management, and (d) Materiel Management. In addition, Supply Officers are required to take a "Supply Management Seminar."

The six-week summer course entitled "Elements of Management and Industrial Engineering" is a tailored series of lectures covering the same general areas as is offered in the five-month course. This course is designed primarily for the Engineer Postgraduate Officers as a supplement to their curricula, and for comparable technical officers on duty in Bureaus and Offices of the Naval Establishment.

No special preparation or qualification for this course is required.

In conjunction with this lecture program, Bureaus and Offices who so desire, sponsor special training programs and workshop seminars.

TABLE I

NAVY MANAGEMENT CURRICULUM (5 MONTHS)

Group Designator MG

No.	Course Title	Class Contact Hours
	APPLIED MANAGEMENT	
MN-341	Principles of Organization and Management	28
MN-342	Human Relations	18
MN-343	Advanced Management Seminar	18
MN-344	Management Economics	12
MN-345	Personnel Administration/Industrial Relations	18
	FINANCIAL MANAGEMENT	
MN-302	Comptrollership	4
MN-303	Managerial Accounting	24
MN-304	Budgeting	24
MN-305	Auditing	4
	MATERIEL MANAGEMENT	
MN-351	Material Planning, Inventory and Distribution	56
*MN-353	Supply Management Seminar	54
MN-354	Contract Administration/Purchasing	28
	INDUSTRIAL MANAGEMENT	
MN-301	Management Statistics	12
MN-346	Production Planning and Control	24
MN-347	Work Measurement/Work Simplification	20
MN-472	EDPM/Operations Analysis/Methods and Procedures	16

*Required for 3100 officers only.

TABLE II

MN-101 "ELEMENTS OF MANAGEMENT AND INDUSTRIAL ENGINEERING"

Course Content	Total Hours
Principles of Management	15
Executive Action	5
Production Planning	15
Work Measurement/Work Simplification	15
Acceptance Sampling/Quality Control	6
Financial Management	15
Personnel Management	15
Contract Administration	15

Training Courses and Workshop Seminars

As prepared and presented by sponsoring Bureaus and Offices.

TABLE III

CURRICULA CONDUCTED AT OTHER INSTITUTIONS

Curriculum	Group Designator	Length	Institution	Liaison Officer
Business Administration	ZKH	2 yrs	Harvard	CO, NROTC Unit
Business Administration	ZKM	1 yr	Michigan	CO, NROTC Unit
Business Administration	ZKS	2 yrs	Stanford	CO, NROTC Unit
Comptrollership	ZS	1 yr	George Washington	Prof. A. R. Johnson
Advanced Management	ZK	12 wks	Harvard	CO, NROTC Unit
Management & Industrial Engineering	ZT	1 yr	R. P. I.	CO, NROTC Unit
Management Problems for Executives	ZKP	8 wks	U. of Pittsburg	Prof. C. L. Van Sickle
Business Executive Program	ZKC	6 wks	U. of Southern California	CO, NROTC Unit

Note: CO indicates Commanding Officer.

MN-301 Management Statistics 12 hours

OBJECTIVE

To create an understanding of the strengths and weaknesses of the utilization of statistics in the Naval executive's decision making.

DESCRIPTION

This course develops the general concepts of probability and frequency distribution, and outlines the application of these concepts in the various fields of management. Measures of central tendency and dispersion are introduced. The technical problems of sampling are considered briefly. Practical problems involving Time Series Analysis, Correlation, and Programming are worked out. The methods of presenting ideas and facts by statistical tables and charts and their oral or written accompaniment are considered.

MN-302 Comptrollership 4 hours

OBJECTIVE

To develop an understanding on the part of Naval executives of the background of comptrollership in government, industry, and in particular the Department of Defense; to view the general functions of comptrollers in the Services at all levels.

DESCRIPTION

Introduces the general subject of comptrollership, examines the history and development of the office in industry and government, leads the officer toward a formulation of a concept of comptrollership; examines the status of comptrollers and their functions primarily within the Navy but with comparison to Army and Air Force and private enterprise, investigates the functions of a comptroller and his relations to other echelons of command management; provides exposure to practicing comptrollers in industry and in the Navy.

MN-303 Managerial Accounting 24 hours

OBJECTIVE

To present to the Naval executive the principles of sound fiscal management and their applications.

DESCRIPTION

Introduces fundamental accounting concepts as recognized in private enterprise; concepts of governmental accounting as they are practiced in the Navy; encourages constructive criticism of principles; examines practices of Navy Industrial Fund accounting, seeks to promote an understanding of Navy management use of accounting.

MN-304 Budgeting 24 hours

OBJECTIVE

To create within the Naval executive an understanding of the principles of sound programming, budget formulation, justification and execution, as exemplified in government and private enterprise.

DESCRIPTION

Portrays the relationship of Navy budgeting to the national economy and fiscal policy, the development of the budget process, the agencies influencing the process, the terminology of budgeting, concepts of performance budgets, estimating and justifying Navy budgets, the relationship of plans to budgets, budget cycles, review levels and methods, Congressional actions and influences, nature of appropriations, apportionment, allocations, administrative control of funds, reporting, probable changes in base of appropriations and budgeting.

MN-305 Auditing 4 hours

OBJECTIVE

To create within the Naval executive an understanding of the principles of auditing as practiced in government and business.

DESCRIPTION

Examines the basic principles of internal control and internal auditing as comptrollership functions; defines the nature of the functions as recognized in business and government upon the background of their development; differentiates external and internal audits and relationship to inspections and investigations; sets forth agency conduct of the Navy Internal Audit program in general and as it relates to a specific activity; considers specific cases in auditing and audit reporting.

MN-341 Principles of Organization and Management 28 hours

OBJECTIVE

To provide the Naval executive with the understanding and solution of problems faced by military executives and to educate officers in the criteria and principles of management which have characterized the most successful organizations in a competitive economy. To stimulate permanent interest in the application of scientific management techniques to effect management improvements in operations of the Naval Establishment.

DESCRIPTION

Particular attention is paid to the type of criteria that could be used to evaluate organizational effectiveness. Emphasis is placed upon organizational purposes and objectives; policies and policy development; planning; problems of centralization versus decentralization; work delegation and the granting of authority commensurate with responsibility; single manager concepts; work organization procedures; administrative, operational and personnel management criteria; budgetary and fiscal objectives; office methods; management problem solving techniques; public relations, internal and external. Selected case studies are used to enable officers to utilize their diversified experience backgrounds in the solution or examination of typical problems faced by executives in the Naval Establishment.

MN-342 Human Relations 18 hours

OBJECTIVE

To emphasize to the Naval executive the need for observing and utilizing those management philosophies, practices, and techniques which produce high esprit de corps and leadership within any competitive working group and which are the hallmark of the successful executive leader in both business and government.

DESCRIPTION

Emphasis is placed on the type of information the executive needs in order to promote motivation for people to work together effectively in the achievment of worthy goals. This course focuses more on group problems and the individual in relation to a group rather than on the individual or the job. It seeks to provide basic answers to the reasons why people in organized work groups act the way they do under certain conditions so that this understanding may be used in the creation of a climate for effective management throughout the whole of Naval operations.

MN-343 Advanced Management Seminar 18 hours

OBJECTIVE

To educate the Naval executive in the philosophies and principles followed by leading military and civilian authorities. To develop the executive's thought processes through written and oral presentations of problems facing the top level Naval executives and the solutions thereto.

DESCRIPTION

Leading military and civilian authorities address the officers and discuss their problems in an off-the-record, informal atmosphere. Officers visit military and civilian activities, view the salient operations and thereafter discuss the administration of the activity with the key executives. These experiences are discussed in oral presentations in the classroom, with the objective of analyzing the effect upon the Naval Establishment of adopting new methods and principles learned. As a requirement for completion of the course, each student is required to make a written presentation of a salient problem facing high level Naval executives, analyze this problem by sound logic in the light of principles and methods learned throughout the course of education, and arrive at a recommended solution.

MN-344 Management Economics 12 hours

OBJECTIVE

To educate the Naval executive in the impact of the military expenditures on the total economy. To emphasize the reasons for conservation of our vital resources and provide a foundation for better evaluation of financial trends as related to military budget responsibilities.

DESCRIPTION

This course concentrates on the problems of economic growth, stability and freedom. The basic economic institutions are discussed in light of these problems. The role of the Naval executive in economic decision making is emphasized. Specific areas covered are: National Income Accounting, Money and Banking, Business Cycles, Big Business, Government Influence, Labor, International Economics, and the Economics of Mobilization and Defense.

MN-345 Personnel Administration/Industrial Relations 18 hours

OBJECTIVE

To provide the Naval executive with basic information on the best and most applicable personnel principles and methods in use by business and government which may be utilized under current policy and regulations; to promote harmonious interpersonal relationships in work situations which require operating under both a military personnel system and a civilian personnel system.

DESCRIPTION

Manpower management problems are discussed as they pertain to both Bureaus and Offices of the Navy Department and to the Fleet and Field Establishment. Sufficient detail is presented to enable the officer to utilize both civilian and military personnel systems to the best advantage of the service and the national interest.

MN-346 Production Planning and Control 24 hours

OBJECTIVE

To educate the Naval executive in the three basic elements of production: organizing, planning and control.

DESCRIPTION

The officer student examines the functions of production controls, production planning and the techniques involved in each of these. The process for analyzing manufacturing techniques and machine capacity are studied. Basic operating procedures for control, including orders, routing, scheduling and dispatching are discussed. The coordination process is presented, emphasizing related activities of departments in order that they might bring about the desired production results in terms of quality, quantity, time and place.

MN-347 Work Measurement/Work Simplification 20 hours

OBJECTIVE

To educate the Naval executive in the development and application of work measurement standards, and with the concepts of work simplification so that they may more effectively administer the activity under their jurisdiction.

DESCRIPTION

This course will present the timing and sampling techniques by which work is measured. The application of these standard times for the purpose of evaluation and control will be studied. The analytical approach to problem solving for the purpose of simplifying work and improving methods successfully will be presented. Applications of these principles to Navy situations will be studied and problems for student solution will be included.

MN-351 Material Planning, Inventory and Distribution 56 hours

OBJECTIVE

To educate Naval executives in the areas of requirements planning, inventory control and distribution management for which they will be responsible.

DESCRIPTION

This course educates the Naval executive in the administrative aspects of logistics planning, focuses his attention on the problems of inventory management and the distribution of material required to support the Fleet and its programs.

MN-353 Supply Management Seminar 54 hours

OBJECTIVE

To increase the executive capacities and skills of Supply Officers through utilization of the individual officer's experiences while discussing the nature of inventory management and considering current developments and difficulties in Fleet support. An important objective of the course is to acquaint future senior Supply Officers with the administrative technical aspects of supply administration and the duties they will assume in the Bureau, Field Activities and the Fleet.

DESCRIPTION

The following topics are discussed in oral presentation or case study discussion:

The history of the Navy Supply Plan and its implementation—The Materiel Missions and the Program Support—Supply Support responsibilities (computation of requirements, distribution) of Supply Demand Control Points—The problems of inter-SDCP Supply Support—The policy and coordination control over the Navy Supply System as exercised by Congress, the Department of Defense, SecNav, CNO, and Bureaus of the Navy Department, Federal Cataloging Standardization Programs—The Single Purchase Service Assignments—Examination of the problems of Fleet support—The Fleet stockage and supply policy—Atlantic Fleet and Pacific Fleet Air Cargo tests—Allowance lists and load lists—Support of new construction, conversion, Ship alterations and overhauls—Determination of methods of supply; centralized vs. decentralized procurement; direct delivery to user vs. depot supply; procurement vs. redistribution; inventory stockage policy; use of formula to determine optimum operating and safety levels of supply; collection, interpretation and projection of demand date; planned requirements; Mobilization Reserve Requirements; economic order and economic retention policies; fractionation of inventories; stratification; redistribution of excess stocks and disposal of surplus stocks.

MN-354 Contract Administration/Purchasing 28 hours

OBJECTIVE

To present the aspects of good contract administration and purchasing through supervised analysis.

DESCRIPTION

This course directs attention to the elements of effective contract administration by illustrating the close cooperation required between Bureau and field personnel. It discusses the factors affecting the above relationship, the significance of various contract types, the process of selecting and evaluating contractors and the process of evaluating and insuring the progress of the contractor. Pricing, regulations for government assistance, approval, amending or changing the contract and terminations and endings of contracts are discussed.

MN-472 EDPM/Operations Analysis/Methods and Procedures **16 hours**

OBJECTIVE

To educate the Naval executive with the potential and limitations of EDPM systems and Operations Analysis methods of analysis and their applications to management control.

DESCRIPTION

This course includes the study and analysis of intermediate and large scale electronic digital data-processing machines in the solution of management problems. An analysis is made of the scientific approach to management problems.

CURRICULA AT OTHER INSTITUTIONS

BUSINESS ADMINISTRATION

ZKH Harvard University

ZKM University of Michigan

ZKS Stanford University

OBJECTIVE

A curriculum consisting generally of courses in the fields of finance, business organization, marketing, statistics, public relations, administrative practices, and geography. The one-year curriculum at the University of Michigan is for advanced students. The curricula at Harvard and Stanford Universities are of two-year duration. The summer between academic years is spent in individual assignments with industrial companies.

COMPTROLLERSHIP

ZS George Washington University

OBJECTIVE

To develop in officers of mature judgment and a broad background of professional experience the ability to interpret and analyze operational statistics for the purpose of developing standards of performance; to provide a periodic review of operations in order to denote areas of management which are not meeting standards; to review budget estimates; and to plan programs for the improvement of management economy and efficiency through better organization, administration and procedures and better utilization of manpower, materials, facilities, funds and time. The course is designed to give graduates a working knowledge of managerial controls adequate for assignment to comptroller duties as a normal preparation for command and executive billets in the shore establishment.

MANAGEMENT AND INDUSTRIAL ENGINEERING

ZT Rensselaer Polytechnic Institute

OBJECTIVE

To prepare selected officers for managerial and industrial engineering billets in the Navy's industrial organization. The curriculum majors in industrial engineering and its application to managerial problems.

EXECUTIVE DEVELOPMENT PROGRAMS

ZK Harvard

ZKP University of Pittsburgh

ZKC University of Southern California

OBJECTIVE

A short course of education to broaden the Executive outlook of the Naval Officer in the philosophy and methods employed in the solution of business problems.

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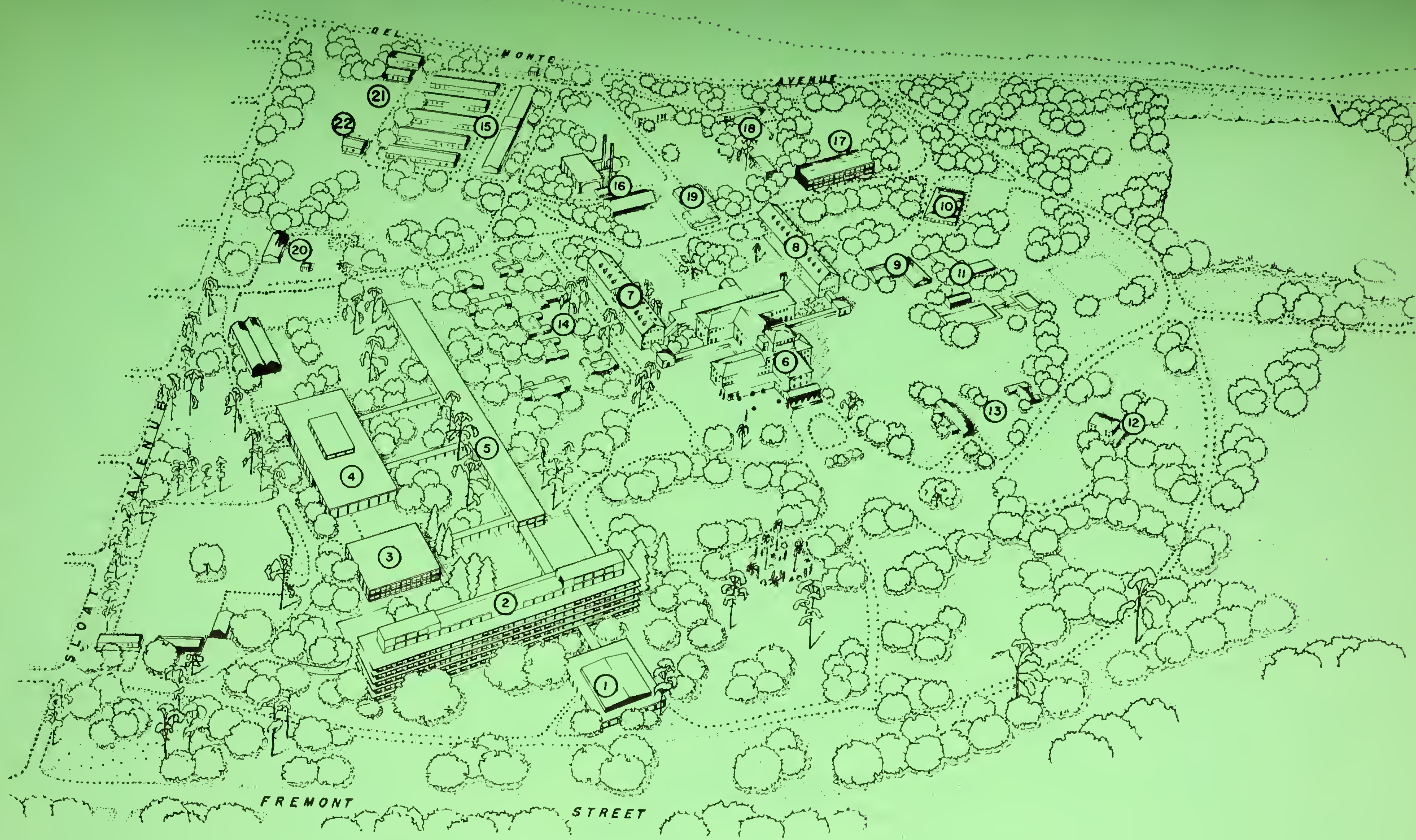
2. Spanagel Hall—Electronics, Physics, Metallurgy and Chemistry, Electrical Engineering, Laboratories and Classrooms—(Building 232)
3. Bullard Hall—Electrical Engineering Laboratory—(Building 233)
4. Halligan Hall—Mechanical and Aeronautical Engineering Laboratories—(Building 234)
5. Root Hall—Library, Classrooms, Mathematics, Aeronautics, Aerology, Mechanical Engineering, Communications—(Building 235)
6. Herrmann Hall—Administration, Chapel, Open, and Closed Messes, BOQ—(Building 220)
7. BOQ—(Building 222)
8. General Line and Naval Science School—(Building 221)
9. Powers Hall—Classrooms—(Building 300)
10. Fleming Hall—Classrooms—(Building 301)
11. Dressing Rooms and Solarium—(Buildings 209, 210)
12. Superintendent's Quarters, Quarters A
13. Married Officers' Quarters, Quarters M, L, and K
14. Married Officers' Quarters, Quarters B through J, and N
15. Engineering School and Public Works Shops and General Line School Laboratories—(Buildings 223 through 229)
16. Power Plants
17. Enlisted Men's Barracks
18. Criscuolo Hall—Enlisted Men's Recreation Hall—(Building 211)
19. Supply Department—(Building 206)
20. Navy Exchange Service Station—(Building 261)
21. CIC/ASW, Ordnance & Gunnery Classrooms, General Line School—(Buildings 238, 239)
22. Fire Station—(Building 258)


DEL MONTE AVENUE
SLOAT AVENUE
FREMONT STREET