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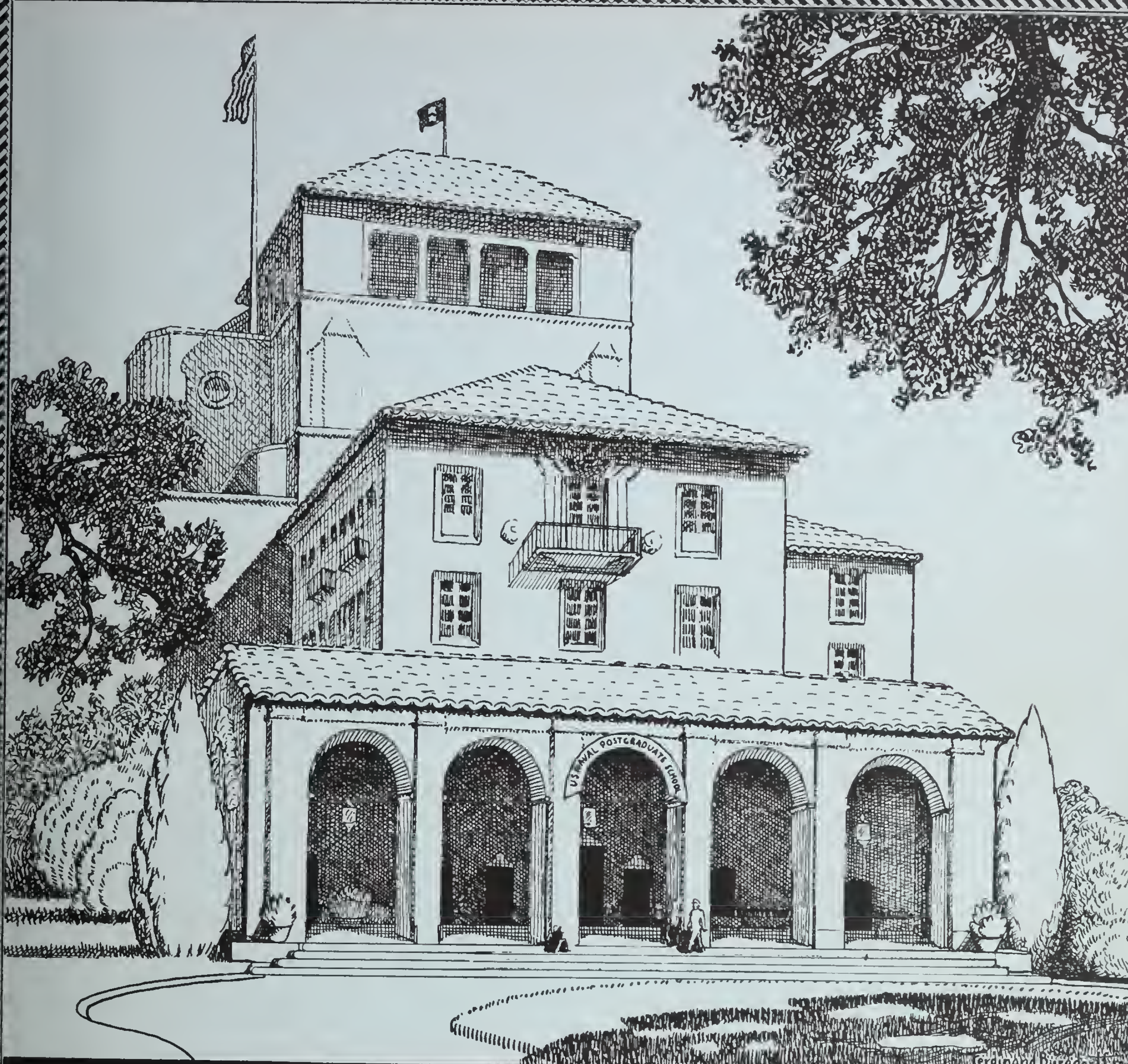
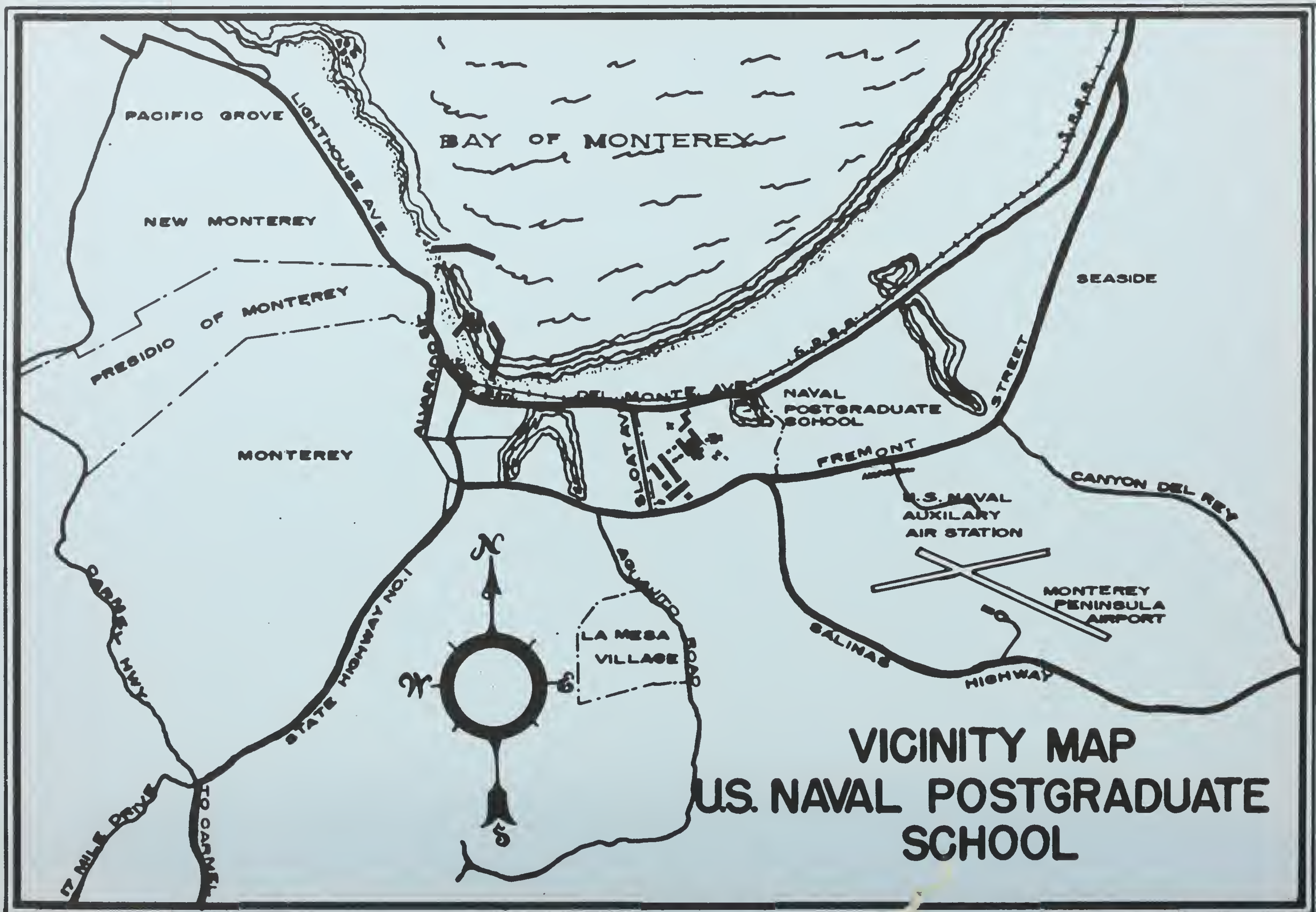


Catalogue of

U. S. NAVAL POSTGRADUATE SCHOOL

Monterey, California

Academic Year 1954-1955



VICINITY MAP
U.S. NAVAL POSTGRADUATE SCHOOL

UNITED STATES NAVAL POSTGRADUATE SCHOOL

CATALOGUE for the Academic Year 1954 - 1955

MONTEREY, CALIFORNIA

1 JULY 1954

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United States Naval Postgraduate School
Calendar

Academic Year 1954-1955

1954

Engineering School First Term Begins	Monday, August 2
Labor Day (Holiday)	Monday, September 6
General Line School Graduation (Class 1954A)	Friday, September 24
Engineering School First Term Ends	Thursday, October 7
Engineering School Second Term Begins	Tuesday, October 12
General Line School Registration (Class 1954B)	Wednesday, October 20
General Line School Classes Begin	Monday, October 25
Armistice Day (Holiday)	Thursday, November 11
Thanksgiving Day (Holiday)	Thursday, November 25
Engineering School Second Term Ends	Friday, December 17
Christmas Leave Period Begins	Friday, December 17

1954

JANUARY

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1955

General Line School Classes Resume	Monday, January 3
Engineering School Third Term Begins	Monday, January 3
Washington's Birthday (Holiday)	Tuesday, February 22
Engineering School Third Term Ends	Friday, March 11
Engineering School Fourth Term Begins	Monday, March 21
General Line School Graduation (Class 1954B)	Friday, May 6
Engineering School Fourth Term Ends	Friday, May 27
Memorial Day (Holiday)	Monday, May 30
Engineering School Graduation	Thursday, June 2

1955

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DECEMBER

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Section III

THE GENERAL LINE SCHOOL

U. S. NAVAL POSTGRADUATE SCHOOL

Superintendent

Frederick MOOSBRUGGER, Rear Admiral, U. S. Navy

Academic Dean

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

Chief of Staff

Charles Edwin CROMBE, Jr., Captain, U. S. Navy

Director, Engineering School

James Henry WARD, Captain, U. S. Navy

Director, General Line School

George Kittrell FRASER, Captain, U. S. Navy

Commanding Officer, Administrative Command

George Thomas McCREADY, Jr., Captain, U. S. Navy

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 technical education through its own facilities at Monterey and by supervision of education at various civilian institutions throughout the country; (b) provides advanced professional education through the medium of the General Line School. Through the performance of these functions the Postgraduate School becomes the agent of the Bureau of Naval Personnel for advanced 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 comptrollership, management and industrial engineering, and personnel administration, at civilian institutions.

The General Line School carries out that portion of the program dealing with professional naval subjects by augmenting previous instruction and training of the junior officer in the naval sciences, thereby rendering him more capable of employing all the tools of his profession and better fitting him for more responsible duties ashore and afloat. Though ultimately the curriculum will cover a one-year period, for the present and until June 1955, the General Line School program is shortened to six months in order to give necessary professional instruction to the large number of former reserve and temporary officers who, since World War II, have transferred to the Regular Navy.

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

ORGANIZATION

The Postgraduate School consist of three main components: the Engineering School, the General Line 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 three components. The Administrative Command is the supporting organization for the schools at Monterey and provides all the usual housekeeping services.

The two schools at Monterey, the Engineering School and the General Line School, both have a military and an academic organization. The civilian faculty of the two 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 two 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 School.

STUDENT INFORMATION

Detailed information on the Postgraduate 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 Auxiliary Air Station, 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 and the General Line 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 will be in the process of moving into the first group of buildings completed as part of this development plan. These buildings will provide proper laboratory space for the first time during the existence of the Engineering School. The following buildings will be opened for use:

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

The Electrical Engineering Laboratory.

The Mechanical Engineering Laboratory

The Aeronautical Engineering Laboratory.

The classroom building, a long, two-story building that also provides quarters for the departments of Mathematics and Mechanics, Aeronautics, Mechanical Engineering, and Aerology. One end of this building will house the Reference and Research Library until such time as a separate 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 and the General Line School, are three in number—the Reference and Research Library, the Christopher Buckley Library, and the Textbook Service.

The Reference and Research Library, temporarily located on the ground floor of the Administrative Building, is an active collection of some 36,000 books, periodicals and research reports dealing mainly with the curricular subjects in the fields of science, engineering 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 the Administration Building, immediately above the Reference and Research Library, is a collection of about 4,000 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 Water Raleigh's "Excellent Observations and Notes, Concerning the Royall 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 donated these books in 1952.

The Textbook Service contains approximately 70,000 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.

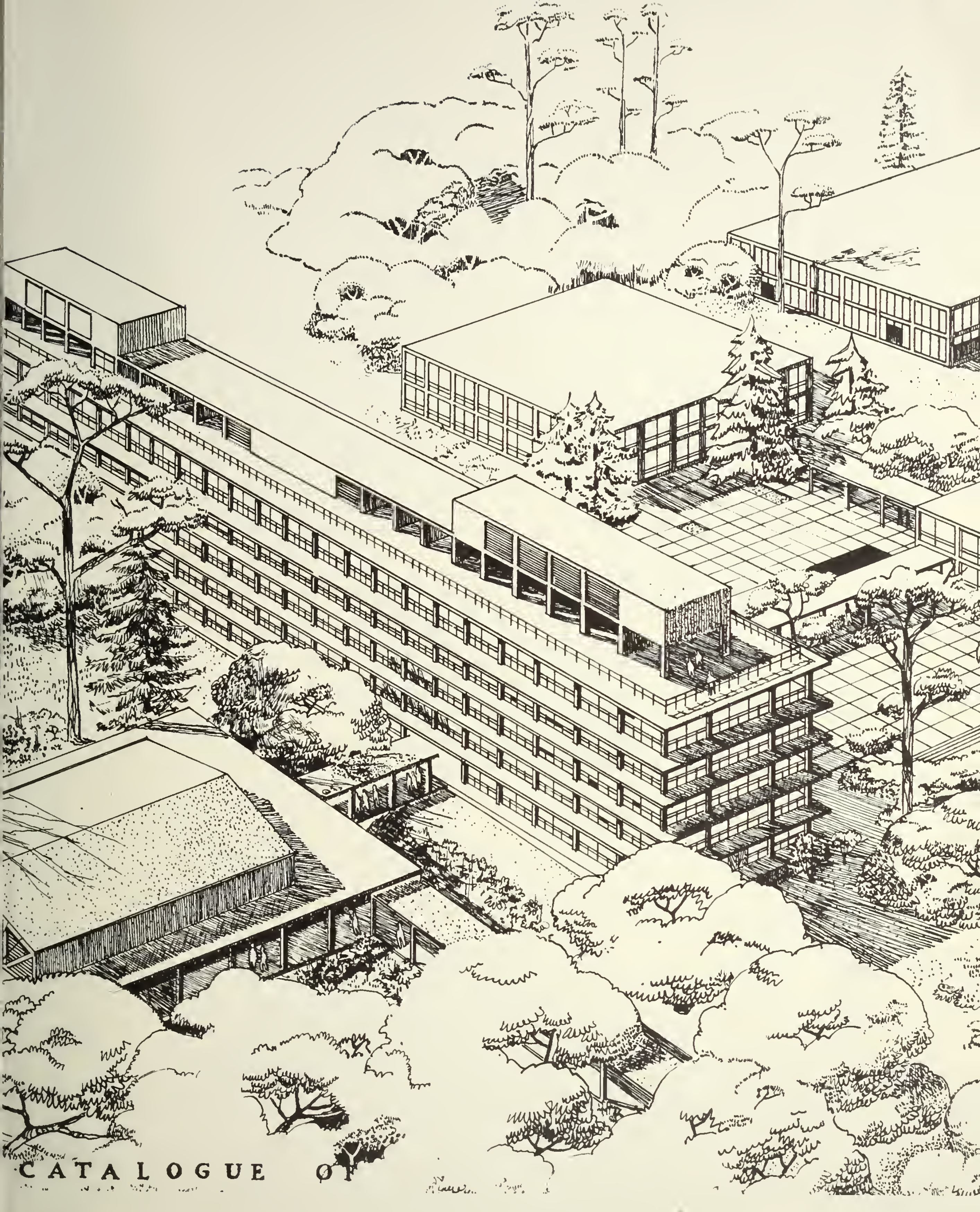
HISTORICAL

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 1200 officer students are enrolled in approximately forty curricula in engineering and related subjects, in the Engineering School and the General Line School. Facilities are being planned and implemented to accommodate a total of 1800 officer students—600 in the Engineering School and 1200 in the General Line 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

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

Aerial view of yard and portion of nearby city of Monterey, with harbor, piers and breakwater in background.



Architect's sketch showing portions of five Engineering School buildings now under construction, scheduled for occupancy in 1954. At lower left is a lecture hall; other buildings house laboratories, offices, classrooms and the interim library.

THE CHAPEL

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. 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 School 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 School 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. 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 School 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; in 1948 an additional General Line School was established at Monterey, California. The objective of the General Line School program for the re-established schools—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. The current curriculum is designed to provide such a course of approximately six months in length for ex-Reserve and ex-Temporary officers who have transferred to Regular status.

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.

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. 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.

The U. S. Naval Postgraduate School, Monterey, now comprises the Engineering School under a Director, the General Line 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.

SECTION II

THE ENGINEERING SCHOOL

DIRECTOR

James Henry WARD, Captain, U. S. Navy
B.S., USNA, 1926
Graduate, USNPGS, 1936,
Ordnance Engineering.

Assistant to the Director

Richard Archibald MONTFORT, Commander, U. S. Navy
B.C.S., Drake Univ., 1939.

NAVAL STAFF

AEROLOGICAL CURRICULA

John Fletcher TATOM
Captain, U. S. Navy
Officer in Charge
B.S., USNA, 1930; M.S., California Institute of Technology, 1939.

John Paul FLEET
Commander, U. S. Navy
Assistant Officer in Charge
Instructor in Aerology
Ph.B., Boston College, 1939;
B.S., USNPGS, 1950.

James Francis O'CONNOR
Lieutenant Commander, U. S. Navy
Instructor in Aerology
B.S., University of Rhode Island, 1937;
B.Educ., Rhode Island College of Education, 1939;
M.S., Massachusetts Institute of Technology, 1943.

Charles Gerhard KNUDSEN
Lieutenant Commander, U. S. Navy
Instructor in Aerology
B. S., St. Johns University, 1936;
A.M., Columbia University, 1939.

Thad Joseph KOWALL
Lieutenant Commander, U. S. Navy
Instructor in Aerology
B.S., Illinois Institute of Technology, 1941.

Willard Samuel HOUSTON, Jr.
Lieutenant, U. S. Navy
Instructor in Aerology
M.S., USNPGS, 1953.

Edward Snide HUDSON
Chief Aerographer, U. S. Navy
Instructor in Aerology

AERONAUTICAL ENGINEERING CURRICULA

Ralph William ARNDT
Commander, U. S. Navy
Officer in Charge
B.S., USNA, 1936; B.S., USNPGS, 1949;
M.S., University of Minnesota, 1950.

Maximilian Walter MUNK
Commander, U. S. Navy
Assistant Officer in Charge
B.S., USNA, 1942; B.S., USNPGS, 1950;
M.S.E., Princeton University, 1951.

COMMUNICATIONS CURRICULA

Leland Griffith SHAFFER
Captain, U. S. Navy
Officer in Charge
B.S., USNA, 1931; USNPGS, 1939,
Applied Communications.

Robert Gwathmey MERRITT
Commander, U. S. Navy
Assistant Officer in Charge
B.S., USNA, 1939.

Myles Cornelius KING
Lieutenant Commander, U. S. Navy
Instructor in Communications
A.B., Boston College, 1938.

George McLain RODGERS
Lieutenant, U. S. Navy
Instructor in Communications
A.B., Pacific University, 1940.

ENGINEERING ELECTRONICS CURRICULA

Paul VAN LEUNEN, Jr.
Captain, U. S. Navy
Officer in Charge
B.S., USNA, 1934; USNPGS, 1943,
Radio Engineering.

Jackson Madison RIGHTMYER
Lieutenant Commander, U. S. Navy
Assistant Officer in Charge

Richard Labagh KILE
Lieutenant, U. S. Navy
Instructor in Engineering Electronics

NAVAL ENGINEERING CURRICULA

Earl Tobias SCHREIBER
Captain, U. S. Navy
Officer in Charge
B.S., USNA, 1929
USNPGS, 1938, Marine Engineering.

William Mac NICHOLSON
Commander, U. S. Navy
Instructor in Naval Engineering
B.S., USNA, 1941; M.S., Massachusetts Institute Of Technology, 1948.

Claude Clyde BRUBAKER
Lieutenant Commander, U. S. Navy
Laboratory and Machine Shop Officer

ORDNANCE ENGINEERING CURRICULA

William Robinson SMITH 3rd
Captain, U. S. Navy
Officer in Charge
B.S., USNA, 1934; USNPGS, 1942.
Ordnance Engineering.

Felix Leonard ENGLANDER
Commander, U. S. Navy
Assistant Officer in Charge and
Instructor in Ordnance Engineering
B.S., USNA, 1940; B.S., USNPGS, 1949;
M.S., Lehigh Univ., 1950.

Clarence Earle THOMAS
Lieutenant, U. S. Navy
Instructor in Mine Warfare
B.E.E., Alabama Polytechnic Institute, 1943.

CIVILIAN FACULTY

Roy Stanley GLASGOW
Academic Dean (1949)*
B.S., Washington Univ., 1918; M.S., Harvard Univ., 1922; E.E., 1925

DEPARTMENT OF AEROLOGY

William Dwight DUTHIE
Professor of Aerology; Chairman (1946)*
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.

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

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 College, 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 Institute of Oceanography, 1948;
Ph.D., Texas A. & M. College, 1953.

Jacob Bertram WICKHAM
Assistant Professor of Aerology and Oceanography (1951)
B.S., Univ. of California, 1947; M.S., Scripps Institute 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.

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

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.

* The year of joining the Postgraduate School faculty is indicated in parentheses.

Charles Horace KAHR, Jr.
Associate 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.

Charles Benjamin OLER
Associate 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
Associate 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
Associate 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.

Robert Edmund BAUER
Associate Professor of Electronics (1948)
B.S., Villanova College, 1947; M.S., Univ of Pennsylvania, 1949.

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

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.

John James DOWNING
Instructor in Electronics (1952)
B.S., Massachusetts Institute of Technology, 1948.

Earl Gascoigne GODDARD
Associate Professor of Electronics (1948)
B.S., New Mexico State College, 1939; A. M., Stanford Univ., 1947; E.E., 1947.

Robert KAHAL
Professor of Electronics (1952)
B.E.E., Cooper Union, 1943; M.E.E., Polytechnic Institute of Brooklyn, 1947; D.E.E., 1950.

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

William Henry ROADSTRUM
Assistant Professor of Electronics (1948)
B.S., Lehigh Univ., 1938; M.S., Carnegie Institute of Technology, 1948. (On leave of absence).

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

Donald Alan STENTZ
Assistant Professor of Electronics (1949)
B.S., Duke Univ., 1949.

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.

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.

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.

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

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

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.

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

Clay Lamont PERRY, Jr.,
Professor of Mathematics (1953)
A.B., Univ. of California at Los Angeles, 1942; A.M., Univ. of Southern California, 1946; Ph.D., Univ. of Michigan, 1949.

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.

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

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

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.

Eugene Elias DRUCKER
Assistant Professor of Mechanical Engineering (1950)
B.S., Massachusetts Institute of Technology, 1949; M.S., 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.

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

Paul James KIEFER
Senior Professor 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.

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

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

Allen Kleiber SCHLEICHER
Assistant Professor of Mechanical Engineering (1950)
B.S., Washington Univ., 1943; M.S., 1950.

Ivar Howard STOCKEL
Assistant Professor of Mechanical Engineering (1950)
B.S., Massachusetts Institute of Technology, 1950; M.S., 1950. (On military leave).

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.E., McGill Univ., 1946; M.S., Carnegie Institute of Technology, 1949.

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
Associate 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.

Lloyd Randall KOENIG
Instructor in Chemical Engineering (1950)
B.S., Washington Univ., 1950. (On military leave)

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

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

Richard Alan REINHARDT
Assistant 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
Assistant Professor of Chemistry (1949)
B.S., Johns Hopkins Univ., 1945

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.

Neal Sample ANDERSON
Associate Professor of Physics (1951)
A.B., Univ. of California at Los Angeles, 1946; A.M., 1949; Ph.D., 1951.

Roderick Keener CLAYTON
Associate Professor of Physics (1952)
B.S., California Institute of Technology, 1947; Ph.D., 1951.

Eugene Casson CRITTENDEN, Jr.
Professor of Physics (1953)
A.B., Cornell Univ., 1934; Pr.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.

William Warner LANG
Instructor in Physics (1951)
B.S., Iowa State College, 1946; M.S., Massachusetts Institute of Technology, 1949. (On leave of absence).

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.

Michael Satoshi WATANABE
Professor of Physics (1952)
B.S., Tokyo Univ., 1933; D.Sc., Paris Univ., 1935; D.Sc., Tokyo Univ., 1940.

LIBRARY

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

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

Jack Benjamin GOLDMANN
Reference Librarian (1952)
A.B., Univ. of California, 1939; A.M., 1940; B.L.S., 1950; Ph.D., 1953.

Georgia Plummer LYKE
Technical Reports Cataloger (1952)
A.A., Hartnell Junior College, 1940.

Margaret H. McBRIDE
Catalog Librarian (1951)
A.B., Univ. of California, 1945; B.L.S., 1947.

Ignatius McGUIRE
Assistant Librarian (1948)

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

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 six 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) Communications
(d) Engineering Electronics
(e) Naval Engineering
(f) 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	Mathematics and Mechanics
Aeronautics	Mechanical Engineering
Electrical Engineering	Metallurgy and Chemistry
Electronics	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.

Finally, most curricular 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 provide a broad course of instruction.

ACADEMIC SCHEDULE

The important dates for the current year are set forth on the academic calendar on page iii. The calendar reflects a general pattern of academic procedure at the Engineering School.

The Engineering School operates on an academic year that encompasses forty weeks of instruction, four terms of ten weeks each, in the course of ten months. The school normally starts the first part of August so that the second term is completed just before Christmas. After a two-week leave period, the third term starts the first part of January, and the academic year terminates the first part of June.

The summer period is usually devoted to approximately six weeks of field trips. The field trips are designed to meet the specific needs of the curricula involved and usually include naval or military installations performing work of particular interest to the students concerned. In some curricula civilian concerns provide better practical experience and are used when such is the case.

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.

In line with the above, it will be found that all 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; i.e., 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 given only one-half the weight of recitation hours, hence the example would have a credit hour value of 4.

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

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 the courses of his curriculum. In very exceptional cases, small deficiences 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 may be selected by the student, subject to the approval of the cognizant department chairman. The completed thesis must indicate ability to perform independent work and to report on it in a scholarly fashion. The thesis, in final form, will be submitted to the cognizant department chairman for review and evaluation. Upon final approval of the thesis by the department chairman, the student shall be certified as eligible for final 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 successfuly 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 one 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.

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 were greatly improved and expanded by the laboratories in the new buildings 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, and bio-physics.

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 equipment of the optics laboratory includes a large-grating spectrograph having a resolving power of 170,000, and a completely automatic infra-red spectrograph.

The Physics laboratories in the new Engineering Building are rapidly being put into operating condition, and they provide for a number of notable additions. The new facilities being provided include: a two-million-volt Van de Graaff nuclear accelerator in the nuclear physics laboratory, a medium-sized anechoic (echo-free) chamber, a small reverberation chamber, and a multiple-unit acoustics laboratory for student experimentation in airborne acoustics; additional facilities will be available for work in atomic physics, bio-physics, gaseous discharges, infra-red spectrometry, and nuclear physics.

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 a 32″ × 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″ × 16″ test section and operating in the Mach number range from 0.4 to 1.4, and a supersonic wind tunnel having a 4″ × 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 consists 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.

The Chemical laboratories of the Department of Metallurgy and Chemistry are well equipped for instructional purposes at both the graduate and undergraduate level. Noteworthy among the available facilities are a Beckman spectrophotometer, an advanced-design adiabatic fractionating column, a plastics laboratory unit where experimental plastics may be prepared, photo-elastic equipment for studies of tensile and compressive strain effects on transparent plastics, a drop-weight apparatus for explosives testing, and equipment for radioactivity studies, as well as precision equipment for studies in analytical and physical chemistry and a well-equipped fuel and lubricant laboratory.

In the new Engineering School building, additional facilities will be available for making, fabricating and testing plastics. The fabricating facilities will include an injection molding press, several 12-ton compression molding presses and two 30-ton compression molding presses.

The Metallurgy laboratory facilities of the Department of Metallurgy and Chemistry include heat treatment and materials fabricating and testing laboratories, a metallography laboratory and a crystallographic laboratory. The heat treatment equipment includes induction heating units and heat treating furnaces. The testing equipment includes three universal testing machines, Rockwell hardness testers and a microhardness machine. The materials fabricating equipment include a rolling mill and a swaging machine. Equipment used in crystal structure studies includes various types of powder cameras, heating cameras for obtaining diffraction patterns at controlled elevated temperatures, Weissenberg x-ray goniometers and a precision recording photodensitometer. Also available are several x-ray diffraction units, a Geiger counter spectrometer and radiographic equipment. In the metallography laboratory are bench-type microscopes and research type metallographs with completely equipped photomicrography facilities.

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 (shared with the Mathematics and Aeronautics departments), BTA motors, wave analyzers, sound meters, special servo analyzers, oscillographs, industrial analyzers, Brush recorders, dynamometers, synchroscopes, amplidynes and rototrols.

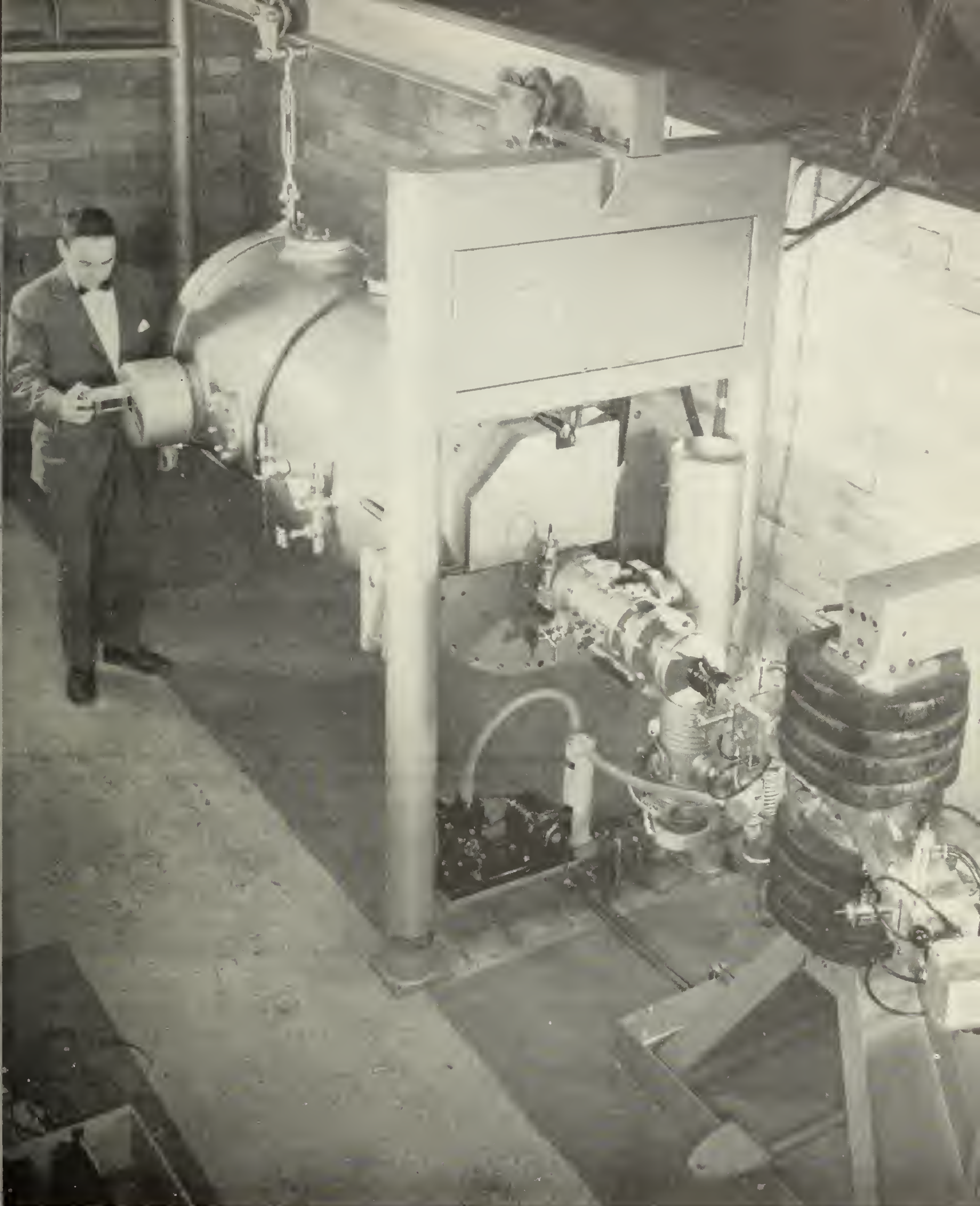
The Electrical Engineering laboratories are housed in a specially designed two-story building (132′ x 132′) adjacent to the main engineering building. The ground floor houses the machinery and high voltage laboratories, and the second floor is devoted to electronics, control, servomechanisms and measurements. 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 **Hydro-mechanics Laboratory** is being developed as new laboratory space becomes available. This laboratory will then include such items as a small circulating water tunnel and channel, and a towing tank.

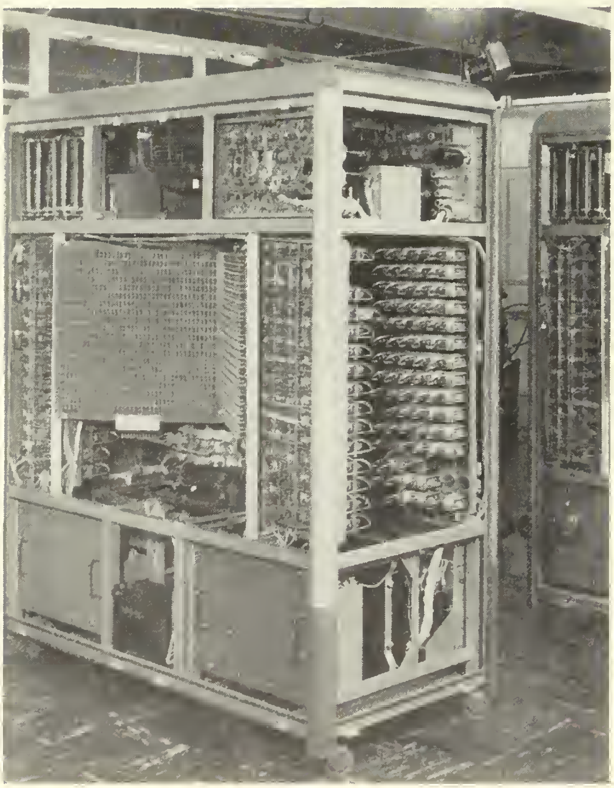
The **Electronics** laboratories are well equipped for carrying on a comprehensive program of experimental work in the various branches of the field. Facilities are available for investigating the operational characteristics of radio and electronic circuits at frequencies ranging from d-c to the microwave 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 electronic countermeasures equipment, radio aids to navigation and a broad selection of Navy radar systems.



The two-million-volt Van de Graaff nuclear accelerator, part of the physics laboratory equipment to be installed in 1954.
(Photo courtesy of High Voltage Engineering Corporation)

The jet engine pit, Aeronautical Engineering Laboratory.



The electronic digital computer. This machine, like the analog computer, is used for computation connected with research projects, and to support Mathematics Department courses in modern computing methods. With such equipment, a great variety of complex problems, such as high-order differential equations, can be solved in a few seconds, which would require several days by more conventional methods.

(By courtesy of Computer Research Corporation)
(Photo by Dean Vance)

Improved facilities are being provided for the study of telemetering systems, computing systems, modern radar systems, antenna radiation characteristics and microwave phenomena, as well as for conducting more advanced work in circuit measurements. Additional space will also be 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 Engineering School. In addition to a general purpose automatically sequenced digital computer, the computing equipment now available includes an electronic analogue differential analyzer used to find the solution to a large class 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 1,000 numbers or instructions on a drum rotating at 40 r.p.s. and 100,000 numbers or instructions on a magnetic tape. 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 from the surface; rasonde 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 measures air temperature and humidity conditions in the lower strata of the atmosphere, an inversion meter designed for remote recordings of atmospheric temperature at designated heights in the boundary layer; and a bathythermograph for recording sea temperature gradients.

RESEARCH PROJECTS

From time to time, research projects, sponsored by a material bureau or other government activity, are undertaken by members of the faculty, utilizing laboratory equipment and specialized skills. The policy of the School is to encourage such work when done without interference with routine teaching. Some outside interests are usually of benefit to the individual and also, indirectly, to the School; moreover, occasionally significant contributions to the supply of knowledge result.

Sponsored research projects are, of course, entirely separate from the normal thesis research, mandatory for the graduate degrees, conducted by the officer students or by junior faculty members.

TABLE I

CURRICULA GIVEN WHOLLY OR IN PART BY THE ENGINEERING SCHOOL

Curriculum	Group Desig.	Length	Cognizant Curricular Officer	Academic Associate
Advanced Science				
Chemistry	RC	3 yrs.	Engineering Electronics	Prof. Kinney
Mathematics	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	MA	18 mos.	Aerological	Prof. Duthie
Advanced Aerology	MS	18 mos.	Aerological	Prof. Duthie
Applied Aerology	M	1 yr.	Aerological	Prof. Duthie
Aeronautical Engineering	A, AG	2 yrs.	Aeronautical Engineering	Prof. Coates
Aerodynamics	AC	3 yrs.	Aeronautical Engineering	Prof. Coates
Armament	AR	3 yrs.	Aeronautical Engineering	Prof. Bleick
Electrical	AE	3 yrs.	Aeronautical Engineering	Prof. Vivell
Flight Performance	AF	3 yrs.	Aeronautical Engineering	Prof. Higgins
General	A	3 yrs.	Aeronautical Engineering	Prof. Coates
Industrial	AI	3 yrs.	Aeronautical Engineering	Prof. Coates
Jet Propulsion	AJ	3 yrs.	Aeronautical Engineering	Prof. Vavra
Nuclear Propulsion	AN	3 yrs.	Aeronautical Engineering	Prof. Coonan
Propulsion and Propulsion Chemistry	APC	3 yrs.	Aeronautical Engineering	Prof. Hering
Propulsion Systems	AP	3 yrs.	Aeronautical Engineering	Prof. Kohler
Seaplane Hydrodynamics	AH	3 yrs.	Aeronautical Engineering	Prof. Coates
Structures	AS	3 yrs.	Aeronautical Engineering	Prof. Coates
Command Communications	C	1 yr.	Communication	Prof. Giet
Engineering Electronics	EA	2 yrs.	Engineering Electronics	Prof. Giet
Engineering Electronics	E	3 yrs.	Engineering Electronics	Prof. Giet
Engineering Electronics (Sonar)	EW	3 yrs.	Engineering Electronics	Prof. Kinsler
Mine Warfare	RW	2½ yrs.	Ordnance Engineering	Prof. Kinsler
Naval Engineering				
Electrical Engineering	NL, NLA	2, 3 yrs.	Naval Engineering	Prof. Polk
Gas Turbines	NJ	3 yrs.	Naval Engineering	Profs. Wright, Vavra
Mechanical Engineering	NH, NHA	2, 3 yrs.	Naval Engineering	Prof. Wright
(Equalization)	NQ	2 yrs.	Naval Engineering	Prof. Wright
(Nuclear Power)	NN	3 yrs.	Naval Engineering	Prof. Wright
Petroleum Engineering	NP	3 yrs.	Naval Engineering	Prof. Coonan
Nuclear Engineering (Effects)	RZ	2 yrs.	Ordnance Engineering	Prof. Frey
Operations Analysis	RO	2 yrs.	Ordnance Engineering	Prof. Cunningham
Ordnance Engineering				
Aviation	OE	3 yrs.	Ordnance Engineering	Prof. Bleick
Explosives	OP	3 yrs.	Ordnance Engineering	Prof. Kinney
Fire Control	OF	3 yrs.	Ordnance Engineering	Prof. Bleick
General	O2	2 yrs.	Ordnance Engineering	Prof. Bleick
Industrial	O3	3 yrs.	Ordnance Engineering	
Jet Propulsion	OJ	3 yrs.	Ordnance Engineering	Prof. Bleick
Special Physics	OX	3 yrs.	Ordnance Engineering	Prof. Frey

TABLE II

CURRICULA CONDUCTED ENTIRELY AT OTHER INSTITUTIONS

Curriculum	Group Desig.	Length	Institution	Cognizant Curr. Officer	Liaison Official
Business Administration	ZKC	2 yrs.	Columbia	Communications	PNS
Business Administration	ZKH	2 yrs.	Harvard	Communications	PNS
Business Administration	ZKS	2 yrs.	Stanford	Communications	PNS
Cinematography	ZCP	1 yr.	USC	Communications	PNS
Civil Engineering, Advanced					
Sanitary Engineering	ZGM	1 yr.	Michigan	Naval Engineering	PNS
Soil Mechanics & Foundations	ZGR	1 yr.	RPI	Naval Engineering	PNS
Structures	ZGI	1 yr.	Illinois	Naval Engineering	PNS
Waterfront Facilities	ZGP	1 yr.	Princeton	Naval Engineering	PNS
Civil Engineering, Qualification	ZG	17 mos.	RPI	Naval Engineering	PNS
Comptrollership	ZS	9 mos.	GWU	Communications	Prof. A. R. Johnson
Hydrographic Engineering	ZV	1 yr.	Ohio State	Aerological	PNS
Journalism	ZNF	1 yr.	Harvard	Communications	PNS
Law	ZHH	3 yrs.	Harvard	Communications	PNS
Law	ZHY	3 yrs.	Yale	Communications	PNS
Management & Industrial Engineering	ZT	9 mos.	RPI	Naval Engineering	PNS
Metallurgical Engineering	ZNM	1 yr.	Carnegie	Naval Engineering	Assoc. Prof. J. W. Ludewig
Naval Architecture and Marine Engineering	ZNB	3 yrs.	Webb Inst.	Naval Engineering	Capt. N.W. Gokey (Ret.)
Naval Construction and Engineering	ZNB	3 yrs.	MIT	Naval Engineering	CO, NavAdmin Unit
Naval Intelligence	ZI	6 mos.	Naval Intell. School	Communications	CO
Nuclear Engineering (Advanced)	ZNE	15 mos.	MIT	Naval Engineering	CO, NavAdmin Unit
Oceanography	ZO	1 yr.	Scripps Inst.	Aerological	Sr. Student
Personnel Administration and Training	ZP	1 yr.	Stanford	Communications	PNS
Petroleum Logistics	ZL	2 yrs.	Pittsburgh	Naval Engineering	Prof. H. G. Botset
Public Information	ZIB	1 yr.	Boston Univ.	Communications	PNS (Harvard)
Religion	ZU	Various			
Special Mathematics	ZMI	2 yrs.	Illinois	Communications	PNS
Textile Engineering	ZM	2 yrs.	Georgia Inst. of Tech.	Communications	PNS

NOTE: PNS signifies the Professor of Naval Science.
An outline of each curricula listed above is given on page 60 et seq.

ADVANCED SCIENCE CURRICULA

Chemistry (RC)
Applied Mathematics (RM)
Metallurgy (RMt)
General Physics (RP)
Nuclear Physics (RX)

OBJECTIVE

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

Officers completing a curriculum in one of these scientific areas may expect certain of their shore duty assignments to be in the Office of Naval Research, in a research facility, or in a material bureau dealing in the technical aspects of new design of weapons or machinery.

CURRICULA

The Advanced Science Curricula are sponsored by the Office of Naval Research and are under the cognizance of the Officer in Charge, Engineering Electronics Curricula. The chairmen of the departments of Chemistry and Metallurgy, Mathematics and Mechanics, and Physics are the Academic Associates.

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 selected by each of the officers with the advice of the appropriate academic associate at the U. S. Naval Postgraduate School and representatives of the Office of Naval Research. 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 by the student officer with the advice of his faculty advisor at the university and the Office of Naval Research, subject to approval by the Officer in Charge, Engineering Electronics Curricula. The courses are 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.

AEROLOGY

OBJECTIVE

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

FIRST YEAR (MA)

FIRST TERM

Ma-161(C)	Algebra, Trigonometry, and Analytic Geometry	5-0
Mr-200(C)	Introduction to Synoptic Meteorology	3-0
Mr-201(C)	Weather Maps and Codes	2-12
Ph-190(C)	Survey of Physics I	3-0
		13-12

SECOND TERM

Ma-162(C)	Introduction to Calculus	5-0
Mr-202(C)	Surface Weather Map Analysis	2-12
Oc-101(C)	Introduction to Oceanography	2-1
Ph-191(C)	Survey of Physics II	3-0
		12-13

THIRD TERM

Ma-163(C)	Calculus and Vector Analysis	5-0
Mr-203(C)	Weather Analysis and Forecasting	2-12
Mr-301(C)	Synoptic Meteorology I	4-0
Mr-402(C)	Meteorological Charts and Diagrams	3-0
SL-101(L)	New Weapons Development I (Lecture)	0-1
		14-13

Field Trip during Intersessional Period

FOURTH TERM

Ma-381(C)	Elementary Probability and Statistics	4-2
Mr-204(C)	Upper Air Analysis and Forecasting	2-9
Mr-302(C)	Synoptic Meteorology II	4-0
Mr-510(C)	Climatology	2-0
Oc-201(C)	Physical Oceanography	3-0
SL-102(L)	New Weapons Development II (Lecture)	0-1
		15-12

SECOND YEAR (MA2)

FIRST TERM

Mr-215(B)	Advanced Weather Analysis and Forecasting	0-12
Mr-303(C)	Synoptic Meteorology III	4-0
Mr-403(C)	Introduction to Physical Meteorology	4-0
Mr-410(C)	Meteorological Instruments	2-3
Mr-610(C)	Sea and Swell Forecasting	2-2
		12-17

SECOND TERM

Mr-110(C)	Aerological Aspects of ABC Warfare	2-0
Mr-216(B)	Advanced Weather Analysis and Forecasting	2-12
Mr-217(B)	Upper Air Analysis and Forecasting	0-8
Oc-203(C)	Amphibious Oceanography	2-1
Oc-301(C)	Military Oceanography	2-1
		8-22

Successful completion of the above curriculum may lead to the award of the Bachelor of Science degree.

APPLIED AEROLOGY

OBJECTIVE

To prepare selected junior officers to become qualified for limited aerological duties.

FIRST YEAR (M)

FIRST TERM

Ma-162(C)	Introduction to Calculus	5-0
Mr-402(C)	Meteorological Charts and Diagrams	3-0
Mr-200(C)	Introduction to Synoptic Meteorology	3-0
Mr-211(C)	Weather Codes, Maps and Elementary Surface Analysis	2-12
		13-12

SECOND TERM

Ma-163(C)	Calculus and Vector Analysis	5-0
Mr-212(C)	Weather Map Analysis	2-12
Mr-311(B)	Synoptic Meteorology Ia	5-0
Mr-510(C)	Climatology	2-0
		14-12

THIRD TERM

Ma-381(C)	Elementary Probability and Statistics	4-2
Mr-213(C)	Weather Analysis and Forecasting	2-12
Mr-312(B)	Synoptic Meteorology IIa	5-0
Mr-403(C)	Introduction to Physical Meteorology	4-0
		15-14

FOURTH TERM

Mr-110(C)	Aerological Aspects of ABC Warfare	2-0
Mr-410(C)	Meteorological Instruments	2-3
Mr-216(B)	Advanced Weather Analysis and Forecasting	2-12
Mr-217(B)	Upper-air Analysis and Forecasting	0-8
Mr-610(C)	Sea and Swell Forecasting	2-2
		8-25

ADVANCED AEROLOGY

OBJECTIVE

To supplement by advanced studies the previous technical education of selected aerological officers, prepare them for individual investigations in the field of research and development, and educate them in the latest aerological and oceanographic techniques which are applicable to naval problems and operations.

FIRST YEAR (MS)

FIRST TERM

Ma-131(C)	Algebraic Equations and Series	3-0
Ma-132(C)	Topics in Engineering Mathematics	5-0
Oc-111(B)	General Oceanography	3-1
Ph-196(C)	Review of General Physics	5-0
		16-1

SECOND TERM

Ma-103(B)	Functions of Several Variables and Vector Analysis	5-0
Mr-411(B)	Thermodynamics of Meteorology	5-2
Mr-412(A)	Physical Meteorology	3-0
Oc-311(B)	Oceanographic Factors in Underwater Sound	3-0
		16-2

THIRD TERM

Ma-134(B)	Vector Mechanics and Introduction to Statistics	5-0
Mr-226(B)	Advanced Weather Analysis and Forecasting	2-9
Mr-228(B)	Southern Hemisphere and Tropical Meteorology	2-0
Mr-321(A)	Dynamic Meteorology I	3-0
Mr-620(B)	Sea and Swell Forecasting	2-2
SL-101(L)	New Weapons Development I (Lecture)	0-1
		14-12

FOURTH TERM

Ma-331(A)	Statistics	4-2
Mr-227(B)	Upper Air Analysis and Forecasting	2-9
Mr-322(A)	Dynamic Meteorology II	3-0
Mr-323(A)	Dynamic Meteorology III (Turbulence and Diffusion)	3-0
Mr-229(B)	Selected Topics in Meteorology	2-0
SL-102(L)	New Weapons Development II (Lecture)	0-1
		14-12

Field Trip during Intersessional Period.

SECOND YEAR (MS2)

FIRST TERM

Ma-135(B)	Partial Differential Equations and Numerical Methods	4-1
Mr-422(A)	The Upper Atmosphere	5-0
Mr-520(B)	Applied Climatology	2-2
	Thesis I	2-6
		13-9

SECOND TERM

Mr-110(C)	Aerological Aspects of ABC Warfare	2-0
Oc-213(C)	Shallow Water Oceanography	2-2
Mr-230(A)	Operational Forecasting	0-10
Mr-810(A)	Seminar	2-0
	Thesis II	4-0
		10-12

Successful completion of the above curriculum normally leads to the award of the Master of Science degree.

AERONAUTICAL ENGINEERING

OBJECTIVE

To provide officers with advanced aeronautical engineering knowledge to meet the techical 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, and aircraft propulsions, electricity and electronics as they concern the particular curriculum.

AERONAUTICAL ENGINEERING, GENERAL

These curricula consist of two years study at the Naval Postgraduate School. Qualified volunteers will be selected at the end of the fifth term to take the three-year curricula, the last year of which is spent at a civilian engineering school. When only two years are undertaken, the last year at the Naval Postgraduate School includes a performance and flight test program. Curricula for the third year at the various civilian institutions are arranged to provide emphasis on such fields as aircraft structural analysis, aircraft propulsion systems, compressibility, hydrodynamics and seaplane design, pilotless aircraft, aircraft performance, and nuclear engineering as well as general aeronautical engineering. Satisfactory completion of any three-year curriculum normally leads to the award of a graduate degree in aeronautical engineering. Satisfactory completion of two years at the Naval Postgraduate School normally leads to the award of a B.S. degree in Aeronautical Engineering.

FIRST YEAR (A)

FIRST TERM

Ae-200(C)	Rigid Body Statics of Aircraft	3-2
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
Mc-101(C)	Engineering Mechanics I	2-2
Mt-201(C)	Introduction to Physical Metallurgy	3-2
		17-10

SECOND TERM

Ae-100(C)	Basic Aerodynamics	3-4
Ae-211(C)	Stress Analysis I	4-0
Ma-112(B)	Differential Equations and Boundary Value Problems	4-0
Mc-102(C)	Engineering Mechanics II	2-2
Me-601(C)	Materials Testing Laboratory	0-2
Mt-202(C)	Ferrous Physical Metallurgy	3-2
Ae-001(L)	Aeronautical Lecture	0-1
		16-11

THIRD TERM

Ae-121(C)	Technical Aerodynamics	3-2
Ae-212(C)	Stress Analysis II	4-2
EE-111(C)	Fundamentals of Electrical Engineering	3-2
Ma-113(B)	Vector Analysis and Introduction to Partial Differential Equations	3-0
Ma-201(C)	Graphical and Mechanical Computation	0-2
SL-101(L)	New Weapons Development I (Lecture)	0-1
		13-9

FOURTH TERM

Ae-131(C)	Aerodynamics Performance	4-2
Ae-213(B)	Stress Analysis III	4-2
EE-351(C)	DC Machinery	2-2
Ma-114(A)	Partial Differential Equations and Functions of a Complex Variable	3-0
ME-131(C)	Engineering Thermodynamics	4-2
SL-102(L)	New Weapons Development II (Lecture)	0-1
		17-9

Note: Approximately six weeks of June and July 1955, Intersessional Period, will be spent in the field at aviation activities.

SECOND YEAR (AG2 and AI2)

FIRST TERM

Ae-132(B)	Flight Analysis	3-2
Ae-311(C)	Airplane Design I	2-4
Ae-410(B)	Thermodynamics (Aeronautical)	3-2
Ae-501(A)	Hydro-Aero Mechanica I	4-0
EE-241(C)	AC Circuits	3-2
IE-101(L)	Principles of Industrial Organization (Lecture)	0-1
		15-11

SECOND TERM

Ae-141(A)	Aircraft Dynamics I	3-4
Ae-151(B)	Flight Testing and Evaluation I	2-0
Ae-161(B)	Flight Testing and Evaluation Laboratory I	0-4
Ae-411(B)	Aircraft Engines	4-2
Ae-502(A)	Hydro-Aero Mechanics II	4-0
Ae-001(L)	Aeronautical Lecture	0-1
		13-11

THIRD TERM

Ae-142(A)	Aircraft Dynamics II	3-4
Ae-152(B)	Flight Testing and Evaluation II	2-0
Ae-162(B)	Flight Testing and Evaluation Laboratory II	0-4
Ae-421(B)	Aircraft Propulsion	3-2
EE-611(B)	Servomechanisms	3-4
IE-103(L)	Applied Industrial Organization (Lecture)	0-1
SL-101(L)	New Weapons Development I (Lecture)	0-1
		11-16

FOURTH TERM

Ae-153(B)	Flight Testing and Evaluation III	2-0
Ae-163(B)	Flight Testing and Evaluation Laboratory III	0-8
Ae-508(A)	Compressibility	3-2
EE-711(C)	Electronics	3-2
IE-104(L)	Technical Lectures	0-1
SL-102(L)	New Weapons Development II (Lecture)	0-1
		8-14

If practicable, a summer period for AG2 group will be spent in a civilian institution summer course in Engineering Administration before reporting to a new duty station.

SECOND YEAR (A2)

FIRST TERM

Ae-132(B)	Flight Analysis	3-2
Ae-311(C)	Airplane Design I	2-4
Ae-410(B)	Thermodynamics (Aeronautical)	3-2
Ae-501(A)	Hydro-Aero Mechanics I	4-0
EE-241(C)	AC Circuits	3-2
IE-101(L)	Principles of Industrial Organization (Lecture)	0-1
		15-11

SECOND TERM

Ae-141(A)	Aircraft Dynamics I	3-4
Ae-214(A)	Stress Analysis IV	3-0
Ae-312(B)	Airplane Design II	1-4
Ae-411(B)	Aircraft Engines	4-2
Ae-502(A)	Hydro-Aero Mechanics II	4-0
AE-001(L)	Aeronautical Lecture	0-1
		15-11

THIRD TERM

Ae-142(A)	Aircraft Dynamics II	3-4
Ae-421(B)	Aircraft Propulsion	3-2
Ae-503(A)	Compressibility I	4-0
*Ch-521(A)	Chemistry of Plastics	3-2
Ma-116(A)	Matrices and Numerical Methods	3-2
IE-103(L)	Applied Industrial Organization (Lecture)	0-1
SL-101(L)	New Weapons Development I (Lecture)	0-1
		16-12

FOURTH TERM

**Ae-215(A)	Advanced Stress Analysis	4-0
Ae-431(A)	Internal Flow in Aircraft Engines	4-0
Ae-504(A)	Compressibility II	3-2
Mc-311(A)	Vibrations	3-2
***ME-622(B)	Experimental Stress Analysis	2-2
IE-104(L)	Technical Lectures	0-1
SL-102(L)	New Weapons Development II (Lecture)	0-1
	A2 & AP2 Group	16-8
	AF2 Group	16-10
	AN2 Group	17-9

*Substitute as follows:
(AN2) Nuclear Group
Ch-561(C) Physical Chemistry 3-2
(AP2) Propulsion Group
Ch-561(A) Physical Chemistry 3-2

**Substitute as follows:
(AF2) Performance Group
EE-715(C) Electronics 3-4

***Substitute as follows:
(AF2) Performance Group
Ma-118(A) Mathematics of Stability Analysis 3-0
(AN2) Nuclear Group
Ph-640(B) Atomic Physics 3-3
(AP2) Propulsion Group
Ch-541(A) Reaction Motors 2-2

Summer period will be spent in a civilian institution summer course in Engineering Administration.

THIRD YEAR CURRICULA
Aeronautical Engineering, General

THIRD YEAR (A3) AT THE UNIVERSITY OF MICHIGAN

Ae-102 Advanced Design
115 Theoretical Aerodynamics
116 Advanced Fluid Mechanics
118 Adv. Experimental Aerodynamics
112 Turbulence and Diffusion
133 Advanced Airplane Structures
134 Materials and Structures
150 Rotary Wing Aircraft
160 Seminar
161 Research (Thesis)
166 Aircraft Propulsion Laboratory
167 Topics in Aircraft Propulsion
170 Seminar on Electronic Analog Computers
171 Principles of Automatic Control
172 Engr. Measurements and Physical Systems
173 Fund. of Aero Instruments and Research Techniques
175 Engr. Applications of the Differential Analyzer
Ae-176 Flight Testing
178 Design of Electronic Analog Computers
179 Gyrokinetics
190 Introduction of Nuclear Engineering
201 Dynamics of Viscous Fluids
202 Dynamics of Compressible Fluids
210 Advanced Engineering Measurements
212 Control & Guides of Pilotless Aircraft
214 Telemetry and Remote Control of Aircraft
248 Advanced Feedback Control
250 Theory of Oscillation of Nonlinear Systems
251 Theory of Nonlinear System Response
252 Seminar Simulation & Solution of Nonlinear Systems
261 Gas Dynamics
262 Combustion and Flame Propagation
275 Advanced Applications of the Differential Analyzer
295 Theory of Nuclear Power

Students may specialize in Aerodynamics, Structures, Mechanics of Flight, Propulsion or Instrumentation and Control. The student will, in consultation with the Graduate Committee, subject to approval of the U. S. Naval Postgraduate School, prepare a schedule of courses including thesis. Courses included in the requirements are six hours of graduate level mathematics and one aeronautical engineering course numbered above 200. He may transfer up to six hours of graduate level hours required for the degree.

SECOND AND THIRD YEAR (A2 and A3)
AT THE COLLEGE OF AERONAUTICS, CRANFIELD, ENGLAND

At the end of the first year of work in the A curriculum at the Postgraduate School certain students may be selected for study at the College of Aeronautics. Students selected may choose a curriculum from the following options:

Aerodynamics
Aircraft Design
Aircraft Propulsion
Aircraft Economics and Production
Aircraft Electronics

Aeronautical Engineering, Aerodynamics
THIRD YEAR (AC3) CALIFORNIA INSTITUTE OF TECHNOLOGY

Ae-260 Research
Ae-261 Hydrodynamics of Compressible Fluids
Ae-266 Real and Perfect Fluids
Ae-265 Adv. Problems in Aerodynamics
Ae-271 Exper. Methods in Aeronautics
Ae-269 Seminar in Fluid Mechanics
Ae-290 Aeronautical Seminar
Thesis

THIRD YEAR (AC3) AT UNIVERSITY OF MINNESOTA

FALL TERM

*Ae-116 Advanced Airplane Stresses
**Ae-201 Aerodynamics of Compressible Flow
Ae-220 High Speed Performance and Design
Ae-280 Thesis

WINTER TERM

Ae-241 Dynamics of Aircraft Structures
Ae-202 Compressible Fluids
Ae-203 High Speed Performance and Design
Ae-280 Thesis

SPRING TERM

Ae-118 Stresses on Aircraft Structures
Ae-204 Supersonic Aerodynamics Laboratory
ME-253 Advanced Gas Turbines
Ae-280 Thesis

*Candidates who have taken Ae-213(B), Stress Analysis, at the U. S. Naval Postgraduate School, and received a grade of B or better, may apply for transfer credit.

**Candidates who have taken Ae-503(A), Compressibility, at the U. S. Naval Postgraduate School, and received a grade of B or better, may apply for transfer credit.

In case transfer credit is granted for either or both of these subjects, they will not be taken and course Ae-204, Supersonic Aerodynamics Laboratory, will will be taken in the Fall Term in order to leave more free time during the Spring Term for thesis work.

Aeronautical Engineering, Flight Performance

THIRD YEAR (AF3) AT PRINCETON UNIVERSITY

FALL TERM

AE-561 Aero Elasticity
AE-565 Airplane Dynamics
AE-567 Helicopter Analysis
AE-583 Advanced Airplane Performance
Thesis

SPRING TERM

AE-566 Airplane Dynamics
AE-568 Helicopter Analysis
EE-528 Servomechanisms
Instrumentation Seminar
Thesis

Aeronautical Engineering, Seaplane Hydrodynamics

THIRD YEAR (AH3) AT STEVENS INSTITUTE OF TECHNOLOGY AND NEW YORK UNIVERSITY

FALL TERM

FD-203 Mechanics of Fluid Resistance
FD-204 Hydrodynamic Theory
FD-215 Seaplane Design I
*FD-217 Marine and Aircraft Propulsion I
*FD-213 Special Problems, Fluid Dynamics I
*MA-517 Ordinary and Partial Differential Equations
*MA-519 Advanced Calculus I
*AE-206 Applied Elasticity
Thesis

SPRING TERM

FD-210 Experimental Mathematics in Hydrodynamics
FD-216 Seaplane Design II
FD-211 Mechanics of Bodies in Fluids
*FD-218 Marine and Aircraft Propulsion II
*FD-214 Special Problems, Fluid Dynamics II
*MA-520 Advanced Calculus II
*AE-117 Aircraft Structural Laboratory
AE-210 Aircraft Stress Analysis
Thesis

*Elective Courses

Aeronautical Engineering, Industrial

THIRD YEAR (AI3) AT PURDUE UNIVERSITY

SUMMER TERM

GE-370 Elements of Accounting
GE-575 Motion and Time Study
GE-578 Production Planning and Control

FALL TERM

GE-570 Cost Accounting
GE-585 Industrial Relations
GE-579 Advanced Production Control
Math-557 Statistical Methods in Engineering
PSY-570 Personnel Psychology
GE-698 Thesis

SPRING TERM

GE-583 Plant Layout
GE-592 Adv. Industrial Engineering Problems
PSY-574 Psychology of Industrial Training
GE-698 Thesis

THIRD YEAR (AI3) AT RENSSELAER POLYTECHNIC INSTITUTE

SUMMER TERM

Elementary Accounting
Introduction to Motion and Time Study
Plus other prerequisite material

FIRST TERM

G 6.02 Cost Analysis
G 6.15 Advanced Motion and Time Study
G 6.18 Production Management
G 6.10 Personnel Management
Thesis

SECOND TERM

G 6.28 Application of Statistical Theory
G 6.11 Industrial Relations
G 6.05 Law for Engineers
Electives
Thesis

Aeronautical Engineering, Jet Propulsion

THIRD YEAR (AJ3) AT CALIFORNIA INSTITUTE OF TECHNOLOGY

FALL TERM

Ae-261 Hydrodynamics of Compressible Fluids
Ae-271 Experimental Methods in Aeronautics
JP-121 Rockets
JP-130 Thermal Jets

SPRING TERM

JP-200 Chemistry in Jet Propulsion
JP 280 Research in Jet Propulsion
Ae-290 Aeronautics Seminar
Thesis

THIRD YEAR (AJ3) AT UNIVERSITY OF MINNESOTA

FALL TERM

*AE-116 Advanced Airplane Stresses
**AE-201 Aerodynamics of Compressible Fluids
ME-252 Advanced Reciprocating Engines
Thesis

WINTER TERM

AE-241 Dynamics of Aircraft Structures
AE-202 Compressible Fluids
ME-253 Advanced Gas Turbines
Thesis

SPRING TERM

AE-119 Stresses on Aircraft Structures
AE-204 Supersonic Aerodynamics Laboratory
ME-255 Thermal Jets and Rockets
Thesis

*Candidates who have taken Ae-213(B), Stress Analysis, at the U. S. Naval Postgraduate School, and received a grade of B or better, may apply for transfer credit.

**Candidates who have taken Ae-503(A), Compressibility, at the U. S. Naval Postgraduate School, and received a grade of B or better, may apply for transfer credit.

In case transfer credit is granted for either or both of these subjects they will not be taken and course Ae-204, Supersonic Aerodynamics Laboratory, will be taken in the Fall Term in order to leave more time during the Spring Term for thesis work.

THIRD YEAR (AJ3)AT PRINCETON UNIVERSITY

FALL TERM

AE-563 Jet Propulsion
AE-581 Gas Dynamics
AE-587 Rockets
AE-589 Fluid Friction and Heat Transfer
Thesis

SPRING TERM

AE-564 Jet Propulsion
AE-582 Gas Dynamics
AE-589 Fluid Friction and Heat Transfer
AE-586 Combustion Problems in Jet Propulsion, or, Mechanical Aspects of Jet Engines
Thesis

Aeronautical Engineering, Nuclear Propulsion

THIRD YEAR (AN3) AT IOWA STATE COLLEGE

FALL TERM

Engg.-501 Elements of Nuclear Engineering
Engg.-620 Seminar
Lib.-614 Bibliographical Research
Phys.-435 Nuclear Physics for Engineers
*ME-325 Heat Transfer
Chem.-529 Radiochemistry
Engg.-600 Research

WINTER TERM

Engg.-502 Reactor Materials and Structures
Phys.-346 Nuclear Physics for Engineers
Chem.-529 Radiochemistry
**Engg.-600 Research

SPRING TERM

Engg.-503 Reactor Fuels and Wastes
Engg.-504 Reactor Design
Engg.-600 Research (Thesis)

*Technical elective to be substituted if candidate has credit in ME-325.

**Physics-422 (Quantum Mechanics) may be substituted for three credits of Engg.-600.

THIRD YEAR (AN3) AT OAK RIDGE SCHOOL OF REACTOR TECHNOLOGY

Reactor Chemistry	36 hours
Nuclear Physics	36 or 72 hours
Reactor Theory	186 hours
Experimental Reactor Physics	90 hours
Metallurgy and Ceramics	72 hours
Engineering	36 or 72-hours
Reactor Engineering	72 hours
Reactor Design Problems or Component Development Research	500 hours

Aeronautical Engineering, Propulsion Systems

THIRD YEAR (AP3) AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY

FALL TERM

2.213 Gas Turbines
2.797 Internal Combustion Engines, Advanced
10.70 Combustion Principles
16.105 Applied Aerodynamics
Thesis

SPRING TERM

2.212 Advanced Mechanics
2.798 Internal Combustion Engines, Advanced
16.56 Jet Propulsion Engines
Thesis

Aeronautical Engineering, Structures

THIRD YEAR (AS3) AT CALIFORNIA INSTITUTE OF TECHNOLOGY

Ae-260 Research
Ae-270 Elasticity Applied to Aeronautics
Ae-271 Experimental Methods in Aeronautics
Ae-274 Aeroelasticity

Ae-275 Seminar in Solid Mechanics
Ae-290 Aeronautics Seminar
AM-150 Vibration and Flutter
Thesis

THIRD YEAR (AS3) AT UNIVERSITY OF MINNESOTA

FALL TERM

*Ae-116 Advanced Airplane Stresses
**Ae-201 Aerodynamics of Compressible Fluids
Ae-240 Dynamics of Airplane Structures
Ae-280 Thesis

WINTER TERM

Ae-117 Advanced Airplane Stresses
Ae-202 Compressible Fluids
Ae-241 Dynamics of Aircraft
Ae-280 Thesis

SPRING TERM

Ae-118 Stresses in Aircraft Structures
Ae-204 Supersonic Aerodynamics Laboratory
Ae-119 Structural Test of Aircraft
Ae-280 Thesis

*Candidates who have taken Ae-213(B), Stress Analysis, at the U. S. Naval Postgraduate School, and received a grade of B or better, may apply for transfer credit.

**Candidates who have taken Ae-503(A), Compressibility, at the U. S. Naval Postgraduate School, and received a grade of B or better, may apply for transfer credit.

In case transfer credit is granted for either or both of these subjects, they will not be taken, and course Ae-204, Supersonic Aerodynamics Laboratory, will be taken in the Fall Term in order to leave the Spring Term more free for thesis work.

Aeronautical Engineering, Propulsion and Propulsion Chemistry

This curriculum is a more specialized form of the General Propulsion curriculum. It consists of two years study at the Postgraduate School during which time greater emphasis is placed upon the chemistry of propulsion, including both fuels and lubricants. The third year, at a civilian university, will be devoted primarily to propulsion.

FIRST YEAR (APC)

FIRST TERM

Ae-200(C)	Rigid Body Statics of Aircraft	3-2
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	3-0
Mt-201(C)	Introduction to Physical Metallurgy	3-2
Ch-101(C)	General Inorganic Chemistry	3-2
		17-8

SECOND TERM

Ae-100(C)	Basic Aerodynamics	3-4
Ae-211(C)	Stress Analysis I	4-0
Ma-112(B)	Differential Equations and Boundary Value Problems	4-0
Me-601(C)	Materials Testing Laboratory	0-2
Mt-202(C)	Ferrous Metals	3-2
Ch-111(A)	Fuel and Oil Chemistry	2-2
Ae-001(L)	Aeronautics Lecture	0-1
		16-11

THIRD TERM

Ae-212(C)	Stress Analysis II	4-2
Ch-311(C)	Organic Chemistry	3-2
Ch-411(C)	Physical Chemistry	3-2
EE-111(C)	Fundamentals of Electrical Engineering	3-2
Ma-113(B)	Vector Analysis and Introduction to Partial Differential Equations	3-0
Ma-201(C)	Graphical and Mechanical Computations	0-2
SL-101(L)	New Weapons Development I (Lecture)	0-1
		16-11

FOURTH TERM

Ae-213(B)	Stress Analysis II	4-2
Ch-312(C)	Organic Chemistry	3-2
Ch-412(C)	Physical Chemistry	3-2
EE-351(C)	DC Machinery	2-2
Ma-114(A)	Partial Differential Equations and Function of a Complex Variable	3-0
SL-102(L)	New Weapons Development II (Lecture)	0-1
		15-9

Summer will be spent in the field at aviation activities.

SECOND YEAR (APC2)

FIRST TERM

Ae-311(C)	Airplane Design I	2-4
Ae-410(B)	Thermodynamics (Aero)	3-2
Ae-510(A)	Hydro-Aero Mechanics I	4-0
Ch-521(A)	Plastics	3-2
EE-241(C)	AC Circuits	3-2
IE-101(L)	Principles of Industrial Organization (Lecture)	0-1
		15-9

SECOND TERM

Ae-411(B)	Aircraft Engines	4-2
Ae-502(A)	Hydro-Aero Mechanics II	4-0
Ch-541(A)	Reaction Motors	2-2
Ge-101(C)	Physical Geology	3-0
Ge-401(C)	Petrology and Petrography	3-2
Ae-001(L)	Aeronautical Lecture Series	0-1
		16-7

THIRD TERM

Ae-121(C)	Technical Aerodynamics	3-2
Ae-146(A)	Dynamics	3-2
Ae-421(B)	Aircraft Propulsion	3-2
Ae-503(A)	Compressibility I	4-0
Mt-203(B)	Physical Metallurgy	2-2
IE-103(L)	Applied Industrial Organization (Lecture)	0-1
SL-101(L)	New Weapons Development I (Lecture)	0-1
		15-10

FOURTH TERM

Ae-136(B)	Aircraft Performance Flight Analysis	3-2
Ae-431(A)	Internal Flow in Aircraft Engines	4-0
Ae-540(A)	Compressibility II	3-2
Ch-581(A)	Chemistry of Special Fuels	2-2
Me-131(C)	Engineering Thermodynamics	4-2
IE-104(L)	Technical Lectures	0-1
SL-102(L)	New Weapons Development II (Lecture)	0-1
		16-10

The summer period will be spent in a civilian institution summer course in Engineering Administration.

THIRD YEAR (APC3)

This course will become AJ3 or AP3 at the option of the student and will be available at universities now offering AJ3 and AP3, listed on preceding pages.

AERONAUTICAL ENGINEERING, ARMAMENT

This curriculum consist of two years study at the Postgraduate School. Selected students will continue for a third year of study at the Massachusetts Insitute of Technology. Satisfactory completion of the three-year curriculum normally leads to the award of a graduate degree. This curriculum is designed to cover electrical, aeronautical, and mechanical engineering subjects and related mathematics, metallurgy, electronics, and ordnance courses. The third year at Massachusetts Institute of Technology majors in guided missile electronics controls and fire control systems.

FIRST YEAR (AR)

FIRST TERM

Ae-200(C)	Rigid Body Statics of Aircraft	3-2
Ch-101(C)	General Inorganic Chemistry	3-2
EE-151(C)	DC Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-3
		16-12

SECOND TERM

Ae-100(C)	Basic Aerodynamics	3-4
Ae-211(C)	Stress Analysis I	4-0
EE-251(C)	AC Circuits	3-4
Ma-112(B)	Differential Equations and Boundary Value Problems	4-0
Mc-102(C)	Engineering Mechanics II	2-2
Ae-001(L)	Aeronautical Lecture	0-1
		16-11

THIRD TERM

Ae-121(C)	Technical Aerodynamics	3-2
Ae-212(C)	Stress Analysis II	4-2
EE-463(C)	Control Motors, Trans. and EM Devices	3-2
Ma-113(B)	Vector Analysis and Introduction to Partial Differential Equations	3-0
Ma-201(C)	Graphic and Mechanical Computation	0-2
Mt-201(C)	Introductory Physical Metallurgy	3-2
SL-101(L)	New Weapons Development I (Lecture)	0-1
		16-11

FOURTH TERM

Ae-136(B)	Aircraft Performance	3-2
Ae-213(B)	Stress Analysis III	4-2
EE-771(B)	Electronics	3-2
Ma-114(A)	Partial Differential Equations and Functions of a Complex Variable	3-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
SL-102(L)	New Weapons Development II (Lecture)	0-1
		16-9

Six weeks intersessional period in the field at aviation activities.

SECOND YEAR (AR2)

FIRST TERM

Ae-311(C)	Aircraft Design	2-4
Ae-501(A)	Hydro-Aero Mechanics I	4-0
EE-551(B)	Transmission Lines and Filters	3-2
EE-772(B)	Electronics	3-2
Ma-115(A)	Differential Equations for Automatic Control	3-0
IE-101(L)	Principles of Industrial Organization (Lecture)	0-1
		15-9

SECOND TERM

Ae-502(A)	Hydro-Aero Mechanics II	4-0
EE-755(A)	Electronic Control and Measurement	3-4
Ma-116(A)	Matrices and Numerical Methods	3-2
Ma-401(A)	Mathematical Computation by Physical Means	3-2
Mc-201(A)	Methods in Dynamics	2-2
Ae-001(L)	Aeronautical Lecture	0-1
		15-11

THIRD TERM

Ae-146(C)	Aircraft Dynamics	3-2
Ae-508(A)	Compressibility	3-2
EE-671(A)	Transients	3-4
Mc-401(A)	Exterior Ballistics	3-0
Or-241(C)	Guided Missiles I	2-0
IE-103(L)	Applied Industrial Organization (Lecture)	0-1
SL-101(L)	New Weapons Development I (Lecture)	0-1
		14-10

FOURTH TERM

EE-672(A)	Servomechanisms	3-3
Es-456(C)	Introduction to Radar (Airborne)	2-2
Mc-402(A)	Dynamics of Missiles and Gyros	3-0
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
Or-242(B)	Guided Missiles II	2-0
IE-104(L)	Technical Lectures	0-1
SL-102(L)	New Weapons Development II (Lecture)	0-1
		12-9

Summer period will be spent in a civilian institution summer course in Engineering Administration.

THIRD YEAR (AR3) AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY

FALL TERM

16.472	Projectiles, Missiles and Rockets
13.39	Vector Kinematics and Gyroscopic Instrument Theory
16.15	Advanced Stability and Control of Aircraft
16.41	Fire Control Principles
16.43	Fire Control Instrument Laboratory
	Thesis

SPRING TERM

16.42	Fire Control Systems
16.44	Advanced Fire Control Instrument Laboratory
16.40	Automatic Control Equipment for Aircraft
	Thesis

AERONAUTICAL ENGINEERING, ELECTRICAL

This curriculum consists of two years study at the Naval Postgraduate School. Selected students will continue for a third year of study at the Naval Postgraduate School. Satisfactory completion of the three-year curriculum normally leads to the award of a graduate degree in electrical engineering. This curriculum is designed to provide major emphasis on electricity and is supported by aeronautics, mathematics, metallurgy, electronics, and mechanics. The objective of this curriculum is to provide electrical engineers who will have a good understanding of aeronautical engineering.

FIRST YEAR (AE)

FIRST TERM

Ae-200(C)	Rigid Body Statics of Aircraft	3-2
Ch-101(C)	General Inorganic Chemistry	3-2
EE-171(C)	Electric Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
		16-12

SECOND TERM

Ae-100(C)	Basic Aerodynamics	3-4
Ae-211(C)	Stress Analysis I	4-0
EE-271(C)	AC Circuits	3-2
Ma-112(B)	Differential Equations and Boundary Value Problems	4-0
Mc-102(C)	Engineering Mechanics II	2-2
Ae-001(L)	Aeronautical Lecture	0-1
		16-9

THIRD TERM

Ae-121(C)	Technical Aerodynamics I	3-2
Ae-212(C)	Stress Analysis II	4-2
EE-272(B)	AC Circuits	2-2
Ma-113(B)	Vector Analysis and Introduction to Partial Differential Equations	3-0
Ma-201(C)	Graphic and Mechanical Computation	0-2
Mt-201(C)	Introductory Physical Metallurgy	3-2
SL-101(L)	New Weapons Development I (Lecture)	0-1
		15-11

FOURTH TERM

Ae-136(B)	Aircraft Performance	3-2
Ae-213(B)	Stress Analysis III	4-2
EE-371(C)	DC Machinery	3-2
Ma-114(A)	Partial Differential Equations and Functions of a Complex Variable	3-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
SL-102(L)	New Weapons Development II (Lecture)	0-1
		16-9

Six weeks intersessional period in the field at aviation activities.

SECOND YEAR (AE2)

FIRST TERM

Ae-311(C)	Aircraft Design	2-4
Ae-501(A)	Hydro-Aero Mechanics I	4-0
EE-471(C)	Transformers and Asynchronous Machines	3-4
Ma-105(A)	Fourier Series and Boundary Value Problems	4-0
IE-101(L)	Principles of Industrial Organization (Lecture)	0-1
		13-9

SECOND TERM

Ae-502(A)	Hydro-Aero Mechanics II	4-0
EE-472(C)	Synchronous Machines and Synchros	3-4
EE-971(A)	Seminar	1-0
Ma-106(A)	Complex Variable and Laplace Transform	4-0
Mc-201(A)	Methods in Dynamics	2-2
Ae-001(L)	Aeronautical Lecture	0-1
		14-7

THIRD TERM

Ae-146(A)	Aircraft Dynamics	3-2
Ae-508(A)	Compressibility	3-2
EE-571(B)	Transmission Lines and Filters	3-4
EE-771(B)	Electronics	3-2
EE-971(A)	Seminar	1-0
IE-103(L)	Applied Industrial Organization (Lecture)	0-1
SL-101(L)	New Weapons Development I (Lecture)	0-1
		13-12

FOURTH TERM

Ch-521(A)	Plastics	3-2
EE-671(A)	Transients	3-4
EE-772(B)	Electronics	3-2
EE-971(A)	Seminar	1-0
MT-203(B)	Physical Metallurgy (Special Topics)	2-2
IE-104(L)	Technical Lectures	0-1
SL-102(L)	New Weapons Development II (Lecture)	0-1
		12-12

THIRD YEAR (AE3)

FIRST TERM

EE-672(A)	Servomechanisms	3-3
EE-871(A)	Electrical Machine Design	4-0
Es-267(A)	Electron Tubes and UHF Techniques	3-2
Es-326(A)	Radio Systems	3-3
	Thesis	0-3
		13-11

SECOND TERM

EE-872(A)	Electrical Machine Design	4-0
EE-971(A)	Seminar	1-0
Es-421(B)	Pulse Techniques	2-3
	Thesis	0-10
		7-13

THIRD TERM

EE-873(A)	Electrical Machine Design	4-0
EE-971(A)	Seminar	1-0
Es-422(B)	Radar System Engineering	3-3
	Thesis	0-10
		8-13

FOURTH TERM

EE-874(A)	Electrical Machine Design	4-0
EE-971(A)	Seminar	1-0
Es-423(B)	Radar System Engineering	3-6
Es-536(B)	Countermeasures	2-3
	Thesis	0-6
		10-15

COMMAND COMMUNICATIONS (C)

OBJECTIVE

To prepare officers for communication, operations and staff duties, and to better fit them for command.

This curriculum majors in practical communications, operations, tactics, electronics, administration and management. Students are required to enroll in Naval War College correspondence course in Strategy and Tactics and to complete the first four assignments prior to graduation.

FIRST TERM

Co-101(C)	Communication Principles and Procedures	3-2
Co-111(C)	Communications-Electronics Security	2-0
Co-131(C)	Naval Warfare Tactics and Procedures	4-3
Co-135(C)	Correspondence Course in Strategy and Tactics	
Co-141(C)	Public Speaking	0-1
Co-161(C)	Administration and Management	3-0
Es-281(C)	Electronics Fundamentals	3-3
IE-101(L)	Principles of Industrial Organization	0-1
		15-10

SECOND TERM

Co-102(C)	Communication Principles and Procedures	3-2
Co-112(C)	Communications-Electronics Security	1-1
Co-132(C)	Naval Warfare Tactics and Procedures	4-3
Co-135(C)	Correspondence Course in Strategy and Tactics	
Co-142(C)	Public Speaking	0-1
Co-162(C)	Naval Fiscal Management	0-3
Es-282(C)	Vacuum Tube Circuits	3-3
		11-13

THIRD TERM

Co-113(C)	Cryptographic Methods and Procedures	1-1
Co-123(C)	Naval Communications Afloat and Ashore	3-2
Co-133(C)	Naval Warfare Tactics and Procedures	4-3
Co-135(C)	Correspondence Course in Strategy and Tactics	
Es-386(C)	Transmitters and Receivers	3-3
Es-786(C)	RF Energy Transmission	3-3
IE-103(L)	Applied Industrial Organization	0-1
SL-101(L)	New Weapons Development (I)	0-2
		14-15

FOURTH TERM

Co-114(C)	Cryptographic Methods and Procedures	0-2
Co-124(C)	Naval Communications Afloat and Ashore	3-2
Co-134(C)	Naval Warfare Tactics and Procedures	4-3
Co-135(C)	Correspondence Course in Strategy and Tactics	
Co-154(C)	Military Communication Organizations	0-2
Es-586(C)	Special Systems	3-3
Ma-320(C)	Introduction to Statistics and Operations Analysis	4-0
SL-102(L)	New Weapons Development (II)	0-2
		14-14

ELECTRICAL ENGINEERING

OBJECTIVE

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

BASIC CURRICULUM (TWO YEARS)

Designed to supply, to maximum extent possible in two years, broad coverage in a variety of subjects essential to understanding of modern naval engineering, with emphasis on electrical engineering.

FIRST YEAR (NL)

FIRST TERM

Ch-101(C)	General Inorganic Chemistry	3-2
EE-171(C)	Electric Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-101(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
		13-10

SECOND TERM

Ch-111(A)	Fuel and Oil Chemistry	2-2
EE-271(C)	AC Circuits	3-2
Ma-102(C)	Differential Equations and Series	5-0
Mc-102(C)	Engineering Mechanics II	2-2
ME-500(C)	Strength of Materials	3-0
ME-601(C)	Materials Testing Laboratory	0-2
		15-8

THIRD TERM

EE-272(B)	AC Circuits	2-2
Ma-103(B)	Functions of Several Variables and Vector Analysis	5-0
Mc-201(A)	Methods in Dynamics	2-2
Mt-201(C)	Introductory Physical Metallurgy	3-2
Ph-610(B)	Atomic Physics	3-0
		15-6

FOURTH TERM

EE-371(C)	DC Machinery	3-2
Ma-104(A)	Partial Differential Equations and Related Topics	5-0
ME-111(C)	Engineering Thermodynamics	4-2
Mt-202(C)	Ferrous Physical Metallurgy	3-2
		15-6

Intersessional Field Trip; summer leave period.

SECOND YEAR (NL2)

FIRST TERM

EE-273(C)	Electrical Measurements I	2-3
EE-471(C)	Transformers and Asynchronous Machines	3-4
ME-122(C)	Engineering Thermodynamics	3-2
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
IE-101(L)	Principles of Industrial Organization (Lecture)	0-1
		10-12

SECOND TERM

EE-274(B)	Electrical Measurements II	2-3
EE-472(C)	Synchronous Machines and Synchros	3-4
EE-971(A)	Seminar	1-0
ME-221(C)	Marine Power Plant Equipment	3-2
ME-421(C)	Hydromechanics	3-2
		12-11

THIRD TERM

EE-571(B)	Transmission Lines and Filters	3-4
EE-771(B)	Electronics	3-2
EE-971(A)	Seminar	1-0
ME-222(C)	Marine Power Plant Equipment	3-4
IE-103(L)	Applied Industrial Organization (Lecture)	0-1
SL-101(L)	New Weapons Development I (Lecture)	0-1
		10-12

FOURTH TERM

EE-651(B)	Transients and Servos	3-4
EE-772(B)	Electronics	3-2
EE-971(A)	Seminar	1-0
*Mt-301(B)	High Temperature Materials	3-0
NE-103(C)	Engineering Department Organization	2-0
IE-104(L)	Technical Lectures	0-1
SL-102(L)	New Weapons Development II (Lecture)	0-1
		12-8

This curriculum normally leads to the degree of Bachelor of Science in Electrical Engineering for students who attain the required quality point rating.

* For this course, a suitable elective may be substituted. The elective must be approved by the Officer in Charge of Curricula and the Academic Associate, and must be previously scheduled in the term concerned.

ADVANCED CURRICULUM (THREE YEARS)

Designed for students, selected from the NL group at the end of the first year, whose performance and records qualify them for advanced study.

FIRST YEAR

Same as basic curriculum

SECOND YEAR (NLA2)

FIRST TERM

EE-273(C)	Electrical Measurements I	2-3
EE-471(C)	Transformers and Asynchronous Machines	3-4
Ma-105(A)	Fourier Series and Boundary Value Problems	4-0
ME-122(C)	Engineering Thermodynamics	3-2
IE-101(L)	Principles of Industrial Organization (Lecture)	0-1
		12-10

SECOND TERM

EE-472(C)	Synchronous Machines and Synchros	3-4
EE-971(A)	Seminar	1-0
Ma-106(A)	Complex Variables and Laplace Transform	4-0
ME-221(C)	Marine Power Plant Equipment	3-2
ME-421(C)	Hydromechanics	3-2
		14-8

THIRD TERM

EE-571(B)	Transmission Lines and Filters	3-4
EE-771(B)	Electronics	3-2
EE-971(A)	Seminar	1-0
ME-222(C)	Marine Power Plant Equipment	3-4
IE-103(L)	Applied Industrial Organization (Lecture)	0-1
SL-101(L)	New Weapons Development I (Lecture)	0-1
		10-12

FOURTH TERM

EE-671(A)	Transients	3-4
EE-772(B)	Electronics	3-2
EE-971(A)	Seminar	1-0
ME-223(B)	Marine Power Plant Analysis	2-4
ME-310(B)	Heat Transfer	3-2
IE-104(L)	Technical Lectures	0-1
SL-102(L)	New Weapons Development II (Lecture)	0-1
		12-14

Intersessional Field Trip; summer leave period.

THIRD YEAR (NLA3)

FIRST TERM

EE-672(A)	Servomechanisms	3-3
EE-871(A)	Electrical Machine Design	4-0
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
or		
Mt-301(B)	High Temperature Materials	3-0
NE-101(C)	Main Propulsion Plants	3-0
Ph-361(A)	Electromagnetism	3-0
		15-5 or 16-3

SECOND TERM

EE-274(B)	Electrical Measurements II	2-3
EE-872(A)	Electrical Machine Design	4-0
EE-971(A)	Seminar	1-0
EE-972(A)	Thesis	2-6
Ph-362(A)	Electromagnetic Waves	3-0
		12-9

THIRD TERM

EE-873(A)	Electrical Machine Design	4-0
EE-971(A)	Seminar	1-0
EE-972(A)	Thesis	2-12
NE-102(C)	Auxiliary Machinery	3-0
		10-12

FOURTH TERM

EE-874(A)	Electrical Machine Design	4-0
EE-971(A)	Seminar	1-0
EE-972(A)	Thesis	2-8
*Ma-301(B)	Statistics	3-2
NE-103(C)	Engineering Department Administration	2-0
		12-10

This curriculum normally leads to the degree of Master of Science in Electrical Engineering for those who attain the required quality point rating and complete a satisfactory thesis.

* For this course, a suitable elective may be substituted. The elective must be approved by the Officer in Charge of Curricula and the Academic Associate, and must be previously scheduled in the term concerned.

ENGINEERING ELECTRONICS

The Engineering Electronics curriculum include:

1. A three-year curriculum presented at graduate level for general naval electronics applications.

2. A three-year curriculum presented at graduate level for general naval electronics applications, but specializing in acoustics. Student officers are selected for this course at their request during their second year at the Postgraduate School.

3. A two-year curriculum presented at undergraduate level for general naval electronics applications. Student officers whose first-year grades indicate they will have difficulty completing the three-year curriculum are placed in this curriculum and graduated at the end of the second year.

THREE-YEAR CURRICULUM

(Presented at graduate level)

OBJECTIVE

To educate officers in Engineering Electronics in order to prepare them for technical and administrative duties ashore and afloat involving all naval electronics equipment.

FIRST YEAR (E)

FIRST TERM

Es-111(C)	DC and AC Electric Circuits	4-5
Es-616(C)	Basic Electric and Magnetic Fields	2-2
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-101(C)	Introduction to Engineering Mathematics	3-1
Ph-211(C)	Optics	3-0
IE-101(L)	Principles of Industrial Organization (Lecture)	0-1
		14-10

SECOND TERM

Es-112(C)	AC Electricity	2-0
Es-212(C)	Electron Tubes and Circuits	4-6
Ma-102(C)	Differential Equations and Series	5-0
Ph-212(B)	Physical Optics and Introductory Dynamics	3-3
		14-9

THIRD TERM

Es-113(C)	Circuit Analysis and Measurements	3-3
Es-213(C)	Electron Tubes and Circuits	4-3
Ma-103(B)	Functions of Several Variables and Vector Analysis	5-0
Ph-113(B)	Dynamics	3-0
IE-103(L)	Applied Industrial Organization (Lecture)	0-1
SL-101(L)	New Weapons Development I (Lecture)	0-1
		15-8

FOURTH TERM

Es-114(C)	Circuit Analysis and Measurement	3-3
Es-214(C)	Electron Tubes and Circuits	4-3
Ma-104(A)	Partial Differential Equations and Related Topics	5-0
Ph-311(B)	Electrostatics and Magnetostatics	3-0
IE-104(L)	Technical Lectures	0-1
SL-102(L)	New Weapons Development II (Lecture)	0-1
		15-8

Summer leave period. Intersessional Field Trip.

SECOND YEAR (E2)

FIRST TERM

Es-225(A)	Electron Tubes	3-6
Es-621(A)	Electromagnetics	3-0
EE-314(C)	DC and AC Machinery	3-4
Ph-421(A)	Fundamental Acoustics	3-0
		12-10

SECOND TERM

Es-121(A)	Advanced Circuit Theory	3-2
Es-126(C)	Radio-Frequency Measurements	2-6
Es-622(A)	Electromagnetics	4-0
Ph-422(A)	Applied Acoustics	3-0
		12-8

THIRD TERM

Es-122(A)	Advanced Circuit Theory	3-2
Es-321(B)	Radio Systems	3-3
Es-623(A)	Electromagnetics	4-0
Ph-423(A)	Underwater Acoustics	2-3
		12-8

FOURTH TERM

Es-123(A)	Advanced Circuit Theory	3-0
Es-226(A)	Ultra-High Frequency Techniques	4-3
Es-322(B)	Radio Systems	3-3
Es-624(A)	Electromagnetics	3-0
		13-6

Intersessional Field Trip; summer leave period.

The B.S. degree in Engineering Electronics is normally awarded at the end of the second year of this curriculum to students meeting the requirements for that degree.

THIRD YEAR (E3)

FIRST TERM

Es-134(A)	Information and Communication Theory	3-0
Es-333(B)	Radio Systems	2-3
Es-431(B)	Radar System Engineering	3-3
Es-736(B)	Antennas, Transmission Lines	3-3
		11-9

SECOND TERM

Es-432(B)	Radar System Engineering	3-6
Es-531(B)	Special Systems	3-3
EE-672(A)	Servomechanisms	3-3
	Thesis	2-0
		11-12

THIRD TERM

This term is spent in an industrial electronics laboratory, such as Bell Telephone Laboratories, R.C.A., or General Electric Company. During this period the student works as a junior engineer or physicist on a selected project which forms part of, or is related to his thesis.

FOURTH TERM

Es-036(L)	Electronics Administration and Programs	2-0
Es-532(B)	Special Systems	3-3
Es-836(A)	Project Seminar	1-0
Ph-631(B)	Atomic Physics	4-0
	Thesis	4-0
		14-3

The M.S. degree in Engineering Electronics is normally awarded at the end of the third year of this curriculum to students meeting the requirements for that degree.

THREE-YEAR CURRICULUM (ACOUSTICS)

(Presented at graduate level)

OBJECTIVE

To educate officers in Engineering Electronics in order to prepare them for technical and administrative duties ashore and afloat involving all naval electronics equipment, with special emphasis on acoustics applications.

FIRST YEAR (E)

Follow first year (E) of three-year curriculum

SECOND YEAR (E2)

Follow second year (E2) of three-year curriculum except substitute Ph-424(A) Shock Waves and Sonar Development for Es-322(B) Radio Systems, and add Ph-631 Atomic Physics in fourth term. A Bachelor of Science degree in Engineering Electronics is normally awarded at the end of the second year to students meeting the requirements for that degree.

THIRD YEAR (EW3) AT UNIVERSITY OF CALIFORNIA AT LOS ANGELES

FALL SEMESTER

Phys 112 Thermodynamics and Introduction to Kinetic Theory
Phys 124 Nuclear Structures
Phys 214 Advanced Acoustics
Phys 220A Theoretical Mechanics

SPRING SEMESTER

Phys 119 Kinetic Theory of Matter
Phys 264 Advanced Acoustics Seminar
Phys 266 Propagation of Waves in Fluids
Phys 284 Experimental Techniques in Acoustics
X-141 Principles of Transducer Design and Evaluation

The degree of Master of Science (Applied Physics) is normally awarded by UCLA to students meeting the requirements for that degree.

TWO-YEAR CURRICULUM

(Presented at undergraduate level)

OBJECTIVE

To educate officers in Engineering Electronics in order to prepare them for technical and administrative duties ashore and afloat involving all naval electronic equipment.

FIRST YEAR (E)

Follow first year (E) of three-year curriculum.

SECOND YEAR (EA2)

FIRST TERM

Es-227(C)	Ultra-High-Frequency Techniques	3-2
Es-326(B)	Radio Systems	3-3
EE-314(C)	DC and AC Machinery	3-4
Ph-427(B)	Fundamental and Applied Acoustics	4-0
		13-9

SECOND TERM

Es-126(C)	Radio Frequency Measurements	2-6
Es-327(B)	Radio Systems	4-3
Es-421(B)	Pulse Techniques	2-3
Ph-428(B)	Underwater Acoustics	2-3
		10-15

THIRD TERM

Es-328(B)	Radio Systems	2-3
Es-422(B)	Radar System Engineering	3-3
Es-521(B)	Special Systems	3-3
Es-721(B)	Antennas and Wave Propagation	3-3
		11-12

FOURTH TERM

Es-036(L)	Electronics Administration and Programs	2-0
Es-423(B)	Radar System Engineering	3-6
Es-522(B)	Special Systems	3-3
Es-722(B)	Antennas and Wave Propagation	3-3
		11-12

The B.S. degree in Engineering Electronics is normally awarded at the end of the second year of this curriculum to students meeting the requirements for that degree.

GAS TURBINES

OBJECTIVE

To prepare officers in advanced mechanical engineering, with special emphasis on 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 second term, from the mechanical engineering (NH) group. Volunteers for this specialized program must have excellent previous academic records, and high grades for the first term. Mathematics and mechanics are particularly important as prerequisites.

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 the gas turbine field.

FIRST YEAR (NJ)

FIRST TERM

Ch-101(C)	General Inorganic Chemistry	3-2
EE-171(C)	Electric Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-101(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
		13-10

SECOND TERM

Ch-111(A)	Fuel and Oil Chemistry	2-2
EE-251(C)	AC Circuits	3-4
Ma-102(C)	Differential Equations and Series	5-0
Mc-102(C)	Engineering Mechanics II	2-2
NE-101(C)	Main Propulsion Plants	3-0
		15-8

THIRD TERM

EE-451(C)	Transformers and Synchros	2-2
Ma-103(B)	Functions of Several Variables and Vector Analysis	5-0
Mc-201(A)	Methods in Dynamics	2-2
ME-711(B)	Mechanics of Machinery	3-2
Mt-201(C)	Introductory Physical Metallurgy	3-2
		15-8

FOURTH TERM

EE-452(C)	Polyphase Transformers, Synchronous Machines and Induction Motors	3-4
ME-111(C)	Engineering Thermodynamics	4-2
ME-511(C)	Strength of Materials	5-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
		15-8

Intersessional Field Trip; summer leave period.

SECOND YEAR (NJ2)

FIRST TERM

ME-112(B)	Engineering Thermodynamics	4-2
ME-512(A)	Strength of Materials	5-0
ME-611(C)	Materials Testing Laboratory	2-2
ME-811(C)	Machine Design	3-2
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
		16-8

SECOND TERM

Ma-104(A)	Partial Differential Equations and Related Topics	5-0
ME-211(C)	Marine Power Plant Equipment	3-2
ME-411(C)	Hydromechanics	3-2
ME-812(B)	Machine Design	3-4
		14-8

THIRD TERM

Ae-451(C)	Gas Turbines I	4-0
ME-212(C)	Marine Power Plant Equipment	3-4
ME-412(A)	Hydromechanics	4-2
ME-712(A)	Dynamics of Machinery	3-2
		14-8

FOURTH TERM

Ae-431(A)	Internal Flow in Aircraft Engines	4-0
Aa-452(C)	Gas Turbines II	3-0
EE-751(C)	Electronics	3-4
ME-310(B)	Heat Transfer	3-2
Mt-301(A)	High Temperature Materials	3-0
		16-6

Intersessional Field Trip; summer leave period.

THIRD YEAR (NJ3)

At Massachusetts Institute of Technology

FALL TERM

2.49 Fluid Mechanics, Advanced
2.213 Gas Turbines
2.521 Heat Transfer, Advanced
Thesis

SPRING TERM

2.783 Control Problems in Mechanical Engineering
2.28 Fluid Machinery
Thesis

This curriculum leads to the degree of Bachelor of Science at end of second year, and Master of Science on completion of third year.

MECHANICAL ENGINEERING

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 understanding of modern naval engineering.

FIRST YEAR (NH)

FIRST TERM

Ch-101(C)	General Inorganic Chemistry	3-2
EE-171(C)	Electric Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-101(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
		13-10

SECOND TERM

Ch-111(A)	Fuel and Oil Chemistry	2-2
EE-251(C)	AC Circuits	3-4
Ma-102(C)	Differential Equations and Series	5-0
Mc-102(C)	Engineering Mechanics II	2-2
NE-101(C)	Main Propulsion Plants	3-0
		15-8

THIRD TERM

EE-351(C)	DC Machinery	2-2
EE-451(C)	Transformers and Synchros	2-2
Ma-103(B)	Functions of Several Variables and Vector Analysis	5-0
Mc-201(A)	Methods in Dynamics	2-2
Mt-201(C)	Introductory Physical Metallurgy	3-2
		14-8

FOURTH TERM

EE-452(C)	Polyphase Transformers, Synchronous Machines and Induction Motors	3-4
ME-111(C)	Engineering Thermodynamics	4-2
ME-511(C)	Strength of Materials	5-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
		15-8

Intersessional Field Trip; summer leave period.

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)	Materials Testing Laboratory	2-2
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
IE-101(L)	Principles of Industrial Organization (Lecture)	0-1
		14-9

SECOND TERM

ME-221(C)	Marine Power Plant Equipment	3-2
ME-422(B)	Hydromechanics	2-2
ME-622(B)	Experimental Stress Analysis	2-2
ME-711(B)	Mechanics of Machinery	3-2
Mt-301(A)	High Temperature Materials	3-0
		13-8

THIRD TERM

ME-217(C)	Internal Combustion Engines (Diesel)	3-2
ME-222(C)	Marine Power Plant Equipment	3-4
ME-712(A)	Dynamics of Machinery	3-2
*NE-102(C)	Auxiliary Machinery	3-0
IE-103(L)	Applied Industrial Organization (Lecture)	0-1
SL-101(L)	New Weapons Development I (Lecture)	0-1
		12-10

FOURTH TERM

*EE-751(C)	Electronics	3-4
ME-223(B)	Marine Power Plant Analysis	2-4
ME-820(C)	Machine Design	2-4
NE-103(C)	Engineering Department Administration	2-0
IE-104(L)	Technical Lectures	0-1
SL-102(L)	New Weapons Development II (Lecture)	0-1
		9-14

This curriculum normally leads to the degree of Bachelor of Science in Mechanical Engineering, for students who attain the required quality point rating.

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 basic curriculum

SECOND YEAR (NHA2)

FIRST TERM

ME-112(B)	Engineering Thermodynamics	4-2
ME-512(A)	Strength of Materials	5-0
ME-611(C)	Materials Testing Laboratory	2-2
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
Ph-610(B)	Atomic Physics	3-0
IE-101(C)	Principles of Industrial Organization (Lecture)	0-1
		16-7

SECOND TERM

Ma-104(A)	Partial Differential Equations and Related Topics	5-0
ME-211(C)	Marine Power Plant Equipment	3-2
ME-411(C)	Hydromechanics	3-2
ME-711(B)	Mechanics of Machinery	3-2
		14-6

THIRD TERM

ME-212(C)	Marine Power Plant Equipment	3-4
ME-412(A)	Hydromechanics	4-2
ME-513(A)	Theory of Elasticity	3-0
ME-712(A)	Dynamics of Machinery	3-2
IE-103(L)	Applied Industrial Organization (Lecture)	0-1
SL-101(L)	New Weapons Development I (Lecture)	0-1
		13-10

FOURTH TERM

Ae-431(A)	Internal Flow in Aircraft Engines	4-0
Ma-301(B)	Statistics	3-2
ME-217(C)	Internal Combustion Engines (Diesel)	3-2
ME-310(B)	Heat Transfer	3-2
IE-104(L)	Technical Lectures	0-1
SL-102(L)	New Weapons Development II (Lecture)	0-1
		13-8

Intersessional Field Trip; summer leave period.

THIRD YEAR (NHA3)

FIRST TERM

*Ch-561(A)	Physical Chemistry	3-2
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
Mt-301(A)	High Temperature Materials	3-0
		14-10

SECOND TERM

*EE-751(C)	Electronics	3-4
ME-216(A)	Marine Power Plant Analysis and Design	2-4
ME-812(B)	Machine Design	3-4
	Thesis	0-2
		8-14

THIRD TERM

Ch-521(A)	Plastics	3-2
*NE-102(C)	Auxiliary Machinery	3-0
	Thesis	2-12
		8-14

FOURTH TERM

EE-651(B)	Transients and Servos	3-4
NE-103(C)	Engineering Department Administration	2-0
*Ph-450(B)	Underwater Acoustics	3-2
	Thesis	2-6
		10-12

This curriculum normally leads to the degree of Master of Science in Mechanical Engineering for those who attain the required quality point rating and complete a satisfactory thesis.

* For this course, a suitable elective may be substituted. The elective must be approved by the Officer in Charge of Curricula and the Academic Associate, and must be previously scheduled in the term concerned.

MECHANICAL ENGINEERING (NUCLEAR POWER)

OBJECTIVE

To prepare a small group of officers in advanced mechanical engineering, for technical and administrative duties, connected with naval machinery and engineering plants, with emphasis on installations powered by nuclear energy.

FIRST YEAR (NN)

FIRST TERM

Ch-101(C)	General Inorganic Chemistry	3-2
EE-171(C)	Electric Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-101(C)	Introduction to Eng. Mathematics	3-1
Mc-101(C)	Eng. Mechanics I	2-2
		13-10

SECOND TERM

Ch-111(A)	Fuel and Oil Chemistry	2-2
EE-251(C)	AC Circuits	3-4
Ma-102(C)	Differential Equations and Series	5-0
Mc-102(C)	Eng. Mechanics II	2-2
NE-101(C)	Main Propulsion Plants	3-0
		15-8

THIRD TERM

EE-351(C)	DC Machinery	2-2
EE-451(C)	Transformers and Synchros	2-2
Ma-103(B)	Functions of Several Variables; Vector Analysis	5-0
Mc-201(A)	Methods in Dynamics	2-2
Mt-201(C)	Introductory Physical Metallurgy	3-2
		14-8

FOURTH TERM

EE-452(C)	Polyphase Transformers, Synchronous Machines and Induction Motors	3-4
ME-111(C)	Engineering Thermodynamics	4-2
ME-511(C)	Strength of Materials	5-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
		15-8

Intersessional Field Trip; summer leave period.

It will be noted that the first year of this curriculum is identical with the first year of Mechanical Engineering (NH) curriculum. Officers desiring the Nuclear Power curriculum will start with the Mechanical Engineering Group. At the end of the first year, a small input is selected from the Mechanical Engineering Group to take the Nuclear Power speciality in the second and third years.

Some of the students in this curriculum may be ordered to the Oak Ridge School of Reactor Technology for the third year.

SECOND YEAR (NN2)

FIRST TERM

ME-112(B)	Engineering Thermodynamics	4-2
ME-512(A)	Strength of Materials	5-0
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
ME-611(C)	Materials Testing Lab.	2-2
Ph-240(C)	Geometrical and Physical Optics	3-3
		16-9

SECOND TERM

Ma-104(A)	Partial Differential Equations and Related Topics	5-0
ME-211(C)	Marine Power Plant Equipment	3-2
ME-411(C)	Hydromechanics	3-2
ME-711(B)	Mechanics of Machinery	3-2
Ph-141(B)	Analytical Mechanics	4-0
		18-6

THIRD TERM

Ch-411(C)	Physical Chemistry	3-2
ME-212(C)	Marine Power Plant Equipment	3-4
ME-412(A)	Hydromechanics	4-2
Ph-142(B)	Analytical Mechanics	4-0
Ph-361(A)	Electromagnetism	3-0
		17-8

FOURTH TERM

Ch-412(C)	Physical Chemistry	3-2
EE-671(A)	Transients	3-4
*EE-751(C)	Electronics	3-4
ME-310(B)	Heat Transfer	3-2
		12-12

Intersessional Field Trip. Summer leave period.

THIRD YEAR (NN3)

FIRST TERM

ME-223(B)	Marine Power Plant Analysis	2-4
ME-811(C)	Machine Design	3-2
Mt-301(A)	High Temperature Materials	3-0
Ph-640(B)	Atomic Physics	3-0
Ph-641(B)	Atomic Physics Lab.	0-3
Ph-810(C)	Biological Effects of Radiation	3-0
IE-101(L)	Principles of Industrial Organization	0-1
		14-10

SECOND TERM

*Ch-551(A)	Radiochemistry	2-2
EE-672(A)	Servomechanisms	3-3
Ph-642(A)	Nuclear Physics	4-0
Ph-643(A)	Nuclear Physics Lab.	0-3
Thesis (A)		2-3
		11-11

THIRD TERM

*ME-241(A)	Nuclear Power Plants	3-0
Mt-402(A)	Nuclear Reactor Materials Effects of Radiation	3-0
**NE-102(C)	Auxiliary Machinery	3-0
Ph-651(A)	Reactor Technology	3-0
IE-103(L)	Applied Industrial Organization	0-1
Thesis (A)		4-6
		16-7

FOURTH TERM

Ch-521(A)	Plastics	3-2
*ME-242(A)	Nuclear Power Plants	3-0
Mt- (A)	Chem. and Met. Seminar	2-0
**NE-103(C)	Eng. Department Administration	2-0
IE-104(L)	Technical Lecture	0-1
SL-102(L)	New Weapons Development	0-1
Thesis (A)		2-6
		12-10

* This course to be developed.

** For this course, a suitable elective may be substituted. The elective must be approved by the Officer in Charge of Curricula and the Academic Associate, and must be previously scheduled in the term concerned.

This curriculum normally leads to the degree of Master of Science for those who attain the required quality point rating and complete a satisfactory thesis.

MINE WARFARE

OBJECTIVE

To train officers in the various phases of mine warfare in order that they may have a basic 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.

FIRST YEAR (RW)

FIRST TERM

Ch-101(C)	General Inorganic Chemistry	3-2
Es-141(C)	DC Electricity and Statics Fields	4-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
		14-10

SECOND TERM

Es-142(C)	AC Electricity	4-3
Ma-112(B)	Differential Equations and Boundary Value Problems	4-0
Mc-102(C)	Engineering Mechanics II	2-2
ME-500(C)	Strength of Materials	3-0
ME-601(C)	Materials Testing Lab	0-2
		13-7

THIRD TERM

Es-261(C)	Electron Tubes and Circuits	3-2
Ma-113(B)	Vector Analysis and Introduction to Partial Differential Equations	3-0
Mt-201(C)	Introductory Physical Metallurgy	3-2
Oc-111(C)	General Oceanography	3-1
Or-191(C)	Mines and Mine Mechanisms	2-0
Ph-610(B)	Atomic Physics	3-0
IE-103(L)	Applied Industrial Organization	0-1
		17-6

FOURTH TERM

Es-262(C)	Electron Tubes and Circuits	3-2
Ma-114(A)	Partial Differential Equations and Functions of a Complex Variable	3-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
Or-104(C)	Ordnance IV	2-1
Or-192(C)	Mining Operations	2-0
Ph-311(B)	Electrostatics and Magnetostatics	3-0
IE-104(L)	Technical Lectures	0-1
		16-6

Summer field trip to representative mine warfare installations.

SECOND YEAR (RW2)

FIRST TERM

Ch-561(A)	Physical Chemistry	3-2
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
Oc-401(C)	Naval Applications of Oceanography	3-0
Or-291(C)	Mine Countermeasures I	3-0
Ph-312(B)	Applied Electromagnetics	3-0
Ph-421(A)	Fundamental Acoustics	3-0
IE-101(L)	Principles of Applied Organization	0-1
		17-5

SECOND TERM

Ae-100(C)	Basic Aerodynamics	3-4
Ch-521(A)	Plastics	3-2
Ma-381(C)	Elementary Probability and Statistics	4-2
Or-292(C)	Mine Countermeasures II	3-2
Ph-425(A)	Underwater Acoustics	3-2
		16-12

THIRD TERM

Ch-591(A)	Blast and Shock Effects	3-0
Ma-382(A)	Probability	3-0
Oa-152(C)	Measures of Effectiveness of Mines	3-0
Or-295(A)	Thesis I	2-9
SL-101(L)	New Weapons Development I	0-1
		11-10

FOURTH TERM

Ma-401(A)	Mathematical Computation by Physical Means	3-2
Oa-153(B)	Game Theory and its Application to Mine Fields	3-0
Or-294(A)	Mine Warfare Seminar	2-0
Or-296(A)	Thesis II	2-6
Ph-424(A)	Shock Waves and Sonar Developments	3-3
SL-102(L)	New Weapons Development II	0-1
		13-12

Six months practical work at various mine warfare installations.

NUCLEAR ENGINEERING (EFFECTS)

OBJECTIVE

To educate officers in the fundamental sciences, particularly those associated with nuclear physics, in order that they may understand atomic processes and the effects of atomic weapons.

This curriculum has been established as a joint curriculum for selected officers of the Army, Navy, Air Force, Marine Corps and Coast Guard.

FIRST YEAR (RZ)

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)	Geometrical and Physical Optics	3-3
		14-9

SECOND TERM

Ch-102(C)	General Inorganic Chemistry	4-2
Es-272(C)	Electronics II	3-3
Ma-182(C)	Vector Analysis and Differential Equations	5-0
Ph-141(B)	Analytical Mechanics	4-0
		16-5

THIRD TERM

Ch-414(C)	Physical Chemistry	3-2
Es-273(C)	Electronics III	3-2
Ma-183(B)	Fourier Series and Complex Variables	5-0
ME-500(C)	Strength of Materials	3-0
Ph-142(B)	Analytical Mechanics	4-0
		18-4

FOURTH TERM

Ch-415(C)	Physical Chemistry	3-2
Ma-184(A)	Matrices and Numerical Methods	3-0
Mc-311(A)	Vibrations	3-2
Ph-361(A)	Electromagnetism	3-0
Ph-640(B)	Atomic Physics	3-0
Ph-641(B)	Atomic Physics Laboratory	0-3
		15-7

Summer field trip to representative AEC installations.

SECOND YEAR (RZ2)

FIRST TERM

Ch-315(C)	Organic Chemistry	3-2
Ma-301(B)	Statistics	3-2
Mr-101(C)	Fundamentals of Atmospheric Circulation	2-0
Ph-362(A)	Electromagnetic Waves	3-0
Ph-530(B)	Thermodynamics	3-0
Ph-720(A)	Introductory Quantum Mechanics	3-0
		17-4

SECOND TERM

*Bi-800A-L(C)	Biological and Physiological Effects of Radiation and Blast	6-0
Ph-441(A)	Shock Waves in Fluids	4-0
Ph-540(B)	Kinetic Theory and Statistical Mechanics	3-0
Ph-642(B)	Nuclear Physics	4-0
Ph-643(B)	Nuclear Physics Laboratory	0-3
		17-3

THIRD TERM

*Bi-801A-L(B)	Biological and Physiological Effects of Radiation and Blast	6-0
Ch-551(A)	Radiochemistry	2-2
Ch-591(A)	Blast and Shock Effects	3-0
ME-550(B)	Elements of Dynamic Structural Analysis	5-0
Ph-900(A)	Thesis	0-5
SL-101(L)	New Weapons Development I	0-1
		16-8

FOURTH TERM

*Bi-802A-L(A)	Biological and Physiological Effects of Radiation and Blast	6-0
Ge-201(C)	Physical Geology	3-0
ME-350(B)	Heat Transfer	2-2
Ph-901(A)	Thesis	0-18
SL-102(L)	New Weapons Development II	0-1
		11-21

* Biology courses taught at Monterey by the University of California Extension.

This curriculum normally leads to the degree of Master of Science in Physics for those who qualify.

OPERATIONS ANALYSIS

OBJECTIVE

To better prepare officers for carryiing out their duties in connection with naval operations by developing an appreciation of the effects of science and technology on naval warfare and an understanding of the analytical solution of the complex problems encountered.

FIRST YEAR (RO)

FIRST TERM

Ch-103(C)	Elementary Physical Chemistry	3-2
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-181(C)	Partial Derivatives and Multiple Integrals	4-1
Ph-240(C)	Geometrical and Physical Optics	3-3
IE-101(L)	Principles of Industrial Organization	0-1
		12-8

SECOND TERM

Ma-182(C)	Vector Analysis and Differential Equations	5-0
Ma-381(C)	Elementary Probability and Statistics	4-2
Ph-141(B)	Analytical Mechanics	4-0
Ph-341(C)	Electricity and Magnetism	4-2
		17-4

THIRD TERM

Ma-183(B)	Fourier Series and Complex Variables	5-0
Ma-382(A)	Probability	3-0
Oa-191(C)	Introduction to Operations Analysis	3-0
Ph-142(B)	Analytical Mechanics	4-0
Ph-361(A)	Electromagnetism	3-0
IE-103(L)	Applied Industrial Organization	0-1
		18-1

FOURTH TERM

Es-466(C)	Radar Propagation and Displays	2-2
Ma-195(A)	Matrix Theory and Integration Theory	5-0
Ma-383(A)	Statistics	3-2
Oa-192(B)	Theory of Search	3-0
Ph-362(A)	Electromagnetic Waves	3-0
IE-104(L)	Technical Lectures	0-1
		16-5

Summer period is devoted to operations analysis work at various plants and naval installations.

SECOND YEAR (RO2)

FIRST TERM

Ma-385(A)	Statistical Decision Theory	3-0
Ma-501(A)	Theory of Games	3-2
Oa-193(B)	Effectiveness of Weapons	4-0
Ph-421(A)	Acoustics	3-0
Ph-541(B)	Kinetic Theory and Statistical Mechanics	4-0
		17-2

SECOND TERM

Ma-496(A)	High Speed Computing Machines	3-2
Oa-194(A)	Optimal Weapon Systems I	4-0
Oa-201(A)	Logistics Analysis	3-2
Oa-401(A)	Theory of Information Communication	3-0
Ph-425(A)	Acoustics	3-2
		16-6

THIRD TERM

Mr-120(C)	Operational Aspects of Meterology	3-0
Oa-195(A)	Optimal Weapon System II	3-0
Oa-202(A)	Econometrics	3-0
Oa-901(A)	Thesis	0-6
Ph-641(B)	Atomic Physics	3-3
SL-101(L)	New Weapons Development I	0-1
		12-10

FOURTH TERM

Oa-891(A)	Seminar	2-4
Oa-902(A)	Thesis	0-8
Ph-642(A)	Nuclear Physics	4-0
Ph-643(A)	Nuclear Physics Laboratory	0-3
SL-102(L)	New Weapons Development II	0-1
		6-16

This curriculum normally leads to the degree of Master of Science for those who qualify.

ORDNANCE ENGINEERING

BASIC OBJECTIVE

Te educate officers in the basic sciences and technical fields related to ordnance in order to better equip them to handle ordnance problems ashore and afloat. The knowledge acquired will be generally applied through the medium of the Bureau of Ordnance Establishment to the end that the best and most advanced ordnance is available to the fleet.

Each three-year curriculum listed below normally leads to a Master of Science degree for those who qualify.

ORDNANCE ENGINEERING (General)

OBJECTIVE

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

FIRST YEAR (O)

FIRST TERM

Ch-101(C)	General Inorganic Chemistry	3-2
EE-151(C)	DC Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
Or-101(C)	Ordnance I	2-1
		15-11

SECOND TERM

Ch-711(C)	Chemical Engineering Calculations	3-2
EE-241(C)	AC Circuits	3-2
Ma-112(B)	Differential Equations and Boundary Value Problems	4-0
Mc-102(C)	Engineering Mechanics II	2-2
Or-102(C)	Ordnance II	3-2
		15-8

THIRD TERM

Ch-631(A)	Chemical Engineering Thermodynamics	3-2
EE-461(C)	Transformers and Synchros	3-2
Ma-113(B)	Vector Analysis and Introduction to Partial Differential Equations	3-0
Mc-401(A)	Exterior Ballistics	3-0
Or-103(C)	Ordnance III	2-2
Ph-610(B)	Atomic Physics	3-0
IE-103(L)	Applied Industrial Organization	0-1
SL-101(L)	New Weapons Development I	0-1
		17-8

FOURTH TERM

Ch-401(A)	Physical Chemistry (Ord.)	3-2
EE-462(B)	Asynchronous Motors and Special Machines	4-2
Ma-114(A)	Partial Differential Equations and Functions of a Complex Variable	3-0
Or-104(C)	Ordnance IV	2-1
Ph-450(B)	Underwater Acoustics	3-2
IE-104(L)	Technical Lectures	0-1
SL-102(L)	New Weapons Development II	0-1
		15-9

Summer field trip to representative ordnance installations.

SECOND YEAR (O2)

FIRST TERM

Ch-541(A)	Reaction Motors	2-2
EE-751(C)	Electronics	3-4
Ma-115(A)	Differential Equations for Automatic Control	3-0
ME-500(C)	Strength of Materials	3-0
ME-601(C)	Materials Testing Lab	0-2
Mt-201(C)	Introductory Physical Metallurgy	3-2
IE-101(L)	Principles of Industrial Organization	0-1
		14-11

SECOND TERM

Ch-521(A)	Plastics	3-2
EE-665(B)	Lines, Filters and Transients	4-2
Mc-402(A)	Dynamics of Missiles and Gyros	3-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
Ph-240(C)	Geometric and Physical Optics	3-3
		16-9

THIRD TERM

EE-745(A)	Electronic Control and Measurement	3-3
Es-446(C)	Introduction to Radar	2-2
Ma-301(B)	Statistics	3-2
Mc-431(A)	Strength of Guns	3-0
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
SL-101(L)	New Weapons Development I	0-1
		13-10

FOURTH TERM

Ch-571(A)	Explosives	3-2
EE-672(A)	Servomechanisms	3-3
Ma-401(A)	Mathematical Computation by Physical Means	3-2
Mc-421(A)	Interior Ballistics	2-0
Mt-301(A)	High Temperature Materials	3-0
Oa-151(B)	Survey of Weapons Evaluation	3-0
SL-102(L)	New Weapons Development II	0-1
		17-8

Summer course in Engineering Administration at selected civilian universities.

This curriculum normally leads to a Bachelor of Science degree in Electrical Engineering for those who qualify.

ORDNANCE ENGINEERING (Aviation)

OBJECTIVE

To further the aims of the basic objective by emphasizing the aviation aspects of ordnance, including the limitations and peculiar advantages that are inherent in the aviation field.

FIRST YEAR (OE)

FIRST TERM

Ch-101(C)	General Inorganic Chemistry	3-2
EE-151(C)	DC Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
Or-101(C)	Ordnance I	2-1
		15-11

SECOND TERM

Ae-100(C)	Basic Aerodynamics	3-4
Ch-711(C)	Chemical Engineering Calucation	3-2
EE-241(C)	AC Circuits	3-2
Ma-112(B)	Differential Equations and Boundary Value Problems	4-0
Mc-102(C)	Engineering Mechanics II	2-2
Ae-001(L)	Aeronautical Lecture	0-1
		15-11

THIRD TERM

Ae-121(C)	Technical Aerodynamics	3-2
Ch-631(A)	Chemical Engineering Thermodynamics	3-2
EE-461(C)	Transformers and Synchros	3-2
Ma-113(B)	Vector Analysis and Introduction to Partial Differential Equations	3-0
Mc-401(A)	Exterior Ballistics	3-0
SL-101(L)	New Weapons Development I	0-1
IE-103(L)	Applied Industrial Organization	0-1
		15-8

FOURTH TERM

Ae-136(B)	Aircraft Performance—Flight Analysis	3-2
Ch-401(A)	Physical Chemistry (Ordnance)	3-2
EE-462(B)	Asynchronous Motors and Special Machines	4-2
Ma-114(A)	Partial Differential Equations and Functions of a Complex Variable	3-0
Or-104(C)	Ordnance IV	2-1
SL-102(L)	New Weapons Development II	0-1
IE-104(L)	Technical Lectures	0-1
		15-9

Summer field trip to representative ordnance installations.

SECOND YEAR (OE2)

FIRST TERM

Ae-501(A)	Hydro-Aero Mechanics I	4-0
Ch-541(A)	Reaction Motors	2-2
EE-751(C)	Electronics	3-4
Ma-115(A)	Differential Equations for Automatic Control	3-0
Mt-201(C)	Introductory Physical Metallurgy	3-2
IE-101(L)	Principles of Industrial Organization	0-1
		15-9

SECOND TERM

Ae-502(A)	Hydro-Aero Mechanics II	4-0
EE-665(B)	Lines, Filters and Transients	4-2
Mc-402(A)	Dynamics of Missiles and Gyros	3-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
Or-102(C)	Ordnance II	3-2
		17-6

THIRD TERM

Ae-146(A)	Dynamics	3-2
Ae-508(A)	Compressibility	3-2
EE-745(A)	Electronic Control and Measurement	3-3
Ma-301(B)	Statistics	3-2
Or-241(C)	Guided Missiles I	2-0
SL-101(L)	New Weapons Development I	0-1
		14-10

FOURTH TERM

Ch-571(A)	Explosives	3-2
EE-672(A)	Servomechanisms	3-3
Es-456(C)	Introduction to Radar (Airborne)	2-2
Ma-401(A)	Mathematical Computation by Physical Means	3-2
Oa-151(B)	Survey of Weapons Evaluation	3-0
Or-242(B)	Guided Missiles II	2-0
SL-102(L)	New Weapons Development II	0-1
		16-10

Summer course in Engineering Administration at selected civilian universities.

THIRD YEAR (OE3)

At Massachusetts Institute of Technology

FALL SEMESTER

16.15 Advanced Stability and Control of Aircraft
16.39 Vector Kinematics and Gyroscopic Instrument Theory
16.41 Fire Control Principles
16.43 Fire Control Instrument Lab
16.47 Rockets, Guided Missiles and Projectiles

SPRING SEMESTER

16.40 Automatic Control Equipment for Aircraft
16.42 Fire Control Systems
16.44 Fire Control Instruments Laboratory (Advanced)
Thesis

ORDNANCE ENGINEERING (Explosives)

OBJECTIVE

To carry out the basic objective in the field of explosives by education in the chemical field as applied to explosives and propellants.

FIRST YEAR (OP)

FIRST TERM

Ch-101(C)	General Inorganic Chemistry	3-2
EE-151(C)	DC Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
Or-101(C)	Ordnance I	2-1
		15-11

SECOND TERM

Ch-221(C)	Qualitative Analysis	3-2
Ch-711(C)	Chemical Engineering Calculations	3-2
EE-241(C)	AC Circuits	3-2
Ma-112(B)	Differential Equations and Boundary Value Problems	4-0
Or-102(C)	Ordnance II	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)	Vector Analysis and Introduction to Partial Differential Equations	3-0
Or-103(C)	Ordnance III	2-2
IE-103(L)	Applied Industrial Organization	0-1
		13-11

FOURTH TERM

Ch-312(C)	Organic Chemistry	3-2
Ch-412(C)	Physical Chemistry	3-2
Ch-521(A)	Plastics	3-2
Ch-611(C)	Thermodynamics	3-2
Ma-114(A)	Partial Differential Equations and Functions of a Complex Variable	3-0
Or-104(C)	Ordnance IV	2-1
IE-104(L)	Technical Lectures	0-1
		17-10

Summer field trip to representative ordnance installations.

SECOND YEAR (OP2)

FIRST TERM

Ch-541(A)	Reaction Motors	2-2
Ch-612(C)	Thermodynamics	3-2
Cr-271(B)	Crystallography and X-ray Techniques	3-2
EE-751(C)	Electronics	3-4
Mt-201(C)	Introductory Physical Metallurgy	3-2
IE-101(L)	Principles of Industrial Organization	0-1
		14-13

SECOND TERM

Ch-413(A)	Physical Chemistry (Advanced)	2-2
EE-651(C)	Transients and Servos	3-4
ME-500(C)	Strength of Materials	3-0
ME-601(C)	Materials Testing Lab	0-2
Mt-202(C)	Ferrous Physical Metallurgy	3-2
Ph-610(B)	Atomic Physics	3-0
		14-10

THIRD TERM

Ch-111(A)	Fuel and Oil Chemistry	2-2
Ch-321(A)	Organic Qualitative Analysis	2-2
Ch-323(A)	The Chemistry of High Polymers	3-0
EE-745(A)	Electronic Control and Measurement	3-3
Ma-301(B)	Statistics	3-2
SL-101(L)	New Weapons Development I	0-1
		13-10

FOURTH TERM

Ch-322(A)	Organic Chemistry Advanced	3-2
Ch-571(A)	Explosives	3-2
Ch-800(A)	Chemistry Seminar	2-0
Mc-421(A)	Interior Ballistics	2-0
Oa-151(B)	Survey of Weapons Evaluation	3-0
Ph-450(B)	Underwater Acoustics	3-2
SL-102(L)	New Weapons Development II	0-1
		16-7

Summer course in Engineering Administration at selected civilian universities.

THIRD YEAR (OP3)

At Lehigh University

FALL SEMESTER

Ch-440	Advanced Physical Chemistry
Ch-357	Qualitative Organic Analysis
Ch-402	Advanced Inorganic Chemistry
Ch-2	Chemistry Research
	Elective (approved advanced course in chemistry or related field)

SPRING SEMESTER

Ch-441	Advanced Physical Chemistry
Ch-358	Advanced Organic Chemistry
Ch-432	Advanced Analytical Chemistry
Ch-2	Chemistry Research
	Elective (approved advanced course in chemistry or related field)

ORDNANCE ENGINEERING (Fire Control)

OBJECTIVE

To carry out the aims of the basic objective in the fire control field by intensive instruction in the applicable basic sciences so that a fundamental grasp of fire control theory is obtained.

FIRST YEAR (OF)

FIRST TERM

Ch-101(C)	General Inorganic Chemistry	3-2
EE-151(C)	DC Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
Or-101(C)	Ordnance I	2-1
		15-11

SECOND TERM

Ch-711(C)	Chemical Engineering Calculations	3-2
EE-241(C)	AC Circuits	3-2
Ma-112(B)	Differential Equations and Boundary Value Problems	4-0
Mc-102(C)	Engineering Mechanics II	2-2
Or-102(C)	Ordnance II	3-2
		15-8

THIRD TERM

Ch-631(A)	Chemical Engineering Thermodynamics	3-2
EE-461(C)	Transformers and Synchros	3-2
Ma-113(B)	Vector Analysis and Introduction to Partial Differential Equations	3-0
Mc-401(A)	Exterior Ballistics	3-0
Or-103(C)	Ordnance III	2-2
Ph-610(B)	Atomic Physics	3-0
IE-103(L)	Applied Industrial Organization	0-1
SL-101(L)	New Weapons Development I	0-1
		17-8

FOURTH TERM

Ch-401(A)	Physical Chemistry (Ordnance)	3-2
EE-462(B)	Asynchronous Motors and Special Machines	4-2
Ma-114(A)	Partial Differential Equations and Functions of a Complex Variable	3-0
Or-104(C)	Ordnance IV	2-1
Ph-450(B)	Underwater Acoustics	3-2
IE-104(L)	Technical Lectures	0-1
SL-102(L)	New Weapons Development II	0-1
		15-9

Summer field trip to representative ordnance installations.

SECOND YEAR (OF2)

FIRST TERM

Ch-541(A)	Reaction Motors	2-2
EE-751(C)	Electronics	3-4
Ma-115(A)	Differential Equations for Automatic Control	3-0
ME-500(C)	Strength of Materials	3-0
ME-601(C)	Materials Testing Lab	0-2
Mt-201(C)	Introductory Phyical Metallurgy	3-2
IE-101(L)	Principles of Industrial Organization	0-1
		14-11

SECOND TERM

EE-665(B)	Lines, Filters and Transients	4-2
Mc-402(A)	Dynamics of Missiles and Gyros	3-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
Ph-240(C)	Geometrical and Physical Optics	3-3
		13-7

THIRD TERM

EE-745(A)	Electronic Control and Measurement	3-3
Es-447(C)	Electronic Pulse Techniques	3-0
Ma-301(B)	Statistics	3-2
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
Or-241(C)	Guided Missiles I	2-0
SL-101(L)	New Weapons Development I	0-1
		13-8

FOURTH TERM

Ch-571(A)	Explosives	3-2
EE-672(A)	Servomechanisms	3-3
Ma-401(A)	Mathematical Computation by Physical Means	3-2
Mc-421(A)	Interior Ballistics	2-0
Oa-151(B)	Survey of Weapons Evaluation	3-0
Or-242(B)	Guided Missiles II	2-0
SL-102(L)	New Weapons Development II	0-1
		16-8

Summer course in Engineering Administration at selected civilian universities.

THIRD YEAR (OF3)

At Massachusetts Institute of Technology

FALL SEMESTER

16.39T Vector Kinematics and Gyroscopic Instrument Theory
16.41 Fire Control Principles
16.43 Fire Control Instrument Lab
6.291 Principles of Radar
6.536 Machine Computation
Thesis

SPRING SEMESTER

16.42 Fire Control Systems
16.44T Advanced Fire Control Instruments Lab
6.292 Principles of Radar
Thesis

ORDNANCE ENGINEERING (Industrial)

OBJECTIVE

To educate ordnance engineers in the principles of industrial management in order to prepare them to exercise effective management control and direction of facilities and plants within the Naval Ordnance Establishment.

First two years are the same as the Ordnance Engineering (General) Curriculum.

THIRD YEAR (OI3)
At Purdue University

SUMMER TERM

GE 370 Elements of Accounting
GE 575 Motion and Time Study
GE 578 Production Planning and Control

FALL SEMESTER

GE 570 Cost Accounting
GE 585 Industrial Relations
GE 579 Advanced Production Control
GE 581 Tool Design
PSY 570 Personnel Psychology
GE 698 Thesis

SPRING SEMESTER

GE 583 Plant Layout
Electives:
- Adv. Motion and Time Study
- Adv. Industrial Engineering Problems
- Reasearch in Industrial Relations

PSY 574 Psychology of Industrial Training
GE 698 Thesis

ORDNANCE ENGINEERING (Jet Propulsion)

OBJECTIVE

To educate officers in the fundamentals of jet propulsion and its applications to ordnance use.

FIRST YEAR (OJ)

FIRST TERM

Ch-101(C)	General Inorganic Chemistry	3-2
EE-151(C)	DC Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
Or-101(C)	Ordnance I	2-1
		15-11

SECOND TERM

Ae-100(C)	Basic Aerodynamics	3-4
Ch-711(C)	Chemical Engineering Calculations	3-2
EE-241(C)	AC Circuits	3-2
Ma-112(B)	Differential Equations and Boundary Value Problems	4-0
Mc-102(C)	Engineering Mechanics II	2-2
Ae-001(L)	Aeronautical Lecture	0-1
		15-11

THIRD TERM

Ae-121(C)	Technical Aerodynamics	3-2
Ch-631(A)	Chemical Engineering Thermodynamics	3-2
Ma-113(B)	Vector Analysis and Partial Differential Equations	3-0
Mc-401(A)	Exterior Ballistics	3-0
Or-103(C)	Ordnance III	2-2
SL-101(L)	New Weapons Development I	0-1
IE-103(L)	Applied Industrial Organization	0-1
		14-8

FOURTH TERM

Ae-136(B)	Aircraft Performance—Flight Analysis	3-2
Ch-401(A)	Physical Chemistry (Ord)	3-2
Ma-114(A)	Partial Differential Equations and Functions of a Complex Variable	3-0
ME-500(C)	Strength of Materials	3-0
ME-601(C)	Materials Testing Lab	0-2
Or-104(C)	Ordnance IV	2-1
SL-102(L)	New Weapons Development II	0-1
IE-104(L)	Technical Lectures	0-1
		14-9

Summer field trip to representative ordnance installations.

SECOND YEAR (OJ2)

FIRST TERM

Ae-501(A)	Hydro-Aero Mechanics I	4-0
Ch-541(A)	Reaction Motors	2-2
EE-751(C)	Electronics	3-4
Ma-301(B)	Statistics	3-2
Mt-201(C)	Introductory Physical Metallurgy	3-2
IE-101(L)	Principles of Industrial Organization	0-1
		15-11

SECOND TERM

Ae-502(A)	Hydro-Aero Mechanics II	4-0
EE-651(C)	Transients and Servos	3-4
Mc-402(A)	Dynamics of Missiles and Gyros	3-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
Or-102(C)	Ordnance II	3-2
		16-8

THIRD TERM

Ae-146(A)	Dynamics	3-2
Ae-508(A)	Compressibility	3-2
EE-745(A)	Electronic Control and Measurement	3-3
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
Or-241(C)	Guided Missiles I	2-0
SL-101(L)	New Weapons Development I	0-1
		13-10

FOURTH TERM

Ch-301(C)	Organic Chemistry	3-2
Ch-571(A)	Explosives	3-2
Mc-421(A)	Interior Balistics	2-0
Mt-301(A)	High Temperature Materials	3-0
Oa-151(B)	Survey of Weapons Evaluation	3-0
Or-242(B)	Guided Missiles II	2-2
SL-102(L)	New Weapons Development II	0-1
		16-7

Summer course in Engineering Administration at selected civilian universities.

THIRD YEAR (OJ3)

At California Institute of Technology

Ae-261 Hydrodynamics of Compressible Fluids
Ae-271 Experimental Methods in Aeronautics
JP-121 Rockets
JP-130 Thermal Jets
JP-200 Chemistry Problems in Jet Propulsion
JP-280 Research in Jet Propulsion
Ae-290 Aeronautical Seminar

ORDNANCE ENGINEERING (Special Physics)

OBJECTIVE

To educate officers in the fundamentals of nuclear physics in order to develop an understanding of the capabilities and limitations of atomic weapons.

FIRST YEAR (OX)

FIRST TERM

Ch-101(C)	General Inorganic Chemistry	3-2
Es-141(C)	DC Electricity and Static Fields	4-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-181(C)	Partial Derivatives and Multiple Integrals	4-1
Mr-101(C)	Fundamentals of Atmospheric Circulation	2-0
Or-101(C)	Ordnance I	2-1
		17-9

SECOND TERM

Es-142(C)	AC Electricity	4-3
Ma-182(C)	Vector Analysis and Differential Equations	5-0
Ph-141(B)	Analytical Mechanics	4-0
Ph-240(C)	Geometrical and Physics Optics	3-3
		16-6

THIRD TERM

EE-451(C)	Transformers and Synchros	2-2
Es-113(C)	Circuit Analysis and Measurements	3-3
Es-261(C)	Electron Tubes and Circuits	3-2
Ma-183(B)	Fourier Series and Complex Variables	5-0
Ph-142(B)	Analytical Mechanics	4-0
SL-101(L)	New Weapons Development I	0-1
		17-8

FOURTH TERM

EE-651(B)	Transients and Servos	3-4
Es-262(C)	Electron Tubes and Circuits	3-2
Ma-194(A)	Laplace Transforms, Matrices and Variations	5-0
Ph-351(A)	Electricity and Magnetism	5-0
SL-102(L)	New Weapons Development II	0-1
		16-7

SECOND YEAR (OX2)
At Massachusetts Institute of Technology

SUMMER SEMESTER

6.80 Electrical Measurements Laboratory
8.08 Electronics

FALL SEMESTER

6.633 Electronic Circuit Theory
8.05 Atomic Physics
8.07 Thermodynamics and Statistical Mechanics
8.71 Introduction to Theoretical Physics I (Mechanics)
L17 Scientific German

SPRING SEMESTER

6.20 Electronic Control and Measurement
6.623 Pulse Circuits, Principles
8.101 Atomic Structure Laboratory
or
8.102 Electronic Devices Laboratory
8.06 Nuclear Physics
8.72 Introduction to Theoretical Physics II (Electromagnetic Theory)

Summer trip to AEC installations.

THIRD YEAR (OX3)
At Massachusetts Institute of Technology

FALL SEMESTER

8.361 Quantum Theory of Matter
8.511 Nuclear Physics I
8.57 Neutron Physics
N21 Nuclear Reactor Engineering I
Thesis

SPRING SEMESTER

8.512 Nuclear Physics II
N.20 Biological Effects of Nuclear Radiations
N.22 Nuclear Reactor Engineering II
Thesis

SECOND YEAR (OX2A)

At the end of the first year the OX group is divided into two groups, one following the Massachusetts Institute of Technology curriculum above, the other following this curriculum.

FIRST TERM

Es-267(A)	Ultra-high Frequency Techniques	3-2
Ph-144(A)	Analytical Mechanics	4-0
Ph-530(B)	Thermodynamics	3-0
Ph-640(B)	Atomic Physics	3-0
Ph-641(B)	Atomic Physics Laboratory	0-3
		13-5

SECOND TERM

Es-461(A)	Pulse Techniques	2-3
Ph-541(B)	Kinetic Theory and Statistical Mechanics	4-0
Ph-642(A)	Nuclear Physics	3-0
Ph-643(A)	Nuclear Physics Laboratory	0-3
Ph-721(A)	Introduction to Quantum Mechanics	4-0
		13-6

THIRD TERM

Es-161(A)	Electronic Instrumentation and Circuits	3-3
Ph-343(A)	Nuclear Instrumentation	4-0
Ph-427(B)	Fundamental and Applied Acoustics	4-0
Ph-644(A)	Advanced Nuclear Physics	4-3
		15-6

FOURTH TERM

Es-162(A)	Electronics Instrumentation and Circuits	3-3
Ph-352(A)	Electromagnetic Waves	3-0
Ph-428(B)	Underwater Acoustics	2-3
Ph-723(A)	Physics of the Solid State	4-0
		12-6

THIRD YEAR (OX3A)

The third year consists of approximately 10 months' work at the Radiation Laboratory of the University of California (Berkeley) under the auspices of the Postgraduate School.

PETROLEUM ENGINEERING

OBJECTIVE

To prepare a small group of officers in the technology of petroleum production, refining, and handling, for duties involving development, applications, specifiations, and inspection of fuels and lubricants in the Naval Establishment.

FIRST YEAR (NP)

FIRST TERM

Ch-121(B) General and Petroleum Chemistry	4-2
Ge-101(C) Physical Geology	3-0
Ma-100(C) Vector Algebra and Geometry	2-1
Ma-101(C) Introduction to Engineering Mathematics	3-1
Ma-201(C) Graphical and Mechanical Computation	0-2
Mc-101(C) Engineering Mechanics I	2-2
	14-8

SECOND TERM

Ch-221(C) Qualitative Analysis	3-2
Cr-301(B) Crystallography and Mineralogy	3-4
Ma-102(C) Differential Equations and Series	5-0
ME-500(C) Strength of Materials	3-0
ME-601(C) Materials Testing Laboratory	0-2
	14-8

THIRD TERM

Ch-231(C) Quantitative Analysis	2-4
Ch-311(C) Organic Chemistry	3-2
Ch-411(C) Physical Chemistry	3-2
Ge-401(C) Petrology and Petrography	2-3
Mt-201(C) Introductory Physical Metallurgy	3-2
	13-13

FOURTH TERM

Ch-312(C) Organic Chemistry	3-2
Ch-412(C) Physical Chemistry	3-2
Ge-241(C) Geology of Petroleum	2-4
Mt-202(C) Ferrous Physical Metallurgy	3-2
	11-10

Intersessional Field Trip; summer leave period.

SECOND YEAR (NP2)
At University of California

FALL TERM

Chem. 143 Introduction to Chemical Engineering
Mech. Eng. 103 Elem. Fluid Mechanics
Pet. Eng. 131A Oil Reservoir Eng.
Pet. Eng. 198A Group Study in Pet. Production
One additional course

SPRING TERM

Math. 130E Statistical Inference for Engineers
Chem. 146A Chemical Engineering Unit Operations
or Mech. Eng. 152 Industrial Mass Transfer
Mech. Eng. 161 Applied Fluid Mechanics
Pet. Eng. 125 Petroleum Production Economics
Pet. Eng. 131B Oil Reservoir Eng.

Summer leave period; field trip.

THIRD YEAR (NP3)
At University of California

FALL TERM

Chem. 146B Chemical Engineering Unit Operations
Mech. Eng. 164 Instrumentation and Automatic Control
Pet. Eng. 209A Seminar in Petroleum Processing I
Pet. Eng. 298A Group Study
Pet. Eng. 299A Individual study or research

SPRING TERM

Math. 264 Statistical Problems of Mass Production and Quality Control
or Pet. Eng. 213 Valuation of Oil and Gas Properties
Elective
Pet. Eng. 209B Seminar in Petroleum Processing II
Pet. Eng. 298B Group Study
Pet. Eng. 299B Individual study or reasearch
Comprehensive examination

Elective to be chosen by student, subject to approval of University of California faculty and Superintendent, U. S. Naval Postgraduate School; technical subjects such as Atomic Physics or Chemical Engineering Thermodynamics.

This curriculum normally leads to the degree of Master of Engineering for students who qualify in accordance with University Graduate School requirements.

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, sponsoring bureau requirements, etc.

Each curriculum is assigned to one of the curricular officers of the Engineering School for supervision and administration of the Postgraduate School functions, including liaison between the sponsoring bureau or office and the college, initiation of changes to the curriculum, contact with students and college faculty, etc.

DESCRIPTIONS

BUSINESS ADMINISTRATION (ZKC, ZKH, ZKS)

A two-year curriculum consisting generally of courses in the fields of finance, business organization, marketing, statistics, public relations, administrative practices, geography, etc. The summer between academic years is spent in individual assignments with industrial companies.

CINEMATOGRAPHY (ZCP)

A twelve-month curriculum, to prepare officers for assignments to duty in connection with the production of training films and motion picture reports, conducted at the University of Southern California. Patterned to meet the needs and background of the individual student, it consists of such courses as Cinematic Effects, Laboratory Practice and Procedure, Film and Education, Sound, Filmic Expression, and Cinema History and Criticism Sponsored by Chief of Naval Operations.

CIVIL ENGINEERING (Qualification) (ZG)

Seventeen months of instruction at Rensselaer Polytechnic Institute to qualify officers for civil engineering duties. Successful completion of this course normally leads to appointment in the Civil Engineering Corps. At present this is the only program for transfer of line officers to the Civil Engineer Corps.

CIVIL ENGINEERING (Advanced) (ZGR, ZGM, ZGI, ZGP)

A graduate program, at the Master of Science level, covering four specialties, or options, and consisting of twelve to fifteen months at selected civilian institutions. Sponsored by the Bureau of Yards and Docks, the program includes the following specialties: (a) Soil Mechanics and Foundations, (b) Structures, (c) Sanitary Engineering and (d) Waterfront Facilities. Students selected for this program will normally be CEC officers of the ranks of lientenant and lientenant (jg) who have a degree in Civil Engineering and have completed three years of commissioned service.

COMPTROLLERSHIP (ZS)

A 9½ month course at George Washington University leading to a Master's degree in Business Administration. Formal academic courses are given in General Accounting, Industrial and Governmental Economics, Statistics and Reports Control, Managerial Accounting, Internal Control and Auditing, Governmental Budget Formulation and Execution, Advanced Management, Human Relations in Administration, Management Engineering and Seminar in Comptrollership. In addition, comptrollers from major industries, and officers and civilians working at the department level present practical aspects of comptrollership.

HYDROGRAPHIC ENGINEERING (ZV)

A one-year course in Hydrographic Engineering given at Ohio State University 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 majors in one of these three fields in order to enable the graduate to perform future hydrographic duties at the Hydrographic Office, on hydrographic survey expeditions or on major fleet staffs.

JOURNALISM (ZNF)

A one-year curriculum at Harvard University for qualified officers nominated by the Chief of Information and cleared by the Nieman Foundation. Normally only one such officer can be enrolled at a time; he actually attends Harvard as a postgraduate student but associates with the Nieman Fellows in their course of study. To promote and elevate the journalistic qualifications of a small, select group.

LAW (ZHH, ZHY)

A three-year curriculum generally following that taken by civilian students working for a degree of Bachelor of Laws but emphasizing Admiralty Law, International Law, Legislative Drafting and Administrative Law where such courses are available. Summer employment is in the Office of Judge Advocate General and at the School of Naval Justice, Newport, R.I.

MANAGEMENT AND INDUSTRIAL ENGINEERING (ZT)

A nine-month curriculum at Rensselaer Polytechnic Institute to prepare selected officers for managerial and executive billets in the Navy's industrial organization. The course majors in advanced production and industrial engineering as applied to managerial problems.

METALLURGICAL ENGINEERING (ZNM)

A one-year curriculum at Carnegie Institute of Technology designed for the graduate of the Naval Contsruction and Engineering Curriculum with the objective of obtaining the maximum possible metallurgical background in the time allotted.

NAVAL CONSTRUCTION AND ENGINEERING (ZNB)

A three-year curriculum at Massachusetts Institute of Technology or at Webb Institute of Naval Architecture to qualify officers for naval construction and engineering assignments. Successful completion of this curriculum normally leads to "Engineering Duty" designation.

NAVAL INTELLIGENCE (ZI)

Six months of instruction at the U. S. Naval School, Naval Intelligence, 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) (ZNE)

A fifteen-month program at the Massachusetts Institute of Technology covering applied Nuclear Physics, Reactor Technology, and other subjects pertaining to Nuclear Engineering. The students for this program are selected by the Bureau of Ships.

OCEANOGRAPHY (ZO)

A one-year course at Scripps Institute of Oceanography to prepare officers for assignment to billets requiring specialized knowledge in the field of oceanography. Provided the student has adequate educational background, completion of the curriculum normally leads to a Master of Science degree.

PERSONNEL ADMINISTRATION AND TRAINING (ZP)

A one-year curriculum to prepare officers for assignment in personnel administration and supervision or administration of training activities, at Stanford University. 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 LOGISTICS (ZL)

A two-year program consisting of one full year at the University of Pittsburgh followed by a year with a major oil company. It prepares selected senior officers for assignment to the Munitions Board or similar high-level logistics billets requiring understanding of the petroleum industry.

PUBLIC INFORMATION (ZIB)

A twelve-month postgraduate course in public information for information-specialist naval officers conducted at Boston University. Two officers are trained per year, one for a billet designated 1100 and one for a billet designated 1300. Students enrolled will be experienced naval officers with previous education and/or experience in the fields of public information and public relations. The course leads to the degree of Master of Science in Public Relations.

RELIGION (ZU)

Each student officer enrolled in this curriculum pursues courses of instruction in such subjects as Psychology, Speech, Education, Theology, Pauline Studies and Visual Aids.

An officer selected for this curriculum will be enrolled in the University of his choice if practicable. In recent years, officers have been enrolled at Fordham University, Harvard University and Union Theological Seminary. They have been collectively designated as the ZU Group.

SPECIAL MATHEMATICS (ZMI)

A two-year curriculum at the University of Illinois, 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.

TEXTILE ENGINEERING (ZM)

A two-year program of study at the Georgia Institute of Technology, to prepare officers for assignments involving manufacture, procurement, receipt, storage and issue of clothing and textiles.

The curriculum best suited to the individual's background and needs is determined in consultation with school authorities after his arrival. Normally includes such courses as Weaving, Fabrics Analysis, Chemical Textile Testing, Physical Textile Testing, Fabric Design, Circular Knitting, Bleaching and Dyeing, and Quality Control.

DETAILS OF CURRICULA CONDUCTED ENTIRELY AT CIVILIAN INSTITUTIONS

CIVIL ENGINEERING

CIVIL ENGINEERING (Qualifications)

At Rensselaer Polytechnic Institute
Refresher Period 8 weeks

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

SUMMER SESSION

10.11 Engineering Geology
5.78 Reinforced Concrete I
5.76 Elementary Structural Analysis

FALL TERM

5.09 Contracts and Specifications
5.05 Photogrammetry
5.15 Highways and Airports Eng. (CEC)
7.72 Utilization of Electrical Energy for Naval Establishments (CEC)
5.77 Structural Design I
5.80 Stresses in Highway and Railroad Bridges
6.55 Personnel Management and Industrial Relations (CEC)

SPRING TERM

5.32 Soil Mechanics (CEC)
5.75 Building Construction
5.79 Reinforced Concrete II
5.82 Indeterminate Structures I
12.42 Heating and Ventilation (CEC)
13.541 Metallurgy and Welding (CEC)
G5.82 Ship Repair and Shipbuilding Facilities (CEC)

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
5.16 Topographical Survey (Field Trip)
5.18 Route Survey (Field Trip)
Degree: BCE at end of Spring Term

CIVIL ENGINEERING (Advanced)

Four "options" or specialties are conducted at the graduate level, in accordance with the revised policy of the Bureau of Yards and Docks; these specialties supersede the former single Civil Engineering (Advanced) program.

SOIL MECHANICS AND FOUNDATIONS

At Rensselaer Polytechnic Institute

SUMMER TERM

11.25 Engineering Mathematics
10.11 Engineering Geology
Soil Mechanics and Foundations Refresher

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
Degree: Master of Civil Engineering

STRUCTURES

At 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 to five units per term.

SECOND SUMMER

CE462 Structural Theory and Design
CE491 Thesis
TAM424 Properties of Eng. Materials
Degree: Master of Science in Civil Engineering.

SANITARY ENGINEERING

At University of Michigan

Objective: To provide advanced technical instruction in the field of water supply and sewerage.

SUMMER

Chem.23 Introduction to Analytical Chemistry
Selected cognate subject such as Conservation of Natural Resources, W194S.

FALL

Bact.111E Bacteriology for Engineers
E.H.225 Sanitary Chemistry (Water and Sewage)
C.E.152 Sewerage and Sewage Treatment
C.E.155 Municipal and Industrial Sanitation
One of following
C.E.140 Hydrology
or
P.H.S.200 Introd. to Public Health Statistics
or
E.H.241 Principles and Methods of Industrial Health

SPRING

Chem.61 Organic Chemistry
C.E.152 Water Purification and Treatment
C.E.157 Industrial Waste Treatment
C.E.254 Sanitary Eng. Design
C.E.250 Sanitary Eng. Research
With approval, E.H.226 and either P.H.P.231 or E.H.228 may be substituted for chem. 61.
E.H.226 Water and Sewage Plant Operation
E.H.228 Radiological Health
P.H.H.P.231 Statistics Applied to Stream Analysis.
Degree: M.S.E.

WATERFRONT FACILITIES

At Princeton University

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

SUMMER

Mathematics Refresher
Mechanics Refresher
Structural Theory Refresher

FALL TERM

Port and Harbor Engineering Seminar
Waterfront Structures Seminar
Eng.505 Graduate Structures
Eng.405 Soil Mechanics (audit) if no background therein.
Public Affairs 507 Problems in Administration
Thesis—Independent research in preparation.

SPRING TERM

Waterfront Structures Seminar
Eng.502 Soil Mechanics, Foundations, and Earth Structures Problems
Politics 512 Public Administration
Thesis
Degree: Master of Science.

COMPTROLLERSHIP

At 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.

This course of instruction is convened six weeks before the beginning of the academic year for a refresher period, during which the officer students are to complete basic undergraduate courses in Accounting, Statistics and Economic Theory prior to the start of graduate studies with the Fall Term.

FALL TERM

ACCTG 3 General Accounting
ACCTG 211 Managerial Accounting
ACCTG 211 Seminar in Government Budgeting
STAT 120 Statistics and Reports Control
BUS ADM 261 Advanced Management
BUS ADM 263 Administrative Review and Program Analysis
BUS ADM 265 Seminar in Comptrollership

SPRING TERM

ACCTG 272 Internal Control and Auditing
ACCTG 222 Seminar in Government Budgeting
BUS ADM 168 Management Engineering
BUS ADM 262 Advanced Management
BUS ADM 264 Administrative Review and Program Analysis
BUS ADM 266 Seminar in Comptrollership
ECON 195 Industrial and Governmental Economics
Degree: Master in Business Administration.

MANAGEMENT AND INDUSTRIAL ENGINEERING

At Rensselaer Polytechnic Institute

Objective: To prepare officers to fill managerial and executive billets in the Navy's industrial organization.

FALL TERM

Cost Analysis
Production Planning and Control
Psychometrics
Personnel Management
Economic Analysis
Law for Engineers

SPRING TERM

Statistical Analysis
Production Management
Industrial Relations
Business and Government
Management Seminar:
Project Study and Thesis
Degree: Master of Science

METALLURGICAL ENGINEERING

At Carnegie Institute of Technology

This program is designed for the graduate of the Naval Construction and Engineering curriculum with the objective of obtaining the maximum possible metallurgical background in a one-year program.

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
This curriculum does not lead to a degree.

NAVAL CONSTRUCTION AND ENGINEERING

At Massachusetts Institute of Technology

Objective: To qualify officers for naval construction and engineering assignments.

Hull Design and Construction Subspecialty (XIII-A-1)

FIRST SUMMER

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

FIRST YEAR

FALL

2.081 Strength of Materials
2.402 Heat Engineering
3.391 Properties of Metals
10.311 Heat Transfer
13.17 History of Warships
M351 Adv. Calculus for Engineers

SPRING

1.401T Structures
1.612 Fluid Mechanics
13.012 Naval Architecture
13.12 Warship General Arrangement
13.21 Warship Form Design
M352 Adv. Calculus for Engineers
Intersessional Field Trip; summer leave.

SECOND YEAR

FALL

1.63T Applied Hydromechanics
13.13 Warship Structural Theory I
13.22 Warship General Design
13.75 Warship Propulsion
13.79 Propeller Design
N Nuclear Engineering

SPRING

1.42 Structures
1.683 Experimental Hydromechanics
3.392 Properties of Metals
13.14 Warship Structural Theory II
13.24 Warship Structural Design II
13.76 Warship Propulsion II
3.15 Welding Engineering
Intersessional Field Trip; summer leave.

THIRD YEAR

FALL

2.216 Experimental Stress Analysis
13.15 Warship Basic Design I
13.16 Warship Basic Design II
13.25 Warship Structural Design II
13.54 Marine Eng. Dynamics
1.58 Elastic Stability of Flat Plates
13.X Marine Electrical Engineering

SPRING

13.26 Preliminary Design of Warships
14.113 Economics and Labor Relations
13.04 Ship Design, Advanced
Thesis
Degree: Naval Engineer.

Note: Three other subspecialties are offered, all of which contain basic ship design, but proportionately greater amounts of other phases of marine engineering. These are:

XIII-S-2 Marine Electrical Engineering
XIII-A-3 Electronics Engineering
XIII-A-4 Ship Propulsion Engineering

NAVAL CONSTRUCTION AND 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 and II
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

Advanced Theoretical Fluid Mechanics
Metallurgy
Advanced Structures I and II
Structures Lab
Electrical Engineering IV
Ship Resistance and Propellers II
Naval Architecture Design III
Theoretical Naval Architecture III
Theory of Warship Design I and II
Warship Design I and II
Internal Combustion Engines
Marine Engineering III and IV

THIRD YEAR

Economics I and II
Advanced Structures III
Kinematics and Machine Design
Vibrations
Theory of Warship Design III and IV
Warship Design III and IV
Marine Engineering V and VI
Thesis
Degree: Master of Science.

NUCLEAR ENGINEERING (Advanced)

At Massachusetts Institute of Technology

FIRST SUMMER

8.06N Nuclear Physics (Special Seminar)
plus other elective courses in Mathematics, Chemical or Heat Engineering to not less than 28 units.

FALL

2.521 Adv. Heat Transfer
3.396 Technology of Nuclear Reactor Materials
8.511 Nuclear Physics I
N.21 Nuclear Reactor Eng. I
N.20 Biological Effects of Nuclear Radiations

SPRING

2.783 Control Probs. in Mech. Engineering
8.512 Nuclear Physics II
8-513 Nuclear Physics Laboratory
N.22 Nuclear Reactor Eng. II
Thesis

SECOND SUMMER

Thesis

Degree: Master of Science.

PETROLEUM LOGISTICS

At University of Pittsburgh and in
Petroleum Industry

Formerly Petroleum Engineering (Advanced)
Objective: To equip senior officers with a broad understanding of the petroleum industry, its problems and economics, for duties on the Munitions Board and other high-level logistics agencies where liaison with civilian industry is required.

FIRST YEAR

FALL

Pet. Eng. 101 Drilling and Development
Pet. Eng. 104 Business of Oil and Gas Production
Pet. Eng. 105 Petroleum Testing
Pet. Eng. 106 Petroleum Production Lab.
Pet. Eng. 110 Fundamentals of Reservoir Eng.
Chem. Eng. 17 Petroleum Processes
Geology 2 Historical Geology

SPRING

Pet. Eng. 101 Petroleum Production Practice
Pet. Eng. 107 Gathering, Transportation and Storage
Pet. Eng. 108 Reservoir Eng. Seminar
Pet. Eng. 200 Research and Thesis
Pet. Eng. 227 Valuation of Oil and Gas Properties
Geology 121 Geology of Oil and Gas
Transportation 109 Principles of Transportation

SUMMER

Pet. Eng. 200 Thesis
Geography 53 World Resources and Industry
or
Ind. Rel. 122 Industrial Relations
or
Commerce 61 Principles of Marketing

SECOND YEAR

Assigned to various petroleum industrial concerns under instruction. This period is devoted to intensive study of operations and procedue in office and field, in close contact with the management.
Degree: M.S. on completion of Summer Term of academic work.

PUBLIC INFORMATION

At Boston University

Objective: To advance the qualifications of a small group of officers in public relations.

The following is a typical curriculum composed of representative courses which are described in the Boston University Bulletin.

FIRST SEMESTER

PR-441 Publicity: Principles and Practice II
PR-461 Government Relations
PR-701 Comtemporary Problems in Public Relations
PR-721 Methods in Social Science Research
PR-741 Propaganda—Its Analysis and Use

SECOND SEMESTER

PR-445 Advanced Techniques in Public Relations Media
PR-702 Contemporary Problems in Public Relations II
PR-761 Factors Influencing Morale
PR-801 Special Problems in Public Relations

SUMMER SESSION

PR-825 Thesis Seminar
Degree: M.S. in Public Relations.

THE ENGINEERING SCHOOL

Description of Courses

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 PARENTHESES 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-101(C) Fundamentals of Atmospheric Circulation 2-0

Primarily designed to give non-aerological student officers 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.

Text: Petterssen: Introduction to Synoptic Meteorology.

Prerequisite: None.

Mr-110(C) Aerological Aspects of Atomic, Biological and Chemical Warfare 2-0

Classified information involving the effects of weather on ABC warfare.

Texts: Classified official publications.

Prerequisites: Ph-191(C) or equivalent; Mr-212-(C) or Mr-103(C).

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

Distribution of physical properties of the atmosphere and the oceans, with resultant circulation patterns. Methods of prediction of weather and sea conditions, with application to naval operations.

Texts: Berry, Bollay, Beers: Handbook of Meteorology; selected NavAer publications.

Prerequisite: None.

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

Composition and vertical structure of the atmosphere, physical processes, general circulation, air masses, fronts, cyclones and anticyclones, and weather forecasting.

Text: Petterssen: Introduction to Synoptic Meteorology.

Prerequisite: None.

Mr-201(C) Weather Maps and Codes 2-12

Elementary principles of meteorology are outlined by lectures and motion pictures. Methods, instruments, and conventions used in observing the state of the atmosphere from the surface and aloft are discussed and the data encoded for transmission and analysis. Data are decoded and plotted. A series of aircraft flights are made.

Texts: Radio Weather Aids, H.O. 206; various Navy and Weather Bureau code publications.

Prerequisite: None.

Mr-202(C) Surface Weather Map Analysis 2-12

Lectures cover the following topics: Weather producing processes; graphical representation of atmospheric properties and processes; geostrophic and gradient wind scales; representativeness and diurnal variation of meteorological elements; anatomy and synoptic characteristics of fronts, wave cyclones and occlusions.

In laboratory, a selected series and current daily weather maps are analyzed, making use of upper wind data; local weather is observed and map analyses discussed. A series of flights are made by the students to compare observed flight conditions with those indicated on the weather map.

Texts: Berry, Bollay, Beers: Handbook of Meteorology; departmental notes.

Prerequisites: Mr-200(C), Mr-201(C).

Mr-203(C) Weather Analysis and Forecasting 2-12

A continuation of Mr-202(C). Lectures cover the following: inversions and cross-sections; fog and fog forecasting; kinematics of fronts and pressure systems; construction of trajectories; constant-level and constant-pressure charts; and differential analyses.

In laboratory, advanced methods of current weather map analysis and forecasting are presented. Relation of upper air observations to the overall structure of the atmosphere, daily forecasts, map discussions and flight cross-sections are covered. Flight cross-sections are verified through a series of flights over various routes.

Texts: Berry, Bollay, Beers: Handbook of Meteorology; selected NavAer publications; departmental notes.

Prerequisites: Mr-202(C), Ma-162(C).

Mr-204(C) Upper-Air Analysis and Forecasting 2-9

A continuation of Mr-203(C). Lectures cover the following: prognostic upper-air charts, forecasting displacement of fronts and pressure systems, and middle-latitude forecasting techniques.

In laboratory, the relationship between various upper-air charts and the sea-level chart. Preparation of differential, jet-stream and isotach analyses, and prognostic upper-air charts. Daily forecasts and map discussions are continued, with verification based on computation of winds and pressure surfaces from aircraft in flight.

Texts: Riehl et al: Forecasting in Middle Latitudes; selected NavAer publications.

Prerequisites: Mr-203(C), Mr-301(C), Mr-402(C), Ma-163(C).

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

Lectures include: techniques of weather observations and the encoding, decoding and plotting of data; fundamentals of map analysis; weather producing processes; graphical representation of atmospheric properties and processes; geostrophic and gradient wind scales. An Aerology series of motion pictures is shown. In laboratory, weather data are decoded and plotted, weather observations are made, an elementary series of maps is analyzed and aircraft flights are made for familiarization.

Texts: Departmental notes.

Prerequisites: None.

Mr-212(C) Weather Map Analysis 2-12

Continuation of Mr-211(C). Lectures include: representativeness and diurnal variation of meteorological elements; anatomy and synoptic characteristics of fronts, wave cyclones and occlusions; upper-air and differential analysis. In laboratory, current daily weather maps are analyzed making use of upper-air data, and map analyses are discussed. A series of flights is made by the students to compare observed flight conditions with those indicated on the weather map.

Texts: Berry, Bollay, Beers; Handbook of Meteorology; departmental notes; selected NavAer publications.

Prerequisites: Mr-200(C); Mr-211(C); Mr-402(C).

Mr-213(C) Weather Analysis and Forecasting 2-12

A continuation of Mr-212(C). Lectures cover the following: upper-level patterns and trends, long and short waves, blocks and closed circulations, and the jet stream; prognostic upper-air charts; forecasting displacement of fronts and pressure systems; deepening and filling; inversions and cross-section; temperature, fog, and precipitation forecasting.

Laboratory work includes: relationship between upper-air charts and the sea-level chart; differential, jet stream and isotach analyses; prognostic surface and upper-air charts; flight cross-sections; daily forecasts and map discussions; special weather sequences for selected areas of the world; verification of flight cross-sections and forecasts based on computation of winds and pressure surfaces and observation of weather from aircraft in flight.

Texts: Berry, Bollay, Beers: Handbook of Meteorology; Riehl et al: Forecasting in Middle Latitudes; Selected NavAer Publications.

Prerequisites: Mr-212(C); Mr-311(B); Ma-163(C).

Mr-215(B) Advanced Weather Analysis and Forecasting 0-12

Various analysis and forecasting techniques developed in previous synoptic and theoretical courses applied to laboratory and inflight solution of selected forecast problems. Special weather sequences for selected localities of the world, arctic, tropics and Southern Hemisphere are analyzed.

Text: None.

Prerequisites: Mr-204(C), Mr-302(C), Oc-201(C).

Mr-216(B) Advanced Weather Analysis and Forecasting 2-12

Lectures cover the following: general operational weather problems; weather briefing for overseas flight clearances, carrier strikes and amphibious operations; pressure pattern flight; single station forecasting, CAA and general flight manuals, instructions and supplements; fleet and area commanders' instructions; and detailed climatology of major areas of interest.

In laboratory, analysis and forecast of the weather in accordance with recent advanced methods using all available sources of information. Coordinated with Mr-217(B). Verification of flight forecasts and cross-sections based on actual inflight observations and computations.

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

Prerequisites: Mr-215(B) or Mr-213(C), Mr-303-(C) or Mr-312(B), Mr-403(C).

Mr-217(B) Upper-Air Analysis and Forecasting 0-8

Constant-pressure, jet-stream, and isotach analysis presented and supplemented by surface map analysis in Mr-216(B). Time cross-sections and constant absolute vorticity trajectories computed. Computations necessary for pressure-pattern flight carried out and checked by inflight observations.

Text: None.

Prequisites: Same as for Mr-216(B).

Mr-226(B) Advanced Weather Analysis and Forecasting 2-9

Lectures review the following: fundamental weather-producing processes; principles of surface map analysis, constant-pressure and differential analyses and preparation of surface and upper-air prognostic charts. In the laboratory, upper-air observations and analyses used to determine air mass characteristics, three-dimensional weather analysis stressed by use of upper-air charts, differential analyses, and vertical cross-sections in conjunction with surface charts. Daily forecasts of surface and upper-air conditions are prepared and discussed.

Texts: Berry, Bollay, Beers: Handbook of Meteorology; selected NavAer and AROWA publications; departmental notes.

Prerequisites: Mr-411(B), Mr-412(A), Ma-103(B).

Mr-227(B) Upper-Air Analysis and Forecasting 2-9

A continuation of Mr-226(B). Lectures review forecasting displacement of fronts and pressure systems, deepening and filling of pressure systems, and latest forecasting methods based on three-dimensional analysis, with emphasis on the role of the jet stream. In the laboratory, principles outlined in lectures are applied to analysis of synoptic charts and preparation of prognostic charts. A special period is devoted to practical trials of new or untested synoptic techniques.

Texts: Same as for Mr-226(B), plus Riehl et al: Forecasting in Middle Latitudes.

Prerequisites: Mr-226(B), Mr-321(A), Mr-228(B).

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.

Texts: Berry, Bollay, Beers: Handbook of Meteorology; selected U. S. Navy and Weather Bureau publications.

Prerequisite: Mr-321(A) concurrently.

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

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

Texts: Selected U. S. Navy and Weather Bureau publications; departmental notes.

Prerequisites: Mr-321(A), Mr-228(B), Ma-134(B).

Mr-230(A) Operational Forecasting 0-10

Presentation and application of recent developments in the technique of preparing surface and upper-level prognostic charts. Preparation of forecast from prognostic charts. Streamline and jet-stream analysis, time cross-sections, constant absolute vorticity trajectories, time and space differential analysis techniques. Instruction in the preparation of aerological annexes to Naval Operations Plans.

Text: Riehl et al: Forecasting in Middle Latitudes.

Prerequisites: Mr-227(B), Mr-422(A), Mr-520(B).

Mr-301(C) Synoptic Meteorology I 4-0

The general circulation, production and transformation of air masses; the equations of motion, wind and pressure systems, the thermal wind, differential analysis, and frontogenesis.

Texts: Berry, Bollay, Beers: Handbook of Meteorology; departmental notes.

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

Mr-302(C) Synoptic Meteorology II 4-0

A continuation of Mr-301(C), covering the following topics: frontal characteristics, theoretical and synoptic analysis of pressure changes, and methods of long-range forecasting.

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

Prerequisites: Mr-301(C), Mr-402(C).

Mr-303(C) Synoptic Meteorology III 4-0

A continuation of Mr-302(C), covering Southern Hemisphere meteorology, tropical analysis and forecasting, arctic and antarctic meteorology, objective forecasting methods, and marine meteorology.

Texts: Same as for Mr-302(C) plus selected NavAer and AROWA pamphlets.

Prerequisites: Mr-302(C), Mr-403(C), Ma-381(C).

Mr-311(B) Synoptic Meteorology Ia 5-0

The general circulation; production and transformation of air masses; the equations of motion, wind and pressure systems, the thermal wind, and differential analysis; frontogenesis, fronts, and frontal characteristics.

Texts: Berry, Bollay, Beers: Handbook of Meteorology; departmental notes.

Prerequisites: Mr-200(C); Mr-402(C); Ma-163(C) concurrent.

Mr-312(B) Synoptic Meteorology IIa 5-0

Theoretical and synoptic analysis of pressure changes; methods of long-range forecasting; Southern Hemisphere, tropical, and polar analysis and forecasting; objective forecasting methods.

Texts: Same as for Mr-311(B), plus selected NavAer and AROWA pamphlets.

Prerequisites: Mr-311(B); Ma-361(C) concurrent.

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

The equations of motion in the absolute and relative reference frames. Solutions in particular atmospheric cases. Geostrophic and gradient winds measured in surfaces of constant property. Streamlines and trajectories. The thermal wind equation in various forms. Surfaces of discontinuity. Solenoids and the circulation theorems.

Texts: Holmboe, Forsythe and Gustin: Dynamic Meteorology; Petterssen: Weather Analysis and Forecasting.

Prerequisites: Mr-411(B), Mr-412(A), Ma-103(B).

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

A continuation of Mr-321(A), covering the topics listed below. Continuity and tendency equations. Convergence and divergence in general and in application to circular and wave-shaped systems. The vorticity theorem with applications to certain types of atmospheric flow. Frontogenesis and frontolysis in relation to linear velocity fields. Perturbation techniques in the solution of the equations of motion. Numerical integration of the equations of motion.

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

Prerequisites: Mr-321(A), Ma-134(B).

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

A continuation of Mr-322(A) and considers the following topics: General effects of viscosity, equations of motion for laminar and turbulent flow, wind variation in the surface layer, energy changes in wind systems, transfer of properties by turbulent mass exchange, diurnal temperature variation; transformation of air masses; and introduction to the statistical theory of turbulence.

Text: Sutton: Micrometeorology.

Prerequisites: Mr-321(A), Ma-134(B).

Mr-402(C) Meteorological Charts and Diagrams 3-0

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: Elementary Meterological Thermodynamics (mimeographed).

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

Mr-403(C) Introduction to Physical Meteorology 4-0

This course divides naturally into two parts: (a) properties of radiation in general, solar and terrestrial radiations and their contributions to certain large and small scale atmospheric energy problems; (b) laminar and turbulent flow. The Navier-Stokes equations and their modification by Reynolds. Structure of the mean wind in the surface and frictional layers. Diurnal variation of certain properties affected by turbulence. Air mass modification by turbulence. Diffusion from point and line sources.

Texts: Berry, Bollay, Beers: Handbook of Meteorology; departmental notes.

Prerequisites: Mr-302(C), Ma-163(C).

Mr-410(C) Meteorological Instruments 2-3

Standard naval meteorological instruments including those required for aircraft observations are studied and used by the students in the laboratory and while airborne. Additional instrumentation peculiar to (1) cold climates, (2) high elevations, and (3) micrometeorological elements is investigated generally. Special attention is paid to errors and reliability of observation.

Texts: Middleton: Meteorological Instruments; Aerographer's Manual; U. S. Weather Bureau: Circular "P"; From: Instrument Work Book.

Prerequisite: Ph-191(C) or equivalent.

Mr-411(B) Thermodynamics of Meteorology 5-2

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

Texts: Holmboe, Forsythe, Gustin: Dynamic Meteorology; U. S. Department of Commerce Publication: The Thunderstorm.

Prerequisites: Ma-132(C), Ph-196(C).

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.

Texts: Berry, Bollay, Beers: Handbook of Meteorology; Elsasser: Heat Transfer by Infra-red Radiation in the Atmosphere; Albright: Physical Meteorology.

Prerequisites: Ph-196(C), Ma-132(C).

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

Quantum theory. 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 atmospherics. Terrestrial magnetic variations. Atmospheric oscillations of tidal origin. The aurora. Composition of the atmosphere.

Texts: Mitra: The Upper Atmosphere; Semat: Atomic Physics.

Prerequisites: Mr-322(A), Mr-323(A).

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.

Prerequisites: Mr-203(C), Mr-301(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: Ma-331(A), Mr-510(C) or equivalent.

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

Wind wave generation, propagation and decay; forecasting surface deep-water waves from meteorological data, their transformation and refraction in shallow water, breakers; statistical properties of waves.

Texts: H.O. 604: Techniques for Forecasting Wind Waves and Swell; H.O. 234: Breakers and Surf; N.Y.U. Tech. Rep. No. I: Practical Methods for Observing and Forecasting Ocean Waves.

Prerequisites: Mr-302(C), Oc-201(C).

Mr-620(B) Sea and Swell Forecasting 2-2

Similar to Mr-610(C), but emphasis on new developments, including statistical theory of wave generation.

Texts: H.O. 604: Techniques for Forecasting Wind Waves and Swell; H.O. 234: Breakers and Surf; N.Y.U. Tech. Rep. No. I: Practical Methods for Observing and Forecasting Ocean Waves.

Prerequisite: Oc-111(B).

Mr-810(A) Seminar 2-0

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

Text: None.

Prerequisites: Mr-229(B), Mr-422(A), Mr-520(B).

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 3-4

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: Fluids Mechanics; Rouse: Elementary Fluids Mechanics.

Prerequisite: None.

Ae-104(C) Aircraft Performance Evaluation 3-0

Fundamentals of technical aerodynamics; aircraft aerodynamic characteristics, performance analysis and propulsion characteristics; operational analysis of aircraft in fuel consumption, range, and performance.

Texts: Dwinnell: Principles of Aerodynamics; NavAer publications.

Prerequisite: Ph-541(B).

Ae-121(C) Technical Aerodynamics 3-2

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 4-2
Performance

The aerodynamic characteristics of the airplane, propeller and engine characteristics; sea level performance; performance at altitudes; superchargers;

range and endurance; special performance problems; charts. The laboratory periods are devoted to computations and performance analysis.

Texts: The same as in Ae-121(C).

Prerequisite: Ae-121(C).

Ae-132(B) Flight Analysis 3-2

Parametric study of aircraft performance; flight test procedure; flight data reduction; special flight problems. Laboratory periods are devoted to problems dealing with the above.

Text: Hamlin: Flight Testing.

Prerequisite: Ae-131(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 3-4

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: USNPS 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

This is a continuation of Ae-151(B) in the same field.

Texts: Same as Ae-151(B).

Prerequisite: Ae-151(B).

Ae-153(B) Flight Testing and Evaluation III 2-0

A continuation of Ae-152(B).

Texts: The same as in Ae-152(B).

Prerequisite: Ae-152(B).

Ae-161(B) Flight Testing and Evaluation Laboratory I 0-4

Flight Test program accompanying Ae-151(B).

Ae-161(B) Flight Testing and Evaluation Laboratory II 0-4

Flight Test program accompanying Ae-152(B).

Ae-163(B) Flight Testing and Evaluation Laboratory III 0-8

Flight Test program accompanying Ae-153(B).

Ae-200(C) Statics of Aircraft 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. 1; Timoshenko and Young: Statics.

Prerequisites: To be taken with Mc-101, with same prerequisites.

Ae-211(C) Stress Analysis I 4-0

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.

Text: 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 II 4-2

A continuation of Ae-211. The general state of plane stress in complicated components of air frames 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 III 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 IV 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 cylinders 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 layout and analysis of a light plane.

Design requirements are for the condition of high angle of attack; prepare equipment list and balance diagram; correct airfoil characteristics for structural use; construct three-view drawing; run the balance calculation and the preliminaries to the wing design.

Texts: The same as in Ae-213(B); also Teichmann: Airplane Design Manual; Sechler and Dunn: Airplane Structural Analysis and Design; C.A.R. 04: C.A.M. 04: Navy Specifications Manual.

Prerequisite: Ae-213(B).

Ae-312(B) Airplane Design II 1-4

A continuation of Ae-311(C). Wing spar analysis, wing truss analysis, fuselage analysis including Maxwell diagram. Design: one wing-spar on basis, shear-resistant web, tension-field web, composite spar of two materials; elevator torque tube in bending and twist for given loading condition; several members of the fuselage truss as columns and as ties; indicated fittings.

Texts: The same as in Ae-311(C).

Prerequisite: Ae-311(C).

Ae-410(B) Thermodynamics (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, Stuart and Kinney: Engineering Thermodynamics; Stoever: Applied Heat Transmission; Keenan and Kaye: Gas Tables.

Prerequisite: ME-131(C).

Ae-411(B) Aircraft Engines 3-2

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; USNPS stencils.

Prerequisite: Ae-410(B).

Ae-421(B) Aircraft Propulsion 3-2

Sea level and altitude performance characteristics of piston engines, propellers, turbo-jet and turbo-prop 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; USNPS stencils.

Prerequisites: Ae-411(B), Ae-131(C).

Ae-431(A) Internal Flow in Aircraft Engines 4-0

This is a fundamental course in the application of thermoaerodynamics to the study of flow in machines. Topics are: momentum theorem; thrust equations; flow equations; relative and absolute flow, relative flow in machines; energy equations; thermodynamic flow equations; axial-flow compressors; centrifugal compressors; axial-flow turbines; centrifugal turbines.

Texts: ATSC: Jet Propulsion; Zucrow: Jet Propulsion and Gas Turbines; USNPS stencils.

Prerequisite: Ae-503(A).

Ae-451(C) Gas Turbines I 4-0

A seminar on the theory, design, and control of gas turbines, stationary and marine.

Text: None.

Prerequisites: Ae-502(A), Ae-410(B) or ME-132(C).

Ae-452(C) Gas Turbines II 3-0

A seminar in continuation of Ae-451(C).

Text: None.

Prerequisite: Ae-451(C).

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: Glauert: Airfoil and Airscrew Theory; Streeter: Fluid Dynamics.

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 airfoils; Chordwise and spanwise load distribution, tunnel-wall effect; viscous fluids.

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 Schetze: 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), 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. 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 disturbances; one-dimensional channel flow; oblique shock waves, reflections; transonic flow shock waves, reflections; transonic flow problems. 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); Ae-502(A).

CHEMISTRY

Ch Courses

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.

Text: 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.

Ch-111(A) Fuel and Oil Chemistry

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.

Prerequisite: Ch-101(C).

Ch-121(B) General and Petroleum Chemistry 4-2

Topics covered in this course are: classification 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; Lowy, Harrow, Apfelbaum: Introduction to Organic Chemistry; Pugh and Court: Fuels and Lubricating Oils.

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-231(C) Quantitative Analysis 2-3

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.

Prerequisite: Ch-101(C) or Ch-121(B), Ch-221(C).

Ch-301(C) Organic Chemistry 3-2

An introduction to the properties, reactions and relationships of the principal 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 Ch-121(B).

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.

Prerequisites: Ch-102(C); Ch-213(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), 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: Fuson: Advanced Organic Chemistry; Alexander: Principles of Ionic Organic Reactions.

Prerequisite: Ch-301(C), 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), Ch-312(C) or Ch-315(C), Ch-521(A)

Ch-401(A) Physical Chemistry 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: Daniels: Outlines of Physical Chemistry; Daniels, Mathews and Williams: Experimental Physical Chemistry.

Prerequisites: Ch-101 or equivalent; Ch-613 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: Daniels: Outlines of Physical Chemistry Daniels, Mathews, Williams and Staff: 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: Daniels: Outlines of Physical Chemistry; Daniels, Mathews, Williams and Staff: 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 consists of experiments designed to supplement the material covered in the lectures.

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. The emphasis in this course is on physical methods of detection, identification, separation and quantitative determination of matter. Topics covered are the liquid, solid and gaseous states, solutions, chemical applications of thermodynamics, thermochemistry. Laboratory work is correlated with the subject matter and the objective of the sequence.

Text: Prutton and Maron: "Fundamental Principles of Physical Chemistry."

Prequisites: Ch-102.

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."

Prerequisites: Ch-414.

Ch-442(C) Physical Chemistry 4-2

A short course in physical chemistry for chemistry majors. Gases, solids, thermochemistry, liquids, solutions, chemical equilibrium, chemical kinetics, electrochemistry and colloids. Laboratory experiments which illustrate principles discussed in the lectures are performed.

Texts: Millard: Physical Chemistry for Colleges; Daniels, Mathews, Williams and Staff: Experimental Physical Chemistry.

Prerequisite: Ch-101(C) or equivalent.

Ch-521(A) Plastics 3-2

A study of the nature and types of plastics, including alkyds, polyesters, silicone-base plastics, and rubbers, both natural and synthetic. 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, a study of their properties, and identification tests.

Text: Richardson and Wilson: Fundamentals of Plastics.

Prerequisite: Ch-101(C) or Ch-121(B).

Ch-531(A) Physical Chemistry (for Metallurgy Students) 2-0

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.

Prerequisite: Physical chemistry; Mt-202.

Ch-541(A) Reaction Motors 2-2

A course covering the classification of reaction motors, basic mechanics, nozzle theory, propellent performance calculations, liquid and solid pro pellent motors, rocket testing, ramjet, pulse jet, military applications. Laboratory period is devoted to working problems.

Text: Sutton: Rocket Propulsion Elements. ATSC Jet Propulsion.

Prerequisite: Ch-101 or equivalent and one term of thermodynamics.

Ch-551(A) Radiochemistry 2-2

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).

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 laboratory experiments are included.

Texts: Millard: Physical Chemistry for Colleges; Danils, Mathews, Williams and Staff: Experimental Physical Chemistry.

Prerequisite: Ch-111(A) or Ch-121(B).

Ch-571(A) Explosives 3-2

Modes of behavior and principles of use of explosive substances as 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 explosive investigation, selection, and development.

Prerequisites: One term each of Thermodynamics and 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.

Ch-591(A) Blast and Shock Effects 3-0

Propagation of shock waves in homogeneous media; scaling laws for damage for air, underwater and underground 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.

Prerequisite: Physical Chemistry, Thermodynamics.

Ch-611(C) Thermodynamics 3-2

Study of the fundamentals of thermodynamics, the concept of energy and its classification and transformation, 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, Stewart and Kinney: Principles of Engineering Thermodynamics.

Prerequisite: Ch-101.

Ch-612(C) Thermodynamics 3-2

A continuation of Ch-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, Stewart and Kinney: Principles of Engineering Thermodynamics.

Prerequisite: Ch-611(C).

Ch-613(A) Chemical Engineering Thermodynamics 3-2

Designed for non-chemical majors, the course extends previous studies in mechanical engineering thermodynamics to include the thermodynamics 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.

Texts: Smith: Introduction to Chemical Engineering Thermodynamics; Perry: Chemical Engineers Handbook.

Prerequisite: One term of Physical Chemistry and one term of Thermodynamics.

Ch-631(A) Chemical Engineering Thermodynamics 3-2

An extension of Ch-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; Robinson: Thermodynamics of Firearms; Keenan and Keyes: Thermodynamic Properties of Steam; Keenan and Kaye: Gas Tables.

Prerequisite: Ch-711(C), or Ch-701(C).

Ch-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, chosen from engineering practice whenever possible, are based on combustion, distillation, absorption, evaporation, humidification, and other unit operations and processes.

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)

Ch-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, processes 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).

Ch-721(C) Unit Operations 3-0

An introduction to the study of the unit operations of chemical engineering. Materials handling, screening, size reduction and handling of solids; classification methods; transportation of fluids; measurements of flow of fluids.

Texts: Brown and Associates: Unit Operations.

Prerequisite: Ch-701, Ch-411.

Ch-722(C) Unit Operations 3-0

A continuation of Ch-721. Filtration, solid-liquid and liquid-liquid extractions; fractionation, stripping and rectifying columns.

Text: Brown and Associates: Unit Operations.

Ch-800(A) Chemistry Seminar

This course involves library investigations of assigned topics, and reports on articles in the current technical journals.

COMMAND COMMUNICATIONS

Co Courses

Co-101(C) Communication Principles and Procedures 3-2

An introduction to naval communications, with study of the basic communication publications.

Text: Classified official publications.

Prerequisite: None.

Co-102(C) Communcation Principles and Procedures 3-2

A continuation of Co-101(C).

Text: Classified official publications.

Prerequisite: Co-101(C).

Co-111(C) Communications-Electronics Security 2-0

A study of the various aspects of communications-electronics security.

Text: Classified official publications.

Prerequisite: None.

Co-112(C) Communcations-Electronics Security 1-1

A continuation of Co-111(C).

Text: Classified official publications.

Prerequisite: Co-111(C).

Co-113(C) Cryptographic Methods and Procedures 1-1

A study of the basic principles of cryptography and the detailed procedures employed in the use of the various cryptosystems.

Text: Classified official publications.

Prerequisite: Co-112(C).

Co-114(C) Cryptographic Methods and Procedures 0-2

A continuation of Co-113(C).

Text: Classified official publications.

Prerequisite: Co-113(C).

Co-123(C) Naval Communications Afloat and Ashore 3-2

A study of the functions and facilities of naval communications, including details of tactical communications and preparation of communications-electronics plans and orders.

Text: Classified official publications.

Prerequisite: None.

Co-124(C) Naval Communications Afloat and Ashore 3-2

A continuation of Co-123(C).

Text: Classified official publications.

Prerequisite: Co-123(C).

Co-131(C) Naval Warfare Tactics and Procedures 4-3

A course designed to provide a 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-132(C) Naval Warfare Tactics and Procedures 4-3

A continuation of Co-131(C).

Text: Classified official publications.

Prerequisite: Co-131(C.

Co-133(C) Naval Warfare Tactics and Procedures 4-3

A continuation of Co-132(C).

Text: Classified official publications.

Prerequisite: Co-132(C).

Co-134(C) Naval Warfare Tactics and Procedures 4-3

A continuation of Co-133(C).

Text: Classified official publications.

Prerequisite: Co-133(C).

Co-135(C) Correspondence Course in Strategy and Tactics

The officer student is required to complete at least four assignments of the U. S. Naval War College Correspondence Course in Strategy and Tactics prior to the completion of his instruction at the Postgraduate School. This provides experience in using the Armed Forces Estimate Plan and the Armed Forces Operation Plan Form.

Co-141(C) Public Speaking 0-1

Instruction and practice in the effective delivery of speech.

Text: None.

Prerequisite: None.

Co-142(C) Public Speaking 0-1

A continuation of Co-141(C).

Text: None.

Prerequisite: None.

Co-154(C) Military Communication Organizations 0-2

A study of the various military communication organizations and their relation to naval communications. A portion of the course is devoted to seminar presentation of papers prepared by each student on a communication subject, and to lectures by representatives of military communication organizations.

Text: Classified official publications.

Prerequisite: None.

Co-161(C) Administration and Management 3-0

A study of the organization of naval staffs; a study of the principles of effective written communication; a study of the Navy Postal System.

Text: Classified official publications.

Prerequisite: None.

Co-162(C) Naval Fiscal Management 0-3

A series of lectures covering the principles of business administration applicable to naval command, administration of allotments, application of fiscal and material controls, conservation and economy measures.

Text: Classified 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 systems, 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.

Text: Dana, Ford: Textbook of Mineralogy; 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: Dana, Ford: Textbook of Mineralogy.

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: Dana, Ford: Textbook of Mineralogy.

Prerequisite: Ch-101(C).

ELECTRICAL ENGINEERING

EE Courses

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.

Prerequisites: Differential and Integral Calculus; Elementary Physics.

EE-151(C) Direct-Current Circuits and Fields 3-4

Designed to provide a good background in electricity and magnetism, this course covers systems of units, Kirchhoff's laws, direct-current measurements, magnetism and magnetic circuits, electrostatics, capacitance and inductance. The emphasis is on fundamental concepts with considerable time spent in working problems.

Text: Corcoran: Basic Electrical Engineering.

Prerequisites: Differential and Integral Calculus; Elementary Physics.

EE-171(C) Electric 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: Basic Electrical Engineering.

Prerequisites: Differential and Integral Calculus; Elementary Physics.

EE-231(C) DC Machines and AC Circuits 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.

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.

Text: Kerchner and Corcoran: Alternating Current Circuits.

Prerequisite: EE-151(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.

Text: Kerchner and Corcoran: Alternating Current Circuits.

Prerequisite: EE-151(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.

Text: Kerchner and Corcoran; Alternating Current Circuits.

Prerequisite: EE-171(C).

EE-272(B) Alternating Current Circuits 2-2

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.

Text: Kerchner and Corcoran; Alternating Current Circuits.

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) AC and DC 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.

Prerequisites: Es-111(C), Es-112(C).

EE-351(C) DC Machinery 2-2

Fundamentals of direct current machinery with emphasis upon operating characteristics and applications. The external characteristics are developed 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) DC 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 DC 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) Polyphase Transformers, Synchronous Machines and Induction Motors 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-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) Asynchronous Motors and Special Machines 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) Transformers, Controls, Motors, and Special Machines 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 signficance of time constants, transfer functions and concepts important in control applications. Laboratory and problem work supplement the theory.

Text: Hehre and Harness; Electrical Circuits and Machinery, Vol. II.

Prerequisites: EE-251(C).

EE-471(C) Transformers and Asynchronous Machines 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: Bryant and Johnson: Alternating Current Machinery.

Prerequisite: EE-272(B).

EE-472(C) Synchronous Machines and Synchros 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: Bryant and Johnson: Alternating Current Machinery.

Prerequisite: EE-471(C).

EE-473(B) Synchros 2-2

Basic theory and mathematical analysis of single-phase and polyphase operating characteristics. 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-271(C) or EE-251(C).

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, impedance 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-611(B) Servomechanisms 3-4

This course presents the essential basic principles of servomechanisms. The topics covered are the amplidyne, the elements of electrical transients, the synchro, and an introduction to servomechanism devices. Problems and laboratory work supplement the classroom theory.

Texts: Kurtz and Corcoran: Introduction to Electric Transients; Lauer, Lesnick and Matson: Servomechanism Fundamentals.

Prerequisite: EE-314(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 classical and Laplace operational methods. Servomechanisms with viscous damping and differential and integral control. Problems and laboratory experiments illustrate the theory.

Texts: Gardner and Barnes: Transients in Linear Systems; Lauer, Lesnick and Matson: Servomechanisms Fundamentals.

Prerequisite: EE-451(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.

Prerequisite: EE-251(C).

EE-665(B) Lines, Filters and Transients 4-2

The basic principles of each subject are presented. The topics covered are: transmission line parameters, infinite lines, open and shorted lines, reflection, matching, stubs, T and Pi sections, constant K and M-derived sections and composite filters; DC and AC transients in series, parallel, series-parallel and coupled circuits for particular boundary conditions using the Laplace transform methods. An introduction to transfer functions and elementary machine transients is included.

Texts: Gardner and Barnes: Transients in Linear Systems; Kurtz and Corcoran: Introduction to Electric Transients; Ware and Reed: Communication Circuits.

Prerequisites: EE-241(C) and Ma-114(A) or equivalent.

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; Kurtz and Corcoran: Introduction to Electric Transients.

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).

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 with practical applications and circuits.

Text: Fink: Engineering 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 consist of experiments to demonstrate the theory.

Text: Ryder: Electronic Engineering Principles.

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 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: MIT Staff: Applied Electronics.

Prerequisite: EE-751(C).

EE-751(C) Electronics 3-4

A general introduction to the art and science of electronics. Topics treated are: electron ballistics, characteristics of vacuum tubes, gas discharge phenomena, gas tube characteristics, transistor theory and applications. The theory of electronic elements 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: Corcoran and Price: Electronics.

Prerequisite: EE-451(C).

EE-753(C) Electronics 1-2

A continuation of EE-751 with emphasis on application and electronic controls. The lectures include the theory and application of magnetic amplifiers, gas tube control circuits and the principles of feedback in the control and regulation of motors, generators and mechanical devices. Laboratory work is emphasized as supplemental to the theory.

Text: None.

Prerequisite: EE-751(C).

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: MIT Staff: Applied Electronics.

Prerequisite: EE-751(C).

EE-771(B) Electronics 3-2

The theory of electron tubes and circuits for those curricula requiring a more advanced treatment. The theory of electron motion in electric and magnetic fields, vacuum and gas tube characteristics and the principles of such tubes as the ignitron, glow tube, cathode-ray tube and phototube. Circuit theory of rectifiers, detectors, amplifiers and oscillators is covered, with particular attention to industrial and naval power and control applications. Laboratory experiments and problems supplement the basic theory.

Text: MIT Staff: Applied Electronics.

Prerequisite: EE-272(C).

EE-772(B) Electronics 3-2

A continuation of EE-771(B). The more complicated electronic circuits encountered in practice with particular attention to the integration of various components in accordance with the basic theory of feedback and stabilization.

Text: MIT Staff: Applied Electronics.

Prerequisite: EE-771(B).

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 consists 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 importance 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.

EE-972(A) Thesis 0-0

This work provides an opportunity for research and study necessary for the preparation of the thesis as required for the master's degree in electrical engineering. Individual laboratory and library work is performed under the general supervision of the members of the Electrical Engineering Staff.

Text: None.

Prerequisite: The first two years of the advanced electrical engineering curriculum.

ENGINEERING ELECTRONICS

Es Courses

Electronics Administration and Programs	Es-036(C)
DC and AC Electrical Circuits	Es-111(C)
AC Electricity	Es-112(C)
Circuit Analysis and Measurements	Es-113(C)
Circuit Analysis and Measurements	Es-114(C)
Advanced Circuit Theory	Es-121(A)
Advanced Circuit Theory	Es-122(A)
Advanced Circuit Theory	Es-123(A)
Radio-Frenquency Measurements	Es-126(C)
Information and Communication Theory	Es-134(A)
DC Electricity and Static Fields	Es-141(C)
AC Electricity	Es-142(C)
Electronic Instrumentation and Circuits	Es-161(A)
Electronic Instrumentation and Circuits	Es-162(A)
Communications Fundamentals	Es-186(C)
Electron Tubes and Circuits	Es-212(C)
Electron Tubes and Circuits	Es-213(C)
Electron Tubes and Circuits	Es-214(C)
Electron Tubes	Es-225(A)
Ultra-High Frequency Techniques	Es-226(A)
Ultra-High Frequency Techniques	Es-227(C)
Electron Tubes and Circuits	Es-261(C)
Electron Tubes and Circuits	Es-262(C)
Electron Tubes and Ultra-High Frequency Techniques	Es-267(A)
Electronics I	Es-271(C)
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Electronic Fundamentals	Es-281(C)
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Vacuum Tube Circuits	Es-283(C)
Pulsing and High Frequency	Es-286(C)
Radio Systems	Es-321(B)
Radio Systems	Es-322(B)
Radio Systems	Es-326(B)
Radio Systems	Es-327(B)
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Radio Systems	Es-333(B)
Transmitter and Receivers	Es-386(C)
Pulse Techniques	Es-421(B)
Radar System Engineering	Es-423(B)
Radar System Engineering	Es-422(B)
Radar System Engineering	Es-431(B)
Radar System Engineering	Es-432(B)
Introduction to Radar	Es-446(C)
Electronics Pulse Techniques	Es-447(C)
Introduction to Radar (Airborne)	Es-456(C)
Pulse Techniques	Es-461(A)
Radar Propagation and Displays	Es-466(C)
Special Systems	Es-521(B)
Special Systems	Es-522(B)
Special Systems	Es-531(B)
Special Systems	Es-532(B)
Counter Measures	Es-536(B)
Special Systems	Es-586(C)
Basic Electric and Magnetic Fields	Es-616(C)
Electromagnetics	Es-621(A)
Electromagnetics	Es-622(A)
Electromagnetics	Es-623(A)
Electromagnetics	Es-624(A)
Antennas and Wave Propagation	Es-721(B)
Antennas and Wave Propagation	Es-722(B)
Antennas, Transmission Lines	Es-736(B)
R-F Energy Transmission	Es-786(C)
Project Seminar	Es-836(A)
Introduction to Electronics	Es-991(C) and Es-992(C)

Es-036(C) Electronics Administration and Programs 2-0

A lecture series designed to present a broad outline of electronics organization and current programs of research and development. Lectures cover military department, other government agencies, and typical electronics industries.

Text: None.

Prerequisite: None.

Es-111(C) DC and AC Electric Circuits 4-5

An introduction to DC and AC circuits. The principal topics are: circuit fundamentals, batteries, non-linear elements, elementary AC concepts, complex quantities, series and parallel circuits, real and apparent power, network theorems, coupled circuits. The laboratory work familiarizes the student with electronic components and basic measuring equipment.

Texts: Tang: Alternating Current Circuits; second edition.

Prerequisite: Mathematics through calculus.

Es-112(C) AC Electricity 2-0

A continuation of Es-111(C). The principal topics are: a brief introduction to polyphase circuits, nonsinusoidal voltages and currents, DC and AC transients in RLC circuits, voltage and current relations, and impedance on transmission lines.

Texts: Tang: Alternating Current Circuits; Everitt: Communication Engineering.

Prerequisite: Es-111(C).

Es-113(C) Circuit Analysis and Measurements 3-3

This course covers ordinary measurements techniques and continues into AC circuit theory. The principal topics are: coupled circuits, network theorems, the infinite line, radio frequency bridges, measurements at high frequencies, measurements involving complex wave forms.

Texts: Everitt: Communication Engineering; Terman: Radio Engineering; Terman: Measurements in Radio Engineering.

Prerequisite. Es-112(C).

Es-114(C) Circuit Analysis and Measurements 3-3

A continuation of Es-113(C). The principal topics are: reflections in lines, solution of the general line, stubs, derivation and use of circle diagrams, constant-K and M-derived filters, impedance measurements with slotted lines.

Text: Everitt: Communication Engineering.

Prerequisite: Es-113(C).

Es-121(A) Advanced Circuit Theory 3-2

An introduction to transient phenomena in electrical networks and their solutions on the loop and nodal basis; modes. Solutions are by classical methods, Fourier Integral, Laplace transforms.

Texts: Guillemin: Communication Networks, Vol. I; Goldman; Frequency Analysis, Modulation, and Noise; Gardner and Barnes: Transients in Linear Systems.

Prerequisite: Es-114(C).

Es-122(A) Advanced Circuit Theory 3-2

A continuation of Es-121(A). The Laplace transform is employed for solution of transients in typical circuits used in radio and radar. The transmission line as a communication facility leading to filter theory involving four terminal networks is treated.

Texts: Gardner and Barnes: Transients in Linear Systems; Guillemin: Communication Networks, Vol. II.

Prerequisite: Es-121(A).

Es-123(A) Advanced Circuit Theory 3-0

This course treats the synthesis of networks with prescribed characteristics. The principal topics are: Foster's Reactance Theorem, including Cauer's extensions, Brune's development of the driving point impedance, the Bott-Duffin synthesis and Darlington's Insertion Loss Theory.

Texts: Bode: Network Analysis and Feedback Amplifier Design; Guillemin: Communication Networks, Vol. II, as references; instructor's notes.

Prerequisite: Es-122(A).

Es-126(C) Radio-Frequency Measurements 2-6

Impedance and frequency bridges and the techniques of the measurement of voltage, current, power, and impedance in the various frequency ranges. The topics include a detailed study of radio-frequency resonant methods, precision slotted lines, microwave measurements, standards of E, R, L, C and F.

Text: Hartshorn: Radio-Frequency Measurements.

Prerequisites: Es-114(C), Es-225(A).

Es-134(A) Information and Communication Theory 3-0

Statistical methods in communication engineering are studied.

Text: instructor's notes.

Prerequisite: Es-123(A).

Es-141(C) DC Electricity and Static Fields 4-4

Develops circuit analysis techniques applicable to direct current circuits and presents fundamental electric and magnetic concepts. Principal topics covered are: Ohm's Law; Kirchhoff's Laws; network theorems; mesh and nodal analysis; electric fields; capacitance; magnetic fields; inductance; mutual inductance. The laboratory work familiarizes the student with electrical components and common configurations thereof, and with basic measuring instruments.

Text: Hessler and Carey: Fundamentals of Electrical Engineering.

Prerequisite: Mathematics through the calculus.

Es-142(C) AC Electricity 4-3

A continuation of Es-141(C). Circuit analysis techniques are extended to include alternating currents and reactive circuits. Principal topics covered are: Definition of alternating voltage and current; non-sinusoidal waves, elementary reactive circuits, resonance, network theorems, analysis of multi-mesh networks, mutual inductance, inductively coupled circuits, equivalent tee and pi sections, impedance transformation, polyphase circuits (brief).

The factual content of Es-141(C) and Es-142(C) is presented rapidly and largely constitutes a review for most students. Emphasis is placed particularly on developing effective analysis techniques.

Text: Tang: Alternating Current Circuits.

Prerequisite: Es-141(C).

Es-161(A) Electronics Instrumentation and Circuits 3-3

The principal topics are: special amplifier circuits, i.e., pulse-shaping, wide-band, difference and feedback amplifiers; grating, mixing and coincidence circuits; electronic counters and scaling circuits; modulation techniques associated with telemetery.

Text: Elmore and Sands: Electronics; selected references.

Prerequisite: Es-461(A).

Es-162(A) Electronic Instrumentation and Circuits 3-3

The principal topics are: transmission, amplification and recording of data from vibration pickups, strain gauges, resistance thermometers, light integrating photoelectric cells, etc.; principles of ultra-high frequency, f-m and c.w. radar as related to altimetry.

Text: Lecture notes; selected references.

Prerequisite: Es-161(A).

Es-186(C) Communications Fundamentals 4-4

The fundamental principles of radio communcations and basic circuits. The principal topics are: fundamentals of energy transmission by means of radio waves, basic alternating-current theory, frequency selectivity circuits, coupled circuits.

Texts: Sheingold: Fundamentals of Radio Communications.

Prerequisite: None.

Es-212(C) Electron Tubes and Circuits 4-6

The principal topics are: physical principles of vacuum and gas tubes, i.e., emission, space charge; tube characteristics and coefficients; R-C and transformer coupled voltage amplifiers; audio power amplifiers; rectifiers and filters.

Texts: Geppert: Basic Electron Tubes; Terman: Radio Engineering.

Prerequisites: Es-111(C), Es-616(C).

Es-213(C) Electron Tubes and Circuits 4-3

A continuation of Es-212(C). Course topics include: voltage regulator; applications of the tube as a switch, i.e., saw-tooth and square-wave generators, clipping clamping, differentiating, and integrating; inverse feedback; video amplifier; tuned amplifiers, i.e., narrow-band voltage and power amplifiers, wide-band voltage amplifier.

Texts: Seely: Electron Tube Circuits; Cruft: Electronic Circuits and Tubes.

Prerequisite: Es-212(C).

Es-214(C) Electron Tubes and Circuits 4-3

A continuation of Es-213(C). The principal topics are: Sine-wave oscillators; methods of modulation; methods of detection; avc; discriminators; receiver principles.

Texts: Cruft Electronics Staff: Electronic Circuits and Tubes; Seely: Electron-tube Circuits; Terman: Radio Engineering.

Prerequisite: Es-213(C).

Es-225(A) Electron Tubes 3-6

A continuation of Es-214(C). The principal topics are: noise, electron ballistics, electron optics, cathode-ray tubes, photo-multiplier tubes, television tubes, polyphase and controlled rectifiers, transistors. Laboratory work includes individual student projects.

Text: Spangenberg: Vacuum Tubes.

Prerequisite: Es-214(C).

Es-226(A) Ultra-High Frequency Techniques 4-3

The principal topics are: ultra-high frequency effects in conventional tubes, cavity resonators, klystron and magnetron tubes and circuits, traveling-wave tubes, pulsing circuits, and related laboratory work.

Texts: Spangenberg: Vacuum Tubes; Ridenour: Radar System Engineering; Massachusetts Institute of Technology Staff: Principles of Radar, Second Ed.: Bell Lab Journals.

Prerequisites. Es-225(A), Es-623(A).

Es-227(C) 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 travelling-wave tubes. The course emphasizes a descriptive presentation rather than a mathematical one.

Texts: Spangenberg: Vacuum Tubes; Massachusette Institute of Technology Radar School Staff: Principles of Radar, Third Ed.

Prerequisite: Es-214(C).

Es-261(C) Electron Tubes and Circuits 3-2

The first term of a two-term course in the fundamentals and general applications of electron tubes and circuits, primarily for non-communication students. The principal topics are: emission, characteristics of vacuum and gas tubes, rectifiers and filters, grid-controlled rectifiers, class A amplifiers.

Text: Seely: Electron Tube Circuits.

Prerequisites: Es-111(C), Es-112(C).

Es-262(C) Electron Tubes and Circuits 3-2

A continuation of Es-261(C). The principal topics are: feedback amplifiers, class B and C amplifiers, oscillators, modulation, detection.

Text: Seely: Electron Tube Circuits.

Prerequisite: Es-261(C).

Es-267(A) Electron Tubes and Ultra-High Frequency Techniques 3-2

The principal topics are: electron ballistics, electron optics, cathode-ray tubes, the cyclotron, 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; Massachusetts Institute of Technology: Principles of Radar, Third Ed.

Prerequisite: Es-262(C) or equivalent.

Es-271(C) Electronics I 3-2

An introduction to DC and AC circuit theory. The principal topics are: elements of DC and AC theory; analysis of series, parallel and coupled circuits, resonance, elementary transients.

Text: Tang: Alternating Current Circuits, second edition.

Prerequisite: None.

Es-272(C) Electronics II 3-3

A continuation of the series beginning with Es-271(C). An introduction to thermionic vacuum tubes. Elementary principles of vacuum tubes, their use as rectifiers, voltage amplifiiers, pulse shapers, flip flop circuits; inverse feedback circuits.

Text: Seely: Electron Tube Circuits

Prerequisite: Es-271(C).

Es-273(C) Electronics III 3-2

A continuation of Es-272(C). Counter circuits, Geiger counters, etc., circuits used in physical measurements, cathode ray oscilloscope, f.m. modulation as used in telemetering.

Text: Seely: Electron Tube Circuits.

Prerequisite: Es-272(C).

Es-281(C) Electronics Fundamentals 3-3

An introduction to a study of basic electronics. The principal topics are: fundamentals of energy transmission by means of radio waves, basic AC theory, underlying physical principles of electron tube operation, and characteristics of electron tube operation.

Text: Sheingold: Fundamentals of Radio Communications.

Prerequisite: None.

Es-282(C) Vacuum Tube Circuits 3-3

A continuation of Es-281(C). This course covers the following applications of vacuum tube circuits: amplifiers; oscillators; power supplies; detectors; and moduators; basic AM receivers and transmitter circuits.

Text: Sheingold: Fundamentals of Radio Communications.

Prerequisite: Es-281(C).

Es-283(C) Vacuum Tube Circuits 3-3

A continuation of Es-282(C). The course covers further applications of electron tubes, in continuation of the material presented in Es-282(C). The principal topics are: sine-wave oscillators, amplitude modulation and the A-M transmitter, demodulation and the TRF receiver, frequency conversion and the superheterodyne A-M receiver, power supplies, frequency modulation.

Text: Sheingold: Fundamentals of Radio Communications.

Prerequisite: Es-282(C).

Es-286(C) Pulsing and High Frequency 3-2

The principles and underlying problems of pulsing and high-frequency circuit operation. The principal topics are: Characteristics of non-sinusoidal waves; pulse-shaping techniques; the sawtooth generator, multivibrator, and blocking oscillator; problems and techniques of high-frequency circuit operation; the magnetron and velocity-modulated tubes; guided waves.

Texts: Navships 900.016: Radar Electronic Fundamentals; Massachusetts Institute of Technology Staff: Principles of Radar, Second Ed.; Sheingold: Fundamentals of Radio Communications.

Prerequisite: Es-282(C).

Es-321(B) Radio Systems 3-3

The first of a sequence of five courses on the engineering applications of theoretical electronics to the specific problems of radio communications and electronic system aimed to give the student experience in design and to integrate his previous theoretical training as applied in radio systems engineering. Included is a general survey of the basic problems of communications systems with emphasise upon the properties of the ionosphere, propagation characteristics of radio waves of different frequencies, and the design of transmitters for medium and high frequencies.

Texts: Terman: Radio Engineering, Third Ed.; Terman: Radio Engineers' Handbook; Federal Telegraph and Radio Corporation: Reference Data for Radio Engineers; Navy Equipment Instruction Books.

Prerequisites: Es-225(A); Ma-104(A).

Es-322(B) Radio Systems 3-3

A continuation of the series begun in Es-321(B). Emphasis is placed upon the design of receivers for the reception of amplitude-modulated signals in the medium and high frequency bands. The design problem is extended to include the VHF region and the changes introduced by the use of frequency and phase modulation.

Text: Sturley: Radio Receiver Design; Terman: Radio Engineer's Handbook; Massachusetts Institute of Technology Radiation Laboratory Series: Microwave Receivers; other selected references.

Prerequisite: Es-321(B).

Es-326(B) Radio Systems 3-3

The first of a sequence of five courses on the engineering applications of theoretical electronics to the specific problems of radio communications and electronics systems, aimed to give the student an appreciation of the problems encountered in such systems design and to integrate his previous theoretical training as applied in radio systems engineering. Included is a general survey of the basic problems of a communications system with emphasis on typical designs employed in transmitters for medium and high frequencies.

Texts: Terman: Radio Engineer's Handbook; War Department Technical Manual, TM11-486 (Electrical Communication System Engineering); Navy equipment instruction books.

Prerequisites: Es-114(C), Es-214(C).

Es-327(B) Radio Systems 4-3

A continuation of the series begun in Es-326(B). Emphasis is placed upon typical circuit designs of receivers for the reception of amplitude-modulated signals in the medium and high frequency band. Circuit modifications to include the VHF region and the changes introduced by the use of frequency and phase modulation are also covered.

Texts: Sturley: Radio Receiver Design; Terman: Radio Engineer's Handbook; Massachusetts Institute of Technology Radiation Laboratory Series: Microwave Receivers; other selected references.

Prerequisite: Es-326(B).

Es-328(B) Radio Systems 2-3

Continues the systems series. The principal topics are: the application of teletype and frequency-shift keying to radio transmission; tone multiplex, applications of multiplexing to remote control, single side-band transmission theory and basic single side-band multiplex transmitter and receiver design.

Texts: Naval instruction books; instructor's notes.

Prerequisite: Es-327(B).

Es-333(B) Radio Systems 2-3

Continues the systems series. The principal topics are: the application of teletype and frequency-shift keying to radio transmission, tone multiplex, applications of multiplexing to remote control, single side-band multiplex transmitter and receiver design.

Texts: Naval instruction books; instructor's notes.

Prerequisite: Es-322(B).

Es-386(C) Transmitters and Receivers 3-3

This course covers the operational characteristics of typical Navy-type transmitters and receivers. Included topics are: frequency standards and meters; Navy transmitters; Navy receivers; specific radiation-systems used with Navy transmitters; proper selection of antennas; antenna tuning; special circuits which have operational significance such as AVC, silencers, filters and noise limiters; preventive maintenance.

Text: Instruction manuals of equipments, printed lecture notes.

Prerequisites: Es-282(C), Es-786(C).

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: Massachusetts Institute of Technology Radar School Staff: Principles of Radar, Third Ed.

Prerequisite: Es-114(C).

Es-422(B) Radar System Engineering 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; Massachusetts Institute of Technology Radar School Staff: Principles of Radar, Second Ed.

Prerequisite: Es-421(B).

Es-423(B) Radar System Engineering 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-431(B) Radar System Engineering 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, transmitters, r-f systems and receivers.

Texts: Ridenour: Radar System Engineering; Massachusetts Institute of Technology Radar School Staff: Principles of Radar, Second Ed.

Prerequisite: Es-226(A).

Es-432(B) Radar System Engineering 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-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: Massachusetts Institute of Technology Radar School Staff: Principles of Radar, Second Ed.

Prerequisite: Es-262(C) or equivalent.

Es-447(C) Electronics 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; Massachusetts Institute of Technology Radar School Staff: Principles of Radar, Second Ed.

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: Massachusetts Institute of Technology Radar School Staff: Principles of Radar, Second Ed.

Prerequisite: Es-262 or equivalent.

Es-461(A) Pulse Techniques 2-3

The principal topics are: clipping circuits, differentiating and integrating circuits, clamping circuits, pulse-coupling circuits, relaxation oscillators, frequency dividers and counters, theory and circuit application of the the transistor.

Texts: Spangenberg: Vacuum Tubes; Massachusetts Institute of Technology: Principles of Radar, Third Ed.

Prerequisite: Es-267(A).

Es-466(C) Radar Propagation and Displays 2-2

The principal topics are: the operational char acteristics of search radar; a complete study of the radar equation; types of indicators and the influence of phosphor types on data interpretation.

Texts: Ridenour: Radar System Engineering; Massachusetts Institute of Technology Staff: Principles of Radar, Third Ed.

Prerequisite: None

Es-521(B) Special Systems 3-3

A continuation of the series starting with Es-321 (B). The principal topics are: pulse-modulation principles, pulse-time-modulation multiplex; principles of television, television receiver and transmitter design practice, facsimile, and basic telemetering systems.

Texts: Naval instruction books; instructor's notes.

Prerequisite: Es-327(B).

Es-522(B) Special Systems 3-3

A continuation of the special systems series. The principal topics are: principles of radio direction finding and navigation, and radio and radar countermeasures.

Texts: Massachusetts Institute of Technology Radiation Laboratory Series: Loran; Radio Research Laboratory Staff: Very High Frequency Techniques, Vol. I; other selected references.

Prerequisite: Es-521(B).

Es-531(B) Special Systems 3-3

A continuation of the series starting with Es-321 (B). The principal topics are: pulse-modulation principles, pulse-time-modulation multiplex, principles of television, television receiver and transmitter design, facsimile and basic telemetering systems.

Texts: Naval instruction books; instructor's notes.

Prerequisite: Es-333(B).

Es-532(B) Special Systems 3-3

A continuation of the special systems series. The principal topics are: principles of radio direction finding and navigation, and radio and radar countermeasures.

Texts: Massachusetts Institute of Technology Radiation Laboratory Series: Loran; Radio Research Laboratory Staff: Very High Frequency Techniques, Vol. I; other selected references.

Prerequisite: Es-531(B).

Es-536(B) Counter Measures 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-586(C) Special Systems 3-3

Navy electronic systems other than communications transmitters and receivers. The principal topics are: electronic countermeasures; principles and underlying problems of pulsing and high frequency circuit operation; image transmission systems; frequency-shift keying techniques; multiplex systems; radar and sonar systems; Loran systems.

Texts: Equipment instruction books; Sheingold: Fundamentals of Radio Communications.

Prerequisites: Es-386(C), Es-786(C).

Es-616(C) Basic Electric and Magnetic Fields 2-2

Electric field concepts (potential, intensity, flux, mapping, energy, capacitance, magnetic field concepts (MMF, potential, intensity, flux, energy, inductance); magnetic circuits (B-H curves, calculation of MMF and flux, hysteresis and eddy currents); electromagnetic induction and forces, cathode ray deflection.

Text: Corcoran: Basic Electrical Engineering.

Prerequisite: None.

Es-621(A) Electromagnetics 3-0

An introduction to the fundamental definitions and circuit parameters later to be used in resonant cavities, wave guides, wave propagation, etc., as exemplified through the differential equations solution of lumped circuits and transmission lines. An application of vector analysis to electrostatics and magnetostatics in rectangular and in generalized coordinates, including the gradient, divergence and curl of electromagnetic fields; scalar and vector potentials; energy stored in electric and in magnetic fields. Text material is considerably amplified in class lectures.

Text: Chaney: Electromagnetics in Engineering Electronics.

References: Ramo and Winnery: Fields and Waves in Modern Radio; Schelkunoff: Electromagnetic Waves.

Prerequisites: Ma-104(A), Ph-311(B).

Es-622(A) Electromagnetics 4-0

A continuation of Es-621(A). An application of complex variables to potential theory; derivation of capacitance and inductance per unit length for open wire and coaxial transmission lines; application of Bessel equations to potential theory; Maxwell's equations; relations between units; Poisson's equations; retarded vector potentials; radiation from current dipole, halfwave antennas, radiation resistance of halfwave antennas in terms of Ci and Si functions; antenna arrays; field patterns and gain of yagi arrays; input impedance of yagi arrays.

Text: Chaney: Electromagnetics in Engineering Electronics.

References: Ramo and Whinnery: Fields and Waves in Modern Radio; Schelkunoff: Electromagnetic Waves.

Prerequisite: Es-621(A).

Es-623(A) Electromagnetics 4-0

A continuation of Es-622(A). The principal topics are: skin effect and internal impedance; solutions involving Bessel and Hankel functions; calculations of inductance; propagation and reflection of plane electromagnetic waves; attenuation; power factor; waves guided by lossy planes; solutions of Maxwell's equations for rectangular and cylinderical wave guides.

Text: Chaney: Electromagnetics in Engineering Electronics.

References: Ramo and Whinnery: Fields and Waves in Modern Radio; Schelkunoff: Electromagnetic Waves.

Prerequisite: Es-622(A).

Es-624(A) Electromagnetics 3-0

A continuation of Es-623(A). The principal topics are: radial disk transmission lines; resonant cavaties; generalized Maxwell's equations; generalized method of deriving radiation field patterns; radiation resistance; long straight wire antenna; Vee antenna; radiation from end of wave guide; rhombic antenna; non-uniform transmission line; input impedance of antennas.

Text: Chaney: Electromagnetics in Engineering Electronics.

References: Ramo and Whinnery: Fields and Waves in Modern Radio; Schelkunoff: Electromagnetic Waves.

Prerequisite: Es-623(A).

Es-721(B) Antennas and Wave Propagation 3-3

Designed to give the student the best possible understanding of the problems involved in the radiation and propagation of electromagnetic energy without the use of the classic Maxwell equation type of approach. The emphasis is on practical problems encountered in communications engineering, including selection of proper antennas for various services as well as proper frequencies for optimum transmission.

Texts: Instructor's notes; Kraus: Antennas; King, Mimno, and Wing: Antennas, Transmission Lines, and Wave Guides.

Prerequisites: Es-327(B), Es-114(C).

Es-722(B) Antennas and Wave Propagation 3-3

A continuation of Es-721(B).

Texts: Instructor's notes; Kraus; Antennas; King, Mimno, and Wing: Antennas, Transmission Lines, and Wave Guides.

Prerequisite: Es-721(B).

Es-736(B) Antennas, Transmission Lines 3-3

The engineering problems associated with the practical design of antennas, antenna systems, and transmission lines. A technique of rapid approximation of antenna field patterns is presented. All common receiving and transmitting antennas are presented and analyzed. The problems inherent in the various frequency ranges are discussed, including the microwave region. The problem of efficient transmission of r-f energy, matching, phasing and achieving proper current distributions are studied. The classwork is accompanied by considerable problem drill and measurements on typical systems.

Text: Kraus: Antennas.

Prerequisite: Es-624(A).

Es-786(C) RF Energy Transmission 3-3

A study of the principles and techniques of energy transmission by means of radio-frequency waves. The principal topics are: conditions for maximum energy transfer between circuits; r-f transmission lines; lines as circuit elements; antennas, type, directivity, efficiency; propagation characteristcs; selection of proper frequencies to establish maximum efficiency of available equipment and ionospheric conditions.

Text: Sheingold: Fundamentals of Radio Communications; NavShips 900,016: Radar Electronics Fundamentals.

Prerequisite: Es-282(C).

Es-836(A) Project Seminar 1-0

Provides the student with the opportunity to prepare a report on the project in which he was engaged during his experience at an industrial laboratory. The student is required to give an oral seminar report.

Text: None.

Prerequisite: None.

Es-991(C) and 992(C) Introduction to Electronics 2-0

This course will continue through two consecutive terms and is intended to acquaint the student officer with the general principles, capabilities and limitations of radio, sonar and radar and to give him a limited familiarity with equipment. The following topics will be studied in an elementary manner: resonant circuits; principles of vacuum tubes; their actions as oscillators, amplifiers, detectors, modulators; general principles of transmitters and receivers, both AM and FM; antennas, wave propagation; basic principles of radar and sonar.

Text: None.

Prerequisite: None.

GEOLOGY

Ge Courses

Ge-101(C) Physical Geology 3-0

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, Knopf: Physical Geology.

Prerequisite: None.

Ge-201(C) Physical Geology 3-0

Course content similar to Ge-101, but directed towards the specific needs of the Nuclear Engineering Groups. As time permits, the methods and procedures used in seismic prospecting are discussed.

Prerequisite: None.

Ge-241(C) Geology of Petroleum 2-2

Seminars and discussions on the origin, accumulation, and structure 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, Russia, 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 2-4

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.

Text: Pirsson, Knopf: Rocks and Rock Minerals.

Prerequisite: Ge-101(C) (may be taken concurrently), or Cr-301(B), or Cr-311.

INDUSTRIAL ENGINEERING

IE Lecture Courses

IE-101(L) Principles of Industrial Organization 0-1

Ten lectures covering the rise and growth of industrial enterprises; standard types of ownership and organization structures; coordination and executive control; standardization; labor compensation; problems of management; effects of science in industry, and related topics. An integrated series given by authorities in the field of industrial and management engineering.

Text: None.

Reference: Kimball and Kimball: Principles of Industrial Organization. Other texts on industrial and management engineering.

Prerequisite: None.

IE-103(L) Applied Industrial Organization 0-1

The application of organization and management principles to the structure of actual industrial and government enterprises; further consideration of problems facing management. In some lectures, representatives of typical industrial or government activities discuss the structure and management of their own activities; in other speeches, educators and authorities in various fields discuss particular aspects of industrial engineering.

Text: None.

Prerequisite: IE-101(L).

IE-104(L) Technical Lectures 0-1

A series of ten lectures covering various technical subjects pertaining to engineering in the Navy, delivered by naval officer specialists or qualified civilians. In addition to strictly engineering subjects, lectures are scheduled in such fields as human engineering, psychophysical systems research, and use of human factors in equipment design.

Text: None.

Prerequisite: None.

MARINE ENGINEERING

NE Courses

NE-101(C) Main Propulsion Plants---------------3-0

A practical study of naval geared-turbine main propulsion plants, boilers and main propulsion plant auxiliaries. This course deals primarily with the Bureau of Ships Manual supplemented by Bureau of Ships Journals and letters, and by descriptive texts as necessary. The purpose of the course is to give the technical engineer a sound basic knowledge of, and familiarity with, the procedures set forth by the bureau of Ships with regard to the operation, maintenance and repair of main propulsion machinery.

Texts: Bureau of Ships Manual; Bureau of Ships Journals; Naval Turbines—1949; Naval Boilers—1949.

Prerequisite: None.

NE-102(C) Auxiliary Machinery 3-0

A practical study of naval machinery other than main propulsion machinery, boilers and main propulsion plant auxiliaries. This course deals primarily with the Bureau of Ships Manual supplemented by Bureau of Ships Journals and letters and by descriptive texts as necessary. The purpose is to give the technical engineer a sound basic knowledge of, and familiarity with, the procedures set forth by the Bureau of Ships with regard to the operation, maintenance and repair of subject machinery.

Texts: Bureau of Ships Manual; Bureau of Ships Journals; Naval Auxiliary Machinery—1949.

Prerequisite: None.

NE-103(C) Engineering Department Administration 2-0

A study of the administrative duties of the Engineer Officer afloat. Subjects treated include: engineering department organization, routine tests and inspections, machinery index, machinery history, current ship's maintenance project, ship's force overhauls, tender overhauls, shipyard overhauls, supplies, spare parts, requisitions, engineering casualty control, safety precautions, engineering competition and economical operation of engineering plants.

Texts: Bureau of Ships Manual; Bureau of Ships Journals; fleet training publications; prepared pamphlets on above subjects.

Prerequisite: None.

MATHEMATICS

Ma Courses

Ma-100(C) Vector Algebra and Geometry 2-1

Review of plane analytic geometry. 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; mimeographed notes.

Prerequisite: A former course in plane analytic geometry.

Ma-101(C) Introduction to Engineering Mathematics 3-1

Introduction to infinite series, differential equations, hyperbolic functions. Partial derivatives, multiple integration. The laboratory periods are devoted to a review of selected topics in basic calculus.

Texts: Sokolnikoff and Sokolnikoff: Higher Mathematics; Granville, Smith and Longley: Elements of the Differential and Integral Calculus.

Prerequisites: A former course in differential and integral calculus, and Ma-100(C) to be taken concurrently.

Ma-102(C) Differential Equations and Series 5-0

A continuation of Ma-100(C) and Ma-101(C). Elementary operations with complex quantities. Solution of algebraic equations, Graeffe's method. Further study of ordinary differential equations and their applications. Operations on series, power series. Introduction to elliptic integrals, Fourier series, numerical harmonic analysis. Systems of ordinary differential equations with constant coefficients, stability criteria.

Texts: Cohen: Differential Equations; Sokolnikoff and Sokolnikoff: Higher Mathematics.

Prerequisites: Ma-100(C), Ma-101(C).

Ma-103(B) Functions of Several Variables and Vector Analysis 5-0

A continuation of Ma-102(C). Elementary matrix theory and applications. Analytic geometry of space curves and surfaces. Applications of partial derivatives. Differentiation of vectors. Differential operators. Line, surface, and space integrals with applications. Divergence theorem and the theorems of Green and Stokes. Curvilinear coordinates. Introduction to analytic functions of a complex variable.

Texts: Sokolnikoff and Sokolnikoff: Higher mathematics; Weatherburn: Elementary and Advanced Vector Analysis; Smith, Gale and Neelley: New Analytic Geometry.

Prerequisite: Ma-102(C) or Ma-132(C).

Ma-104(A) Partial Differential Equations and Related Topics 5-0

A continuation of Ma-103(B). Total differential equations and systems of ordinary differential equations. Linear and other first order partial differential equations. Special cases of higher order partial differential equations with emphasis on those with constant coefficients. Solution of ordinary differential equations by series. Gamma, Beta, Bessel and Legendre functions. Introduction to boundary value problems and orthogonal functions with applications to heat flow, vibrations of strings and membranes, and flow of electricity in cables. Interpolation formulas of Newton, Stirling and Lagrange. Quadrature formulas and numerical integration of ordinary differential equations and systems of such equations.

Texts: Sokolnikoff and Sokolnikoff: Higher Mathematics; Cohen: Differential Equations; Scarborough: Numerical Mathematical Analysis.

Prerequisite: Ma-103(B).

Ma-105(A) Fourier Series and Boundary Value Problems 4-0

Derivation of the basic partial differential equations of theoretical physics. Study of the trigonometric, Bessel and Legendre functions, and other systems of orthogonal functions. The Sturm-Liouville theory. Solution of boundary value problems by orthogonal series. Method of relaxation. Uniqueness of the solution. Rayleigh-Ritz method.

Texts: Churchill: Fourier Series and Boundary Value Problems; H. W. Emmons: Numerical Solution of Partial Differential Equations (Quart. Appl. Math., 2, 1944, 173-195).

Prerequisite: Ma-104(A) or Ma-114(A).

Ma-106(A) Complex Variables and Laplace Transforms 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; special theorems and manipulations for the Laplace transform; application to partial differential equations and difference equations. Nyquist stability criterion.

Texts: Churchill: Introduction to Complex Variables and Applications; Churchill: Modern Operational Mathematics in Engineering; Gardner and Barnes: Transients in Linear Systems.

Prerequisite: Ma-104(A).

Ma-109(A) Topic in Advanced Calculus 3-0

Extension of natural numbers to real number system; basic theorems on limits; continuity and differentiation properties of functions; the difinite integral and improper definite integrals; infinite series.

Text: Landau: Grundlagen der Analysis; Courant: Differential and Integral Caluclus, Volume I; Osgood: Functions of Real Variables.

Prerequisite: Ma-104(A) or Ma-184(A), or one of these to be taken concurrently.

Ma-111(C) Introduction to Engineering Mathematics 3-1

Partial differentiation; multiple integrals; hyperbolic functions; algebra of complex numbers; first order ordinary differential equations. The laboratory periods are devoted to a review of selected topics in basic calculus.

Texts: Golomb and Shanks: Ordinary Differential Equations; 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 to be taken concurrently.

Ma-112(B) Differential Equations and Infinite Series 4-0

A continuation of Ma-111(C). Ordinary linear differential equations with constant coefficients; power series and power series expansions of functions; 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 3-0

A continuation of Ma-112(B). Series solution of ordinary differential equations; solution of partial differential equations by means of series of orthogonal functions; analytic functions of a complex variable; line integrals in complex plane; infinite series.

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). Theory of residues; 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; stability investigations; theories of Poincare and of Kryloff and Bogoliuboff; resonance. The Laplace transform as used in ordinary initial value problems and partial differential equations; inversion integrals; Fourier transforms. Application of Laplace transforms to non-linear mechanics.

Texts: Stoker: Nonlinear Vibrations; Churchill: Modern Operational Mathematics in Engineering; Pipes: Operational Methods in Non-linear Mechanics.

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: Scarborough: Numerical Mathematical Analysis; Frazer, Duncan and Collar: Elementary Matrices; Reprints of articles from scientific journals; Salvadori and Baron: Numerical Methods in Engineering.

Prerequisite: Ma-114(A).

Ma-118(A) Mathematics of Stability Analysis 3-0

This course covers topics important in the study of aircraft flight performance. These topics include differential operator methods, Laplace transform methods, applications of matrix theory and non-linear mechanics.

Text: Pipes: Applied Mathematics for Engineers and Physicists.

Prerequisite: Ma-104(A) or Ma-114(A).

Ma-131(C) Algebraic Equations and Series 3-0

Solution of algebraic equations, Graeffe's method. Determinants and systems of linear equations. Fundamentals of series. Power series and applications. Fourier Series.

Texts: Sokolnikoff and Sokolnikoff: Higher Mathematics; Granville, Smith and Longley: Elements of the Differential and Integral Calculus (Revised Edition).

Prerequisite: A former course in differential and integral calculus.

Ma-132(C) Topics in Engineering Mathematics 5-0

Introduction to three-dimensional analytics and vectors. Partial differentiation and multiple integrals. Ordinary differential equations of first order. Linear differential equations with constant coefficients.

Texts: Smith, Gale and Neelley: New Analytic Geometry; Sokolnikoff and Sokolnikoff: Higher Mathematics; Weatherburn: Elementary Vector Analysis; Cohen: Differential Equations.

Prerequisites: A former course in differential and integral calculus and Ma-131(C) to be taken concurrently.

Ma-134(B) Vector Mechanics and Introduction to Statistics 5-0

Vector equations of motion. Streamlines and trajectories. Irrotational, solenoidal and linear vector fields. Elementary differential geometry of surfaces. Preliminary considerations in the analysis of observational data. Elementary probability; discrete and continuous probability distributions.

Texts: Weatherburn: Advanced Vector Analysis; Snyder and Sisam: Analytic Geometry of Space; Wilks: Elementary Statistical Analysis.

Prerequisite: Ma 103(B).

Ma-135(B) Partial Differential Equations and Numerical Methods 4-1

Total differential equations and systems of linear differential equations. Partial differential equations.

Introduction to orthogonal functions and boundary value problems with applications to physics. Numerical interpolation, differentiation and integration. Elementary alignment charts.

Texts: Cohen: Differential Equations (Revised); Churchill: Fourier Series and Boundary Value Problems; Scarborough: Numerical Mathematical Analysis.

Prerequisite: Ma-103(B).

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 (Revised Edition).

Prerequisite: Ma-161(C) or satisfactory evidence of competence in analytic geometry.

Ma-163(C) Calculus and Vector Analysis 5-0

Elementary vector operations. Infinite series. 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 Differential and Integral Calculus (Revised Edition).

Prerequisite: Ma-162(C), Ma-140(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, Longley: Differential and integral Calculus; Sokolnikoff: Higher Mathematics.

Prerequisites: A former course in differential and integral calculus, and Ma-100(C) to be taken concurrently.

Ma-182(C) Vector Analysis and Differential Equations 5-0

Vector differentiation. Vector integral relations. Physical appplications. Ordinary first order differential equations. Higher order linear differential equations. Systems of differential equations. Physical interpretation. Infinite series.

Texts: Sokolnikoff: Higher Mathematics: Phillips: Vector Analysis.

Prerequisites: Ma-100(C), 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: Higher Mathematics; Churchill: Fourier Series and Boundary Value Problems; Churchill: Complex Variables.

Prerequisite: Ma-182(C).

Ma-184(A) Matrices and Numerical Methods 3-0

Algebra of matrices. Characteristic values of matrices. Applications of matrices. Notation of finite differencies. Numerical differentiation and numerical integration.

Texts: Sokolinkoff: Higher Mathematics; Margenau and Murphy: Mathematics of Physics and Chemistry.

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 5-0

Algebra of matrices; characteristic values 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.

Texts: Frazer, Duncan and Collar: Elementary Matrices; McKinsey: Introduction to the Theory of Games; Munroe: Introduction to Measure and Integration.

Prerequisite: Ma-183(B).

Ma-201(C) Graphical and Mechanical Computation 0-2

Construction of scales. Use of coordinate papers. Construction of nomograms, including alignment charts, by geometric methods and use of determinants. Conversion of empirical data into alignment charts. Improvements of charts by projection (accomplished by determinants). Theory and use of the planimeter and integrator.

Texts: Lipka: Graphical and Mechanical Computation; Rybner: Nomograms (G. E. Review, 33, 1950, 164 ff); Baude: Simplified Nomogram Construction (Machine Design, May 1952, 155 ff); USNPGS Multiliths.

Prerequisite: Ma-100(C). (May be taken concurrently).

Ma-301(B) Statistics 3-2

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: Wilks: Elementary Statistical Analysis; Hoel: Introduction to Mathematical Statistics.

Prerequisite: Ma-103(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. Probability of a hit on an evasive target. Probability of detection. Analysis of combat operations. Basic probability distributions. Sampling theory.

Texts: C. E. Clark: Introduction to Statistics; Wilks: Elementary Statistical Analysis; Morse and Kimball: Operations Research; Granville, Smith and Longley: Differential and Iintegral Calculus.

Prerequisite: A former course in differential and integral calculus.

Ma-331(A) Statistics 4-2

A continuation of Ma-134(B). Gamma and Beta functions. Mathematical expectation, moments and moment generating functions. Theoretical distribution functions of one variable. Distribution functions of two or more variables. Large and small sampling theory. Testing statistical hypotheses; sampling and the design of experiments. Applications to problems in aerology.

Text: Hoel: Introduction to Mathematical Statistics; Mood: Introduction to the Theory of Statistics.

Prerequisite: Ma-134(B).

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.

Text: Wilks: Elementary Statistical Analysis.

Prerequisite: Ma-163(C) or Ma-181(C).

Ma-382(A) Probability 3-0

Mathematical probability. Joint distributions. Functions of stochastic variables. Mathematical expectation. Limit theorems. Probabilities of hypotheses and Baye's theorem. Probabilities in continuum.

Texts: Munroe: Theory of Probability; Uspensky: Introduction to Mathematical Probability.

Prerequisite: Ma-381(C) or Ma-301(B).

Ma-383(A) Statistics 3-2

Sampling distribution of mean, chi-square, range, F and t. Tests of hypotheses. Analysis of variance and design of experiments.

Texts: Mood: Introduction to the Theory of Statistics; Hald: Statistical Theory with Engineering Applications.

Prerequisite: Ma-382(A).

Ma-385(A) Statistical 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; Classified official publications.

Prerequisites: Ma-383(A), Ma-501(A).

Ma-401(A) Mathematical Computation by Physical Means 3-2

Elementary physical 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. Automatic digital computers. Some of the material is presented to the class by the students as informal reports.

Texts: Murray: Theory of Mathematical Machines; reprints of articles from scientific periodicals; Booth: Automatic Digital Computers; W. W. Soroka: Analog Methods in Computation and Simulation.

Prerequisite: Ma-103(B) or Ma-113(B).

Ma-496(A) High Speed Computing Machines 3-2

The logical design of punch card machines, automatic digital computers and simulators. Programming and coding. Laboratory operation of computing machines. Numerical analysis. Applications to problems in operations analysis.

Texts: Booth: Automatic Digital Computers; Hartree: Calculating Instruments and Machines.

Prerequisite: Ma-195(A), or Ma-116(A), or Ma-184(A).

Ma-501(A) Theory of Games 3-2

The basic concepts and foundations for the theory of games, such as game, play, strategy, complete and incomplete information, zero-sum games, etc. The structures of various games, particularly two-person zero-sum games with finite and infinite strategies. Games of timing. The related algebra of matrices and bilinear forms to yield methods for evaluating games. The minimax theorem and properties of minimax strategies. Games involving three or more persons and the effects of coalitions.

Texts: Dresher: Theory and Applications of Games of Strategy (RAND Report); McKinsey: Introduction to the Theory of Games; USNPGS Mulitiliths.

Prerequisites: Ma-195(A), Ma-382(A).

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; plane trusses; funicular polygon; 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.

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 (a) linear momentum, (b) angular momentum, (c) work and energy, (d) power and energy, (e) conservation of energy, (f) virtual work, and (g) 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.

Prerequisites: Mc-102(C) and Ma-103(B). (The latter may be taken concurrently.)

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).

Prerequisite: Ma-104(A), Mc-102(C) and ME-500(C).

Mc-401(A) Exterior Ballistics 3-0

Topics presented include the vacuum trajectory; density and temperature structure of the atmosphere; application of dimensional analysis to the problem of air resistance; theory of longitudinal elastic waves in the air; numerical integration of differential equations of motion under standard conditions; differential corrections for abnormal conditions; weighting factors; integration of the adjoint system; exact and approximate construction of firing tables for aircraft machine guns. The projectile is treated as a mass particle, aerodynamic and rocket considerations being deferred to a later course, Mc-402(A).

Texts: Ritter: A Course in Exterior Ballistics; Scarborough: Numerical Mathematical Analysis (First Edition).

Prerequisite: Mc-102(C).

Mc-402(A) Dynamics of Missiles and Gyros 3-0

Review of the dynamics of rigid bodies; gyroscopes; the general aerodynamic system of forces acting on a spinning projectile; necessary and sufficient conditions for the stability and trailing of a spinning projectile; computation of drift; dispersion of fin-stabilized and spin-stabilized rockets; effect of wind on rockets.

Texts: Synge and Griffith: Principles of Mechanics (Second Edition); McShane, Kelley and Reno: Exterior Ballistics.

Prerequisite: Mc-401(A).

Mc-421(A) Interior Ballistics 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. The contribution of modern interior ballistic theory to the problem of gun design is emphasized.

Texts: Hirschfelder and Sherman: Simple Calculation 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), Ch-631(A).

Mc-431(A) Theory of Plasticity of Metals and Strength of Guns 3-0

Types of gun construction; theory of the tensile test; geometry of stress; Mohr's representation of stress; octahedral stresses; the Lode parameter; geometry of strain; theories of mechanical strength; the three rules of plastic deformation; theory of plastic deformation of thick-walled spheres and cylinders; autofrettage process used in the radial expansion of guns.

Text: Nadai: Theory of Flow and Fracture of Solids (Second Edition).

Prerequisites: Ma-112(B), Mc-102(C).

MECHANICAL ENGINEERING

ME Courses

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. This course is the first of a coordinated sequence containing ME-112 or 122, 211 or 221, et cetera.

Text: Kiefer, Kinney and Stuart: Engineering Thermodynamics.

Prerequisite: Ma-102(C), or equivalent.

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, equilibrium 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. The course is in continuation of ME-111.

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 thermodynamic 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-131(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 property, Second and Third Laws of thermodynamics, Maxwell relations. Phase rule, thermodynamic characteristics of liquids and vapors. Property relations, tables and diagrams for ideal or quasi-ideal gases and representative reversible and irreversible processes with these. Gas mixtures, low-pressure gas-vapor mixture and their indices, representative processes with them, multi- and mono-pressure hygrometric charts. Elements of atmospheric thermodynamics.

Text: Kiefer, Kinney and Stuart: Engineering Thermodynamics.

Prerequisite: Ma-102(C), or equivalent.

ME-132(C) Engineering Thermodynamics 3-2

Materials and energy balance in combustion. Spark-ignition engine and simpler gas-turbine power installations and their performance characteristics. Subsonic and supersonic flow of compressible fluids, reversible and shockwise, in nozzle, diffuser or duct; associated wall forces and their operation in turbine or compressor blading and in jet propulsion or the rocket motor. Elements of heat transmission. Sequent to ME-131, those thermodynamic applications are considered which are of major concern in aircraft power installations.

Text and Supplements: Kiefer, Kinney and Stuart: Engineering Thermodynamics; Keenan and Kaye: Gas Tables.

Prerequisite: ME-131(C).

ME-141(C) Engineering Thermodynamics 4-2

The fundamental concepts of thermodynamics; energy and its accounting; availability and entropy of energy; the thermodynamic properties of pure substances and their changes in various processes, including chemical interaction. Emphasis is placed on those topics essential for subsequent studies of torpedo power plants, jet engines, explosives and similar applications where non-standard fluids are involved. The laboratory periods are used for student solution of practical problems chosen to illustrate the principles discussed in the classroom.

Text: Kiefer, Kinney and Stuart: Engineering Thermodynamics.

Prerequisite: Ma-103(B).

ME-142(A) Engineering Thermodynamics 2-2

Organization of the thermodynamic properties of non-ideal gases through the use of the residual functions, preparation and use of thermodynamic diagrams for simple systems of ideal and non-ideal gases and for complex systems in chemical equilibrium, heat and work effects in representative processes involving complex mixtures such as the products of combustion. This course is a continuation of ME-141(C). The laboratory periods are used for students solution of practical problems to illustrate the principles discussed in the classroom.

Text: Kiefer, Kinney and Stuart: Engineering Thermodynamics.

Prerequisite: ME-141(C).

ME-143(A) Engineering Thermodynamics 4-4

Thermodynamic aspects of the flow of compressible fluids in nozzle, diffuser and duct, compressive shocks, dynamics of the jet and diverted flow. Application of thermodynamic facilities to power plants such as jet engines and torpedo motors which operate on non-standard fluids. Turbine nozzle and blading design factors and performance indices. Elements of heat transfer. Associated problems.

Texts: Kiefer, Kinney and Stuart: Engineering Thermodynamics; Church: Steam Turbines.

Prerequisite: ME-142(C).

ME-150(C) Thermodynamics 4-2

Fundamental aspects of energy accounting at molecular levels; the mechanical availability of such energy. Thermodynamic properties of gases at lower and at extreme pressures, and their correlation in connection with representative processes. The course is adapted more particularly to the needs of the interior-ballistics engineer.

Text and Supplement: Kiefer, Kinney and Stuart: Engineering Thermodynamics; Keenan and Kaye: Gas Tables.

Prerequisite: Ma-181(C).

ME-211(C) 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.

Text: Kiefer, Kinney and Stuart: Engineering Thermodynamics; miscellaneous supplementary material.

Prerequisite: ME-112(B).

ME-212(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-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(C); 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 specialized 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 (Diesel) 3-2

The studies include the thermodynamic analysis of the fundamental cycle, ideal and actual combustion processes, cyclic processes, injection phenomena and methods of injection system analysis, and the variables that affect the efficiency and performance of the engine. The laboratory work includes a series of tests on various engines to determine volumetric and mechanical efficiency, speed-torque characteristics, fuel consumption rates, effect of injection system variables upon engine performance, analysis of high speed engine indicator card, etc.

Texts: Lichty: Internal Combustion Engine; Taylor and Taylor: Internal Combustion Engine; Heldt: High Speed Diesel Engines.

Prerequisite: ME-112(B) or 122 (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. Asociated 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).

ME-310(B) Heat Transfer 3-2

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.

Prerequisites: Ma-104(A) or 183(B) or equivalent, ME-112(B) or equivalent.

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.

Prerequisite: Ma-182(C) or equivalent.

ME-411(C) Hydromechanics 3-2

The mechanical properties of liquids, hydrostatic pressures and forces on submerged surfaces and associated matters of buoyancy and ship stability. Energy aspects of liquid flow, the resistance to such flow through pipes, liquid flow metering and control, hydraulic force-transmission and arrester systems. Dynamic forces associated with flow through confining channels, the centrifugal pump and hydrodynamic coupling, etc. The principle of dynamic similarity and dimensional analysis are developed and employed extensively. The laboratory periods are used for student's solution of related practical problems and for related laboratory tests. The course is the first of a sequence of ME-411 and 412.

Text: Departmental notes (Kiefer and Drucker), Mechanics of Hydraulic Equipment.

Prerequisite: Ma-103(B) or equivalent.

ME-412(A) Hydromechanics 4-2

Basic concepts and characteristics of flow, primarily with ideal and incompressible fluids. The flow net and primary flow patterns, their synthesis initially by graphical technics but subsequently utilizing the mathematic facilities of vector calculus and the complex variables. Theory and applications of conformal transformation. Laminar flow, particularly in hydromechanic lubrication.

Texts: Departmental notes (Kiefer and Drucker), Mechanics of Hydraulic Equipment; Streeter: Fluid Dynamics.

Prerequisites: ME-411(C), Ma-104(A) or equivalent.

ME-421(C) Hydromechanics 3-2

The course is the first of a sequence of ME-421 and 422. The content parallels that of ME-411, but proceeds at a slower rate.

Text: Departmental notes (Kiefer and Drucker), Mechanics of Hydraulic Equipment.

Prerequisite: Ma-102 or equivalent.

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 technics. Elements of hydrodynamic lubrication.

Text: Departmental notes (Kiefer and Drucker), Mechanics of Hydraulic Equipment.

Prerequisites: ME-421, Ma-103 or equivalent.

ME-441(B) Hydromechanics 4-2

A one-term coverage of materials as follows: Mechanical properties of fluids. Hydrostatic pressures and force distribution, submerged surfaces. Energy aspects of flow; resisitance to laminar and turbulent flow in ducts, with introduction to the correlation of relevant variables through the principle of dynamic similarity and use of dimensional analysis. Flow metering and control elements of hydraulic arrester. Dynamics of flow in representative devices, and performance correlations by dynamic similarity principle. Introduction to the concepts of the stream function, velocity potential, source, sink and free vortex and their synthesis to form simpler irrotational flow patterns. Brief survey of the utilization of vector calculus and the complex variable in analysis of more complex patterns.

Text: Departmental notes (Kiefer and Drucker): Mechanics of Hydraulic Equipment.

Prerequisites: Ma-153(B) and Ma-154(A).

ME-442(B) Compressible-fluid Flow 2-2

Review of general thermodynamic principles, and of the thermodynamic properties and property relation for gaseous fluids. Thermodynamics of the subsonic and supersonic flow of compressible fluids, reversible and shockwise, in nozzle or diffuser and about simpler obstructions. Associated wall forces, and their operation in jet propulsion and the rocket motor.

Text and Supplements: Kiefer, Kinney and Stuart: Engineering Thermodynamics; Keenan and Kaye: Gas Tables.

Prerequisites: Ch-401(A) and Ch-631(A).

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-101(C) and Mc-101(C) or equivalent.

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: Strength of Materials, Vols. I and II.

Prerequisites: Ma-101(C) and Mc-101(C) or equivalent.

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) or equivalent.

ME-522(B) Strength of Materials 4-0

Beam columns, strain energy, shear center, thick cylinders, rotating disks, torsion of non-circular sections.

Text: Timoshenko: Strength of Materials, Vols. I and II.

Prerequisite: ME-511(C).

ME-541(C) Strength of Materials 3-0

Stress, strain, Hooke's law, thin-walled cylinders, combined stresses, torsion of solid and hollow shafts, elementary beam theory, combined bending and torsion, combined bending and axial load, behavior of columns.

Text: Timoshenko and MacCullough: Elements of Strength of Materials.

Prerequisites: Ma-101(C) and Mc-101(C) or equivalent.

ME-542(B) Strength of Materials 3-0

Statically indeterminate problems in bending, bending beyond the yield point, curved beams, strain energy, mechanical properties of materials.

Text: Timoshenko and MacCullough: Elements of Strength of Materials.

Prerequisite: ME-541(C).

ME-550(B) Elements of Dynamic Structural Analysis 5-0

Elastic analyses of statically indeterminate structural elements, plastic analyses of statically determinate and indeterminate structural elements, methods of strain energy, mechanical properties of materials under impact loadings, dynamic response of simple structures to impact loading through their elastic and plastic ranges with particular attention to maximum deformations, final deformations and ultimate failure.

Texts: Timoshenko: Strength of Materials, Vol. I and II; Atomic Energy Commission: The Effects of Atomic Weapons; Newmark: Methods of Analysis for Structures Subjected to Dynamic Loading (Report to the Dept. of Air Force); Federal Civil Defense Administration: Windowless Structures, (Report No. TM-5-4); other current reports.

Prerequisites: ME-500(C) and Mc-311(A).

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), ME-541(C), or Ae-211.

ME-611(C) Materials Testing Laboratory 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 columns.

Texts: Timoshenko: Strength of Materials, Vol. II; 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 laboratory 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

Introduction to the theory of elasticity, dimensional analysis, strain gage techniques, photoelasticity, brittle lacquer method, membrane analogy, miscellaneous methods in experimental stress analysis. Laboratory projects are assigned to demonstrate the several methods presented.

Text: Lee: An Introduction to Experimental Stress Analysis.

Prerequisite: ME-522(B) and ME-611(C) or equivalent.

ME-700(C) Kinematics of Machinery 2-3

This is a general service course. The following topics are studied: link-work, cams, toothed gearing, trains of mechanisms, velocities, accelerations, static forces and inertia forces on machine members. The practical work periods are devoted to the solution on the drawing board of selected problems.

Text: Ham and Crane: Mechanics of Machinery.

Prerequisite: Mc-102(C).

ME-711(B) Mechanics of Machinery 3-2

Topics considered briefly include link-works, cams and gears. Major emphasis is on the velocities and accelerations of moving parts, static and inertia forces and their balancing, critical speeds in shafts. This course is the first of a co-ordinated sequence of ME-711 and 712.

Text: Ham and Crane: Mechanics of Machinery.

Prerequisite: Mc-102(C).

ME-712(A) Dynamics of Machinery 3-2

Studies are made of the following topics: balancing of solid rotors, torsional vibrations by the Holzer method, single and two degrees of freedom linear vibrating systems with and without damping, tuned pendulum absorbers, harmonic analysis of the reciprocating engine. Laboratory work includes the following experiments: balancing a solid rotor on a mechanical as well as an electrical balancing machine, vibrating linear damped vibration absorbers on the Westinghouse equipment, and operating a torsional vibration inducer unit.

Texts: Den Hartog: Mechanical Vibrations; Notes by E. K. Gatcombe.

Prerequisites: Ma-103(B) or equivalent, Mc-201-(A), ME-711(B) and ME-511(C).

ME-730(B) Dynamics of Machinery 3-2

Studies are made of the following topics: balancing of solid rotors, torsional vibration analysis by the Holzer method, single and two degrees of freedom linear vibrating systems with and without damping, tuned pendulum absorbers, harmonic analysis of the radial aircraft engine. The laboratory work includes the following experiments: balancing of solid rotors on the mechanical as well as the electrical balancing machine, vibrating linear damped vibration absorbers on the Westinghouse equipment and operating a torsional vibration inducer unit.

Text: Den Hartog: Mechanical Vibrations; Notes by E. K. Gatcombe.

Prerequisites: Ma-103(B) or equivalent, Mc-201-(A) and Ae-211(C).

ME-740(C) Kinematics and Machine Design 3-2

Studies are made of the following topics: displacements, velocities, and accelerations of the various kinematic linkages, such as the four bar mechanism, the drag link, cams, gears, intermittent motions, cyclic gears and gyros. Several design topics will be considered: the design of shafting (considering strength, deflection, bearing loads, critical speeds etc.); couplings; springs; bearings, fits and tolerances.

Texts: Ham and Crane: Mechanics of Machinery; Notes by E. K. Gatcombe.

Prerequisites: Mc-102(C) and ME-542(B).

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) or equivalent, 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 manufacture. The objective is to create designs which may actually be fabricated.

Text: Notes by E. K. Gatcombe.

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, deflecttion, fits and tolerances, vibrations, etc. General design information on bearings, springs, shafting, screw fastenings, gears, clutches, brakes, cams and thick and thin cylinders.

Text: Notes by E. K. Gatcombe.

Prerequisite: ME-700(C).

Reference: Vallance and Doughtie: Design of Machine Members.

ME-830(C) Machine Design 4-2

Review of strength of materials, selections of materials for different designs. Stress-concentration, bearing design, fits and tolerances. Several short design projects as follows: tabulation of tolerances for shafts and holes for 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 cylinder design.

Text: Vallance and Doughtie: Design of Machine Members.

Prerequisite: ME-700(C) and Ae-202(C) or equivalent.

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).

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 fundamentals 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), 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-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 characterisitc 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; Heyer: Engineering Physical Metallurgy.

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; Heyer: Engineering Physical Metallurgy.

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.

Prerequisite: Mt-202(C).

Mt-204(A) Advanced Physical Metallurgy 3-4

An enlargement of material covered in Mt-201 and Mt-202 to prepare students for advanced study in theoretical physical metallurgy. Subjects covered include the nature and source of structures occurring in steels and other ferrous materials, the interdependence of structures and mechanical properties, phase transformations in steels under isothermal and continuous cooling conditions, response to quenching and hardenability of steels, practical heat treating of steels, effects of welding and the nature and properties of engineering cast irons and cast steels.

Text: Bullens-Battelle: Steel and Its Heat Treatment, Vol. I, II, and III.

Prerequisite: Mt-201(C), Mt-202(C).

Mt-205(A) Advanced Physical Metallurgy 3-4

The subject matter includes a discussion of equilibrium in alloys systems, structure of metals and alloys, phase transformations and diffusion.

Text: Barrett: Structure of Metals.

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.

Prerequisite: Mt-205(A).

Mt-207(A) The Physics of Solids 3-0

A course for engineers intended as an introduction to the current concepts of the nature of solids. Topics discussed include the wave and particle aspects of electrons, the band structure of metals, insulators and semi-conductors, perfect crystal and imperfect crystals and the interpretation of bulk properties, in terms of electronic, atomic and crystal structures.

Text: Instructor's notes.

Prerequisites: Mt-201, Ph-631, Ph-540.

Mt-301(A) High Temperature Materials 3-0

A study of the methods used in evaluating the probable behavior of materials at elevated temperatures, a consideration of the properties of particular importance in such service; evaluation of present heat-resisting alloys; a study of the effect of high temperature on the behavior of alloys; metals used in gas turbines, jets, and rockets; the use of ceramics for elevated temperatures.

Text: None.

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-204(A).

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), 204(A), or 205(A).

Mt-304(C) Radiography 2-2

Principles of x-ray and gamma ray radiography, including a discussion of high voltage equipment, film characteristics and a comparison of radiography with other non-destructive methods of inspection.

Text: None.

Prerequisite: Mt-202(C).

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.

Text: Cottrell: Theoretical Structure Metallurgy.

Prerequisite: Mt-205(A), Ph-610(B), or 640(B).

Mt-402(B) Nuclear Reactor Materials-Effects of Radiation 3-0

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.

Prerequisite: Mt-202.

NEW WEAPONS DEVELOPMENT

SL Lecture Courses

SL-101(L) New Weapons Development I 0-1

Consists of the first ten lectures of a twenty-lecture series to be delivered by authorities in the field of new weapons development, the latter term being used in its broadest sense and including such developments as atomic energy, guided missiles, pilotless aircraft, radar, special communication equipment, countermeasures, special fuzes and jet propulsion.

Text: None.

Prerequisite: None.

SL-102(L) New Weapons Development II 0-1

A continuation of Course SL-101(L) and consists of the second ten lectures of the twenty-lecture series described under SL-101(L).

Text: None.

Prerequisite: None.

OCEANOGRAPHY

Oc Courses

Oc-101(C) Introduction to Oceanography 2-1

A survey of the physical and chemical properties of sea water, marine biology, and submarine geology; ocean currents, heat budget, water masses, tides, oceanographic observations and instruments.

Texts: Sverdrup: Oceanography for Meteorologists; NavAer 50-1R-242: The Application of Oceanography to Subsurface Warfare.

Prerequisites: Ma-161(C) or Ma-100(C); Ph-190-(C) or Ph-196(C) or equivalent.

Oc-111(B) General Oceanography 3-1

Physical, chemical, and biological properties of the oceans; exchange of heat, moisture, and momentum between sea and atmosphere; equations of relative mean motion, special forms; oceanographic instruments and observations.

Texts: Sverdrup, Johnson and Fleming: The Oceans; NavAer 50-1R-242: The Applications of Oceanography to Subsurface Warfare.

Prerequisites: Ma-163(C) or equivalent.

Oc-201(C) Physical Oceanography 3-0

Processes which tend to modify the distribution of physical properties in the oceans: turbulence, diffusion, wind stress, mass transport, internal waves, evaporation, the geostrophic current, upwelling and sinking, stability.

Texts: Sverdrug: Oceanography for Meteorologists; NavAer 50-1R-242: The Applications of Oceanography to Subsurface Warfare.

Prerequisites: Ph-191(C) or Ph-196(C) or equivalent; Ma-163(C) or Ma-100 and Ma-140; Oc-101(C).

Oc-203(C) Amphibious Oceanography 3-1

The characteristics of breaking waves, littoral currents and beach processes, and their effects upon amphibious operations; types and characteristics of beaches and coasts; estuarine circulation; bottom sediments; all these and their naval applications; shallow-water observations and equipment.

Text: Mimeographed notes:

Prerequisite: Mr-610(C) or Mr-620(B).

Oc-213(C) Shallow Water Oceanography 2-2

Similar to course Oc-203(C), but emphasizing recent developments in the field.

Texts: Mimeographed notes.

Prerequisites: Oc-111(B), Mr-620(B), Mr-323(A).

Oc-301(C) Military Oceanography 2-1

The oceanographic factors involved in sound ranging; thermal gradients, ambient noise, volume and surface scattering and their time variation; forecasting sonar ranges and changes in ranging conditions as related to meteorological factors.

Texts: NavAer 50-1R-242: The Application of Oceanography to Subsurface Warfare; NDRC Technical Summary: The Principles of Underwater Sound.

Prerequisite: Oc-201(C).

Oc-311(B) Oceanographic Factors in Underwater Sound 3-0

Refraction, absorption, scattering, and diffraction of underwater sound as a function of the oceanic environment. Similar to course Oc-301(C), but emphasizing recent developments.

Texts: NDRC Technical Summary: The Principles of Underwater Sound; NavAer 50-1R-242: Applications of Oceanography to Subsurface Warfare; mimeographed notes.

Prerequisites: Oc-111(B), Ph-196(C) or equivalent.

Oc-401(C) Naval Applications of Oceanography 3-0

Waves, currents, tides, thermal structure and biological phenomena in the oceans, and submarine geology; their applications to problems in landing operations, navigation, mine, and submarine warfare.

Text: NavAer 50-1R-242: The Application of Oceanography to Subsurface Warfare.

Prerequisite: Oc-101(C).

OPERATIONS ANALYSIS

Oa Courses

Oa-151(B) Survey of Weapons Evaluation 3-0

Sources of firing errors and their relative contributions to the over-all errors. Determination of aim point for an evading target. Concept and evaluation of lethal area as a function of both the target and the weapon system. Damage probabilities. Patterns of projectiles, bombs, torpedoes, and mines.

Texts: Operations Evaluation Group: Report No. 54, Methods of Operations Research; Classified official publications.

Prerequisites: Ma-100(C), Ma-101(C), Ma-301(B).

Oa-152(C) Measures of Effectiveness of Mines 3-0

Introduction to operations analysis. Actuation probability and actuation radius. Lethal volume. Probability of damage. Comparative evaluation of mine types. Errors in mine laying. Theory of mine field operation.

Texts: Classified official publications.

Prerequisites: Ma-381(C), Ma-382(A).

Oa-153(B) Game Theory and Its Applications to Mine Fields 3-0

A continuation of Oa-152(C). Introduction to game theory. Operations of a mine field according to game theory. Design of mine fields. Detection of mines.

Texts: Classified official publications.

Prerequisite: Oa-152(C).

Oa-191(C) Introduction to Operations Analysis 3-0

Development of fundamental concepts and methods of operations analysis as illustrated in the fields of submarine and anti-submarine warfare. Over-all measures of effectiveness of a submarine as a weapon system. Determination of effectiveness as a product of measures of detection, attack, and kill capabilities.

Texts: Operations Evaluation Group: Report No. 54, Methods of Operations Research; Classified official publications.

Prerequisites: Ma-182(C), Ma-381(C).

Oa-192(B) Theory of Search 3-0

Theory of radar detection. Methods of evaluating the operational performance of search radars. Blip-scan ratios and their determination by tracking runs and by computational methods. Search patterns. Barrier patrols.

Texts: Classified official publications.

Prerequisites: Oa-191(C), Ma-382(A).

Oa-193(B) Effectiveness of Weapons 4-0

The operations analysis of a mine field. The probability of a hit by a single shot at an evading target. The probability of a hit by a succession of shots with correlation between shots. Comparison of weapons. Queueing theory, with applications.

Texts: Classified official publications.

Prerequisites: Ma-182(C), Ma-382(A), Oa-192(B).

Oa-194(A) Optimal Weapon Systems I 4-0

The appraisal of weapon systems. Selection of optimum airplane weapon system for anti-submarine patrol. Selection of optimum airplane weapon system for mine-laying. The selection and optimal use of psychological and other weapons.

Texts: Classified official publications.

Prerequisites: Ma-501(A), Oa-193(B).

Oa-195(A) Optimal Weapon Systems II 3-0

A continuation of Oa-194(A). Air defense. Atomic weapons. Biological warfare. Applications of game theory.

Texts: Classified official publications.

Prerequisite: Oa-194(A).

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. 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.

Prerequisites: Ma-501(A), 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.

Prerequisites: Oa-201(A), Ma-195(A).

Oa-401(A) Theory of Information Communication 3-0

Bayes' formula; uncertainty of distributions; Markov chains; maximum capacity of a channel. Stochastic functions, stationary processes, correlation, prediction; filtration. Automatic control.

Texts: Shannon and Weaver: The Mathematical Theory of Communication; S. Goldman: Information Theory; P. M. Woodward: Probability and Information Theory with Applications to Radar.

Prerequisites: Ma-195(A), Ma-383(A).

ORDNANCE

Or Courses

Or-101(C) Ordnance I 2-1

The first of four courses in a series designed to provide a survey of the organization, principles, and theories used in the various ordnance fields with limited examples to demonstrate application. Bureau of Ordnance organization and activities; logistics; safety precautions; explosives; ammunition selection and capabilities; ordnance literature.

Text: Classified official publications.

Prerequisite: None.

Or-102(C) Ordnance II 3-2

Continuation of Or-101(C) series. Basic mechanisms (mechanical, electrical, and electronic); aviation ordnance; guided missiles; underwater ordnance.

Text: Classified official publications.

Prerequisite: None.

Or-103(C) Ordnance III 2-2

Continuation of Or-101(C) series. A study of the surface and AA fire control theories and fundamentals. Fire control radar; comparison of fundamentals of AA fire control systems; dynamics of fire control systems; theory of lead computing gunsights.

Texts: NavPers 16116B; classified official publications.

Prerequisite: None.

Or-104(C) Ordnance IV 2-1

Continuation of Or-101(C) series. Chemical warfare, agents, effects, methods; biological warfare, agents, methods; atomic warfare, nuclear reactions, effects, damage criteria and weapons size.

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-192(C) Mining Operations 2-0

Mine layers. Tactical and strategic mining. Mine fields. Minelaying plans. Procedures. Requirements. Operation plans.

Text: Classified official publications.

Prerequisite: Or-191(C).

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 doppler 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 3-2

Continuation of Or-291(C). Theory of various countermeasures techniques. Lab demonstrations. Mine detection by various means. Scope of detection devices. Mine destruction. Operation plans, and procedures.

Text: Classified official publications.

Prerequisite: Or-291(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-295(A) Thesis I 2-9

Thesis preparation and research in a designated mine warfare subject guided by appropriate staff and faculty members.

Text: None.

Prerequisite: None.

Or-296(A) Thesis II 2-6

Continuation of Or-295(A). Completion of research and thesis.

Text: None.

Prerequisite: Or-295(A).

PHYSICS

Ph Courses

Ph-113(B) Dynamics 3-0

Kinematical and dynamical motions of a particle and of rigid bodies, energy concepts in dynamics, constrained motion, equations of Lagrange and of Hamilton, oscillations of a dynamical system. Both analytical and vector methods are used.

Text: Lindsay: Physical Mechanics.

Prerequisites: Ma-103(B). (May be taken concurrently); Ph-212(B).

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.

Texts: Lindsay: Physical Mechanics; Page: Introduction to Theoretical Physics.

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.

Texts: Lindsay: Physical Mechanics; Page: Introduction to Theoretical Physics.

Prerequisite: Ma-183(B). (May be taken concurrently); 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: Slater and Frank: Mechanics; lecture notes.

Prerequisite: Ph-142(B) or equivalent.

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 short 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-211(C) Optics 3-0

Reflection and refraction of light; lenses and lens aberrations; stops; optical systems; dispersion.

Text: Jenkins and White: Fundamentals of Optics.

Prerequisite: Ma-101(C). (May be taken concurrently.)

Ph-212(B) Physical Optics and Introductory Dynamics 3-3

A continuation of Ph-211(C). An analytical presentation of interference, diffraction, polarization, origin of spectra, optical behavior of radio waves, introductory dynamics.

Texts: Jenkins and White: Fundamentals of Optics; Lindsay: Physical Mechanics.

Prerequisites: Ma-102(C). (May be taken concurrently); Ph-211(C).

Ph-240(C) Geometrical and Physical Optics 3-3

Reflection and refraction of light, lenses, optical systems, dispersion, interference, diffraction, polarization.

Text: Jenkins and White: Fundamentals of Optics.

Prerequisite: Ma-101(C) or 181(B). (May be taken concurrently.)

Ph-241(B) Polarized Light 1-3

Primarily a laboratory course in polarized light. The following experiments are included: polarization phenomena caused by transmission of light through crystals, polarization by reflection from dielectrics, reflection from metals and optical constants of metals, analysis of elliptically polarized light, wave plates, and optical activity.

Text: Lecture notes.

Prerequisite: Ph-240(C).

Ph-311(B) Electrostatics and Magnetostatics 3-0

Coulomb's law, Gauss' law, dipoles, dielectric theory, polarization, harmonic 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.

Text: Harnwell: Principles of Electricity and Electromagnetism.

Prerequisites: Ma-103(B); Es-112(C).

Ph-312(B) 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.

Text: Harnwell: Principles of Electricity and Magnetism.

Prerequisite: Ph-311(B).

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: Harnwell: Principles of Electricity and Magnetism; NavShips 900,016; lecture notes.

Prerequisite: Ma-182(B). (May be taken concurrently.)

Ph-351(A) Electricity and Magnetism 5-0

Electrostatics, electromagnetic fields and potentials, dielectrics, Maxwell's equations, electromagnetic waves.

Text: Slater and Frank: Electromagnetism.

Prerequisites: Ph-142(B); Es-272(C).

Ph-352(A) Electromagnetic Waves 3-0

A continuation of Ph-351(A). Cylinderical and spherical waves with applications; electromagnetic momentum and radiation reaction.

Texts: Slater and Frank: Electromagnetism; Sommerfield; Electrodynamics; lecture notes.

Prerequisite: Ph-351(A) or equivalent.

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; electromagnetic waves.

Text: Slater and Frank Electromagnetism.

Prerequisites: Ma-104(A); EE-272(C), or equivalent.

Ph-362(A) Electromagnetic Waves 3-0

A continuation of Ph-361(A). Reflection and refraction of electromagnetic waves; wave guides; cavity resonators; electromagnetic radiation.

Text: Slater and Frank: Electromagnetism.

Prerequisite: Ph-361(A).

Ph-410(B) Sound 3-0

A brief survey of vibrating systems, and of the problems arising in connection with the radiation, transmission and reception of sound in air and in water.

Text: Kinsler, Frey: Fundamentals of Acoustics.

Prerequisite: Ma-102(C).

Ph-421(A) Fundamental Acoustics 3-0

An analytical study of the dynamics of vibrating systems including free, forced, damped, and coupled simple harmonic motion, vibrations of strings, bars, membranes, and diaphragms. A development of the acoustic wave equation. Propagation of plane waves through pipes and between different media. Propagation of spherical waves, including radiation from pulsating sphere and circular piston.

Text: Kinsler, Frey: Fundamentals of Acoustics.

Prerequisite: Ma-104(A) or Ma-193(B).

Ph-422(A) Applied Acoustics 3-0

A continuation of Ph-421(A). An analytical treatment of acoustic resonators; acoustic impedance; effects of branches, orifices, and viscosity on propagation of plane waves through pipes; horn, loud speaker, and microphone theory and practice. Fundamentals of acoustical measurements including rating and calibration methods of microphones and loud speakers. Architectural acoustics. Fundamentals of hearing.

Text: Kinsler, Frey: Fundamentals of Acoustics.

Prerequisite: Ph-421(A).

Ph-423(A) Underwater Acoustics 2-3

A continuation of Ph-422(A). An analytical treatment of the piezoelectric effect and the magnetostriction effect with applications to sonar transducers and to crystal oscillators; transmission of sound in sea water, including problems of refraction, attenuation and reverberation. Physical principles and electronic circuits used in design and operation of modern sonar equipment. Experiments in acoustical measurements, sound beam and sonar equipment measurements, operation of sonar equipment.

Text: NDRC Technical Summary: Principles of Underwater Sound.

Prerequisite: Ph-422(A).

Ph-424(A) Shock Waves and Sonar Developments 3-3

Theory of propagation of explosive shock waves in water, scaling laws, Rankine-Hugoniot equations of shock front, experimental measurements of shock waves. Transducer theory. New sonar equipments and developments are studied in the laboratory.

Texts: Cole: Underwater Explosives; Classified reports and official publications.

Prerequisite: Ph-423(A) or Ph-425(A).

Ph-425(A) Underwater Acoustics 3-2

A continuation of Ph-421(A). 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(A).

Ph-426(B) Acoustics Laboratory 0-3

A laboratory course to accompany Ph-421(A). An experimental study of vibrating systems and acoustic radiations.

Text: None.

Prerequisite: Ph-421(A) concurrently.

Ph-427(B) Fundamental and Applied Acoustics 4-0

A study of the dynamics of vibrating systems and of the propagation of acoustic waves. Applications of basic acoustic theory to design of resonators, filters, loudspeakers, microphones, etc.

Text: Kinsler, Frey: Fundamentals of Acoustics.

Prerequisite: Ma-103(A).

Ph-428(B) Underwater Acoustics 2-3

A continuation of Ph-427(B). A study of the transmission of sound in sea water including problems arising from refraction, absorption, reverberation, background noise, etc. Physical principles, electronic circuits, and transducers used in modern sonar equipment. Experiments in acoustical measurements, sound beam and sonar equipment measurements, operational characteristics of sonar equipment.

Text: NDRC Technical Summary: Principles of Underwater Sound.

Prerequisite: Ph-427(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); Ph-142(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-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); Ma-103(B) or Ma-183(B).

Ph-540(B) Kinetic Theory and Statistical Mechanics 3-0

Properties of an ideal gas, Maxwell-Boltzman distribution, mean free path, collision cross-section, non-ideal gases, viscosity, heat conductivity, diffusion; introduction to classical and quantum statistics, including Fermi-Dirac and Bose-Einstein statistics.

Texts: Kennard: Kinetic Theory of Gases; Sears: Thermodynamics; lecture notes.

Prerequisites: Ph-113(B) or Ph-142(B); Ma-103(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); Ph-142(B).

Ph-542(A) Thermodynamics and Statistical Mechanics 4-0

The principal topics are: Equations of state, first and second laws of thermodynamics; introduction to classical and quantum statistics, including Fermi-Dirac and Bose-Einstein statistics; theory of fluctuations.

Text: Allis and Herlin: Thermodynamics and Statistical Mechanics; lecture notes.

Prerequisites: Ph-113(B) or Ph-142(B); Ma-103(B) or Ma-183(B).

Ph-610(B) Atomic 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-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, artificial radioactivity.

Texts: Semat: Atomic Physics; 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: Finklenburg: Atomic Physics; Semat: Atomic Physics.

Prerequisites: Ph-142(B); 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.

Prtrequisite: Ph-650(B). (To be taken concurrently.)

Ph-642(B) Nuclear Physics 4-0

Nuclear structure, radioactivity, nuclear reactions and nuclear fission.

Text: Halliday: Introductory Nuclear Physics.

Prerequisites: Ph-720(A); Ph-640(B). (May be taken concurrently.)

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). (To be taken concurrently.)

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. Elementary pile theory.

Texts: Blatt and Weisskopf: Theoretical Nuclear Physics; Glasstone and Edlund: The Elements of Nuclear Reactor Theory; lecture notes.

Prerequisite: Ph-642(B) or equivalent.

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-651(A) Reactor Technology 3-0

Nuclear fission, the diffusion and slowing down of neutrons, homogeneous and heterogenous thermal reactors, reactor control.

Text: Glasstone and Edlund: The Elements of Nuclear Reactor Theory.

Prerequisite: Ph-642(B).

Ph-720(A) Introductory Quantum Mechanics 3-0

Schroedinger's wave mechanics, with application to such problems as the free particle, particle in a potential well, harmonic oscillator and the hydrogen atom.

Text: Rojansky: Introductory Quantum Mechanics.

Prerequisite: Ph-640(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, cold cathode emission, natural radioactivity, harmonic oscillator, free rotator, hydrogen atom and the one-dimensional potential lattice for the solid state.

Text: Rojansky: Introductory Quantum Mechanics.

Prerequisites: Ph-142(B); Ph-640(B) or equivalent.

Ph-722(A) Physics of the Solid State 3-0

Properties of ionic crystals such as lattice energies, electrical conductivity, absorption, phosphorescence and fluorescence. The transistor. Properties of metals such as specific heats, electrical conductivity and magnetic susceptibility.

Text: Seitz: Modern Theory of Solids.

Prerequisite: Ph-721(A) or equivalent.

Ph-723(A) Physics of the Solid State 4-0

An introductory survey covering such topics as thermal properties of solids, ferromagnetism and antiferromagnetism, band theory of metals and semiconductors, including transistors.

Text: Kittel: Introduction to Solid State Physics.

Prerequisites: Ph-631(B); Ph-640(B); Ph-720(A) or 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(A) Physics Seminar 4-0

Discussion, conducted primarily by the students, of special topics in various fields of physics.

Text: None.

Prerequisite: Ph-642(B) or consent of instructor.

Ph-810(C) Biological Effects of Radiation 3-0

Principles of biological dose measurement. Tolerance levels; genetic and physiological effects of ionizing radiations.

Text: Lecture notes.

Prerequisite: Ph-640(B).

SECTION III

THE GENERAL LINE SCHOOL

Director

George Kittrell FRASER, Captain, U. S. Navy
B.S., USNA, 1927; Graduate Aviation Ordnance Engineering, USNPGS, 1938.

Assistant to the Director

Edgar Smith PALMER, Lieutenant Commander, U. S. Navy

Training Aids Officer

Gordon Leonard KALLENBERG, Lieutenant, U. S. Navy

NAVAL STAFF

COMMAND AND STAFF DEPARTMENT

Marcus William WILLIAMSON
Captain, U. S. Navy
Head of Department
B.S., USNA, 1932.

Preston Randolph BELCHER
Commander, U. S. Navy
Senior Instructor in Administration and Leadership

Charles Dean DAVOL, Jr.
Commander, U. S. Navy
Instructor in Administration and Leadership
A.B., Harvard Univ., 1941.

Lloyd Webb BERTOGLIO
Lieutenant Commander, U. S. Navy
Senior Instructor in Aviation

James Stuart NEILL
Commander, U. S. Navy
Senior Instructor in Logistics
B.S., Trinity College, 1940.

Joseph Alois KRIZ
Lieutenant Commander, U. S. Navy
Instructor in Logistics
B.S., USNA, 1943; M.B.A., Columbia Univ., 1952.

Thomas Richard FONICK
Commander, U. S. Navy
Senior Instructor in Military Law
B.S., Univ. of Washington, 1934.

Daniel Donald McCLEOD
Lieutenant Commander, U. S. Navy
Instructor in Military Law
LL.B., Univ. of Arkansas, 1936.

John Clarence ROBERTS
Commander, U. S. Navy
Instructor in Military Law
LL.B., Univ. of Texas.

OPERATION COMMAND DEPARTMENT

Hugh Kent LAING
Commander, U. S. Navy
Head of Department
B.S., Univ. of Minnesota.

Edwin Claude MILLER
Commander, U. S. Navy
Senior Instructor in Tactics
California Nautical School, 1934; B.S., California Maritime Academy, 1941.

John Joseph REIDY, Jr.
Commander, U. S. Navy
Instructor in Tactics
A.B., Harvard Univ., 1938; LL.B., George Washington Univ., 1948.

Robert Arnold NEWCOMB
Commander, U. S. Navy
Instructor in Tactics
B.S., USNA, 1940.

Norman Allan SMITH
Lieutenant Commander, U. S. Navy
Instructor in Tactics

William Michael ROBINSON
Commander, U. S. Navy
Instructor in Tactics
B.S., AeE, New York Univ., 1938;
B.S., USNA, 1942.

NAVAL STAFF

Orin Nicholas FORD
Lieutenant Commander, U. S. Navy
Instructor in Tactics
A.A., Hartnell College, 1941.

Joseph Delos FULLER
Lieutenant Commander, U. S. Navy
Instructor in CIC-ASW

Carl William BURROWS, Jr.
Lieutenant Commander, U. S. Navy
Senior Instructor in Communications
B.S., USNA, 1944.

Robert Calder ALEXANDER
Lieutenant Commander, U. S. Navy
Instructor in Communications

Paul Henry BARKLEY
Lieutenant, U. S. Navy
Instructor in Communications

Francis Vincent KENNEY
Commander, U. S. Navy
Senior Instructor in CIC-ASW

William Park BAKER
Lieutenant Commander, U. S. Navy
Instructor in CIC-ASW
B.S., USNA, 1943.

William Ramsey TROTTER
Lieutenant, U. S. Navy
Instructor in CIC-ASW

Derrill Plummer CROSBY
Lieutenant, U. S. Navy
Instructor in CIC-ASW

SEAMANSHIP AND NAVIGATION DEPARTMENT

Edward Frank STEFFANIDES, Jr.
Commander, U. S. Navy
Head of Department
B.S., USNA, 1931.

Philip Thompson GLENNON
Commander, U. S. Navy
Senior Instructor in Navigation
and Submarines
B.S., USNA, 1940.

John Winston GROSS
Commander, U. S. Navy
Instructor in Navigation
B.S., Univ. of Alabama, 1937.

William Gwynette SHORES
Lieutenant Commander, U. S. Navy
Instructor in Navigation

Alden Seymour RIKER
Lieutenant Commander, U. S. Navy
Instructor in Navigation

Frank Gordon REESE
Lieutenant, U. S. Navy
Instructor in Navigation and Submarines
B.S., Univ of Washington, 1944.

Lewis Odell SMITH
Lieutenant, U. S. Navy
Instructor in Navigation and Submarines
B.A., Univ. of Virginia, 1944.

John Lee GALLAHAR
Commander, U. S. Navy
B.A., East Central State College, Oklahoma, 1940.
Instructor in Meteorology

Harry Victor HARTSELL, Jr.
Lieutenant Commander, U. S. Navy
Senior Instructor in Seamanship

Frank Clyde DUNHAM, Jr.
Lieutenant Commander, U. S. Navy
A.B., Harvard Univ., 1943.
Instructor in Seamanship

Robert Louis SELF
Lieutenant, U. S. Navy
Instructor in Seamanship

ORDNANCE AND GUNNERY DEPARTMENT

Roger Farrington MILLER
Commander, U. S. Navy
Head of Department
B.S., Univ. of California, 1931.

Chester Maurice LEE
Commander, U. S. Navy
Senior Instructor in Ordnance and Gunnery
B.S., USNA, 1942.

John Newell CUMMINGS
Lieutenant Commander, U. S. Navy
Instructor in Ordnance and Gunnery

Robert Wilson MILLER
Lieutenant, U. S. Navy
Instructor in Ordnance and Gunnery
B.S., Pennsylvania State Teachers College, 1943.

Teddy Roosevelt FIELDING
Lieutenant, U. S. Navy
Instructor in Ordnance and Gunnery

David Dean DITZLER
Lieutenant, U. S. Navy
Instructor in Ordnance and Gunnery

ENGINEERING AND DAMAGE CONTROL DEPARTMENT

John Albert LEONARD
Commander, U. S. Navy
Head of Department
B.S., USNA, 1938.

Arthur Ralph WAGGENER
Lieutenant Commander, U. S. Navy
Instructor in Naval Engineering

Ross PETERS
Lieutenant, U. S. Navy
Instructor in Naval Engineering

Charles SCHOOLER
Lieutenant Commander, U. S. Navy
Senior Instructor in Damage Control

Edmund Eugene LE BER
Lieutenant, U. S. Navy
Instructor in Damage Control
B.S., Webb Institute, 1930.

Charles Golden TYLER
Lieutenant, U. S. Navy
Instructor in Damage Control

CIVILIAN FACULTY

Roy Stanley GLASGOW, Academic Dean

B.S., Washington Univ., 1918; M.S., Harvard Univ., 1922; E.E,. 1925

ELECTRICAL ENGINEERING AND MATHEMATICS DEPARTMENT

Frank Emilio LA CAUZA
Professor of Electrical Engineering,
Head of Department (1929)*.
B.S., Harvard Univ., 1923; M.S., 1924; A.M., 1929.

Edward Markham GARDNER
Professor of Electrical Engineering (1929).
B.S., Univ. of London, 1923; M.S., California Institute of Technology, 1938.

John Dewitt RIGGIN
Professor of Electrical Engineering (1946).
M.S., University of Pennsylvania, 1941.
B.S., Univ. of Mississippi, 1934; M.S.. 1936.

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

David Boysen HOISINGTON
Associate Professor of Electrical Engineering (1947).
B.S., Massachusetts Institute of Technology, 1940; M.S., University of Pennsylvania, 1941.

Raymond Patrick MURRAY
Associate Professor of Electrical Engineerong (1947).
B.E., Kansas State College, 1937.

John Pershing PADDOCK
Assistant Professor of Electrical Engineering (1949).
B.S., Stanford Univ., 1947; M.S., 1948.

Darrel James MONSON
Assistant Professor of Electrical Engineering (1951).
B.S.,Univ. of Utah, 1943; M.S., Univ. of California, 1951.

William Everett NORRIS
Assistant Professor of Electrical Engineering (1951).
B.S., Univ. of California, 1941; M.S., 1950.

Herbert LeRoy MYERS
Assistant Professor of Electrical Engineering (1951).
B.S., Univ. of Southern California, 1951.

* The year of joining the General Line School faculty is indicated in parentheses.

THE GENERAL LINE SCHOOL

OBJECTIVE

To supplement and broaden the professional knowledge of unrestricted line officers of the Regular Navy in order to increase their capabilities and to prepare them for duties afloat and ashore commensurate with their rank.

CURRENT AND FUTURE PROGRAMS

Current. The current six-months' curriculum is designed to supplement the educational background and professional knowledge of former Reserve and Temporary officers who have transferred to the Regular Navy and who have gaps in their naval experience resulting from limited or specialized assignments.

Future. It is anticipated that the future program, to be inaugurated in 1955, will provide a year's study for each unrestricted line officer after he has attained approximately six years of commissioned service. In addition to providing necessary supplementary knowledge, as in the current program, this program will be designed to broaden his knowledge and mental outlook, and to foster his individual growth, initiative and problem-solving ability.

ADMINISTRATION

Responsibility for administration of the General Line School rests in the director. Under the director are the Naval Staff and the Civilian Faculty.

The Naval Staff consists of five officers who are heads of departments, and such additional officers as may be assigned to those departments as instructors. The Civilian Faculty consist of one civilian head of department and the civilians assigned him in that department. The Civilian Faculty members are under the over-all supervision and administration of the academic dean, insofar as their academic work and performance are concerned. The dean represents the superintendent and the director, with many of the functions usually resting in the dean of a civilian college. The faculty members are civil service personnel, with special status.

The officer students of the General Line School are divided into sections for the purpose of administration and classroom assignments. The senior officer of each section is designated section leader with responsibility for exercising administrative control of the officers in his section. Each student section has an officer instructor assigned to it as section advisor. The section advisor provides a connecting link between the school administration and the students.

FACILITIES AND EQUIPMENT

The administrative offices of the General Line School are located in the West Wing of the Administration Building. Here are the offices of the director, heads of departments and instructors. Classrooms located in the Companion East Wing are used jointly by the Line School and the Engineering School. Most of the classrooms for the General Line School are located in Fleming Hall, a temporary building located to the east of the Administration Building.

Laboratory and practical exercises are provided for at the Naval Auxiliary Air Station located approximately two miles from the main school grounds;but transportation is provided for the students. One building houses the electrical and electronics laboratories. In another building there are facilities for the practical navigation exercises in which the student utilizes the equipment such as loran receivers and loran receiver mockups, normally used by a navigator at sea. A third building contains models and cutaways of engineering equipment and installations used aboard ship. Classes and practical works in CIC and ASW are conducted in a specially designed building containing two classrooms and a problem-generating room having facilities and equipment simulating that found in two rada picket destroyers, twin DDR CIC mock-ups and twin sonar installations containing the latest type ASW attack-direction systems. Helm simulating units enable the two "ships" to maneuver either independently or in formation. Officer students man and control all bridge, CIC and sonar stations during simulated task force problems and ASW attacks.

The following ordnance and associated equipment is available for laboratory purposes in the Gun and Mount Building located on the main school grounds: 40 millimeter Bofors heavy machine gun, 5"/38 caliber dual-purpose gun mount, 3"/50 cailber rapid-fire gun mount, auxiliary gun director, mines, rocket launcher and torpedoes.

Plans have been submitted for the construction of new buildings for the General Line School on the main grounds which will meet the need of a new Line School program to be inaugurated in 1955, at which time the West Wing will revert to its former use of housing bachelor officers.

CURRICULUM AND INSTRUCTION

General. In view of the wide disparity in rank, background and experience of the officer students, the current curriculum is broad enough to meet the needs of officers deficient in any of the principal, vital areas of the naval profession. In view of the limited time available, each course is necessarily quite intense; the relative amount of time devoted to each course is a reflection of the analysis of student deficiences and its relative importance to the average officer. Each student pursues the same curriculum regardless of past experience, except that non-aviators get some additional courses during the periods allotted to aviators for flying. Extra instruction is afforded for student deficiencies in the basic sciences.

Practice Cruise. The formal curriculum is augmented by a practice cruise at sea, normally of one week's duration. The students embark in combatant type ships and are given the opportunity to observe the organization and technical details of the ship, and, where practicable, to take over the functions of the ship's personnel at various stations, under supervision, while the ship performs routine evolutions.

CURRICULUM

	Hours
Command and Staff Department	
Administration and Leadership	32
Military Law	40
Logistics	24
Aviation (for non-aviators)	24
Seamanship and Navigation Department	
Seamanship	40
Navigation	80
Meteorology	16
Submarine	8
Operational Command Department	
Naval Tactics	96
Combat Information Center/Anti-Submarine Warfare	56
Communications	40
Electrical Engineering and Mathematics Department	
Mathematics Review	19
Mechanics Review	8
Electrical Engineering	45
Electronics Survey	9
Engineering and Damage Control Department	
Naval Engineering (Basic)	48
Naval Engineering (Augmented)	12
Damage Control (Basic)	48
Damage Control (Augmented)	12
Ordnance and Gunnery Department	
Ordnance and Gunnery (Basic)	56
Ordnance and Gunnery (Augmented)	24

ADMINISTRATION AND LEADERSHIP

OBJECTIVE

To provide a course of wide scope designed to stimulate interest and increase knowledge and capability in general administrative matters and in leadership, and thus to increase the effectiveness of students in their future assignments.

COURSE DESCRIPTION

The course concerns matters affecting the naval officer and his career, philosophy and techniques of leadership, personnel administration and general administration. Within these four general areas as many pertinent topics as practicable are presented in the limited time allotted. No attempt is made to give complete treatment to any topic; the idea is to highlight salient factors, alert students to the importance of matters of chief concern and provide them with information and means for more intensive and effective effort on an individual basis.

SYLLABUS

	Hours
Philosophy of Military Life	1
Customs and Traditions	2
Career Planning	1
Personal Finances	2
Performance, Promotion, Retirement	4
Leadership	5
Enlisted Training Programs	1
Enlisted Rating Structure	1
Classification	1
Personnel Accounting and Records	2
Personnel Policies; Manpower Utilization	2
Shipboard Organization	1
Foreign Relations; Protocol	1
Public Relations and Information	1
Welfare and Recreation Programs	1
Mess Administration	1
Correspondence and Directives	5
	32

MILITARY LAW

OBJECTIVE

To present the principles of the Uniform Code of Military Justice and the Manual for Courts-Matrial, United States, 1951 (including the Naval Supplement thereto), to the end that the administration of justice in the U. S. naval service will be sustained and strengthened.

COURSE DESCRIPTION

The course in military law covers jurisdiction of courts-martial, offenses, preferment of charges, investigations, non-judicial punishment, rules of evidence, court-martial procedure, duties of counsel and members of courts-martial, and review of courts-martial by the convening authority, supervisory authority, boards of review and the Court of Military Appeals. Preparation for classes by the student includes reading assignments in the Manual for Courts-Martial, United States, 1951, and the Naval Supplement thereto; legal research problems requiring the use of Court-Martial Reports, Digest of Opinions of the Judge Advocates General of the Armed Forces, and other legal authorities; exercises in drafting charges and specifications, charge sheets and appointing orders for courts-martial; and preparation of a trial brief for and participation in the proceeding of a moot special court-martial.

SYLLABUS

	Hours
Introduction and Jurisdiction	2
Charges and Specifications	2
Legal Research Problem	1
Punitive Articles of Uniform Code of Military Justice	7
Rules of Evidence	8
Non-judicial Punishment and Preliminary Inquiries	3
Court Martial Procedure	13
Action on Court Martial Proceedings by Reviewing Authorities	2
Courts of Inquiry and Investigations	1
Administrative Matters Relating to Military Justice	1
	40

LOGISTICS

OBJECTIVE

To provide basic instruction in logistics, calculated to instill in the officer student a full appreciation of naval logistics in its present-day concepts.

The course is presented by lecture method and is developed as follows:

COURSE DESCRIPTION

A concept of logistics is derived by developing its meaning today and its importance in modern warfare.

The student is made aware of the important organization and commands involved and how they function.

The components of logistics are expanded subject by subject to give the student an understanding of logistic processes.

The operational or combat phases of logistics are discussed with emphasis placed upon logistics planning and execution as practiced in World War II and in Korea.

SYLLABUS

	Hours
Organization	3
Determination of Requirements and Budgetary Aspects	3
Procurement and Distribution	7
Manpower and Petroleum	2
Transportation	3
Theater Logistics	3
Logistics Computations	3
	24

AVIATION

OBJECTIVES

To give the non-aviation officer a broad concept of the mission, organization and objective of naval aviation; to create an appreciation of the significance and uses of naval aviation; to indicate the capabilities and limitations of naval aircraft.

COURSE DESCRIPTION

This course is presented primarily by lecture method augmented by moving pictures and includes discussion of all phases of naval aviation, its aircraft and their tactical employment in the science of naval warfare.

In keeping with the scope of the course, no attempt is made to explore the more technical aspect of naval aviation but rather to present each topic to the student in the light of present employment, high-lighting the capabilities and limitations so as to bring about a more concrete understanding of the role of naval aviation.

In addition to classroom presentation one hour of the syllabus is devoted to practice work in the Link trainer. Each student is placed at the actual controls of this synthetic flight simulator with the purpose of acquainting him with the technique and problems of piloting an aircraft.

SYLLABUS

	Hours
History and Mission of Naval Aviation	1
Principles of Flight	1
Aircraft Carriers/Carrier Aircraft	4
Patrol Aircraft	1
LTA and Utility Aircraft	1
Fundamentals, Flight Control and Operational Use of Helicopters	1
All-Weather Flying, Airways, Landing Aids	2
Link Trainer Practical Work	2
Air Support in Amphibious Operations	2
Aerial Mining	1
Aircraft in ASW	3
New Developments	2
Jet Propulsion and Problems of High Altitude/Speed Flight	3
	24

SEAMANSHIP

OBJECTIVE

To present a theoretical and background knowledge of seamanship and the rules of the nautical road.

COURSE DESCRIPTION

The seamanship course is divided into three parts: deck seamanship, rules of the road, and duties of the officer of the deck. Deck seamanship covers duties of the first lieutenant, marlinespike seamanship, weight handling, boat stowage and handling, replenishment at sea, towing and ground tackle. Rules of the road include fog signals, meeting signals, lights, and emergency ship handling. Duties of the officers of the deck cover maneuvering in confined waters, rudder and screw effects, standard orders, mooring lines, formation steaming, and heavy weather steaming.

The above topics are covered in thirty-eight lecture hours. Two additional hours are spent in the shiphandling trainer. Additional practical application is obtained during the cruise.

SYLLABUS

SYLLABUS	Hours
Deck Seamanship Evolutions	11
Duties of the Officer of the Deck	2
Shiphandling	9
Rules of the Nautical Road	16
Shiphandling Trainer	2
Total exclusive of cruise at sea	40

NAVIGATION

OBJECTIVE

To provide a practical and theoretical knowledge of marine navigation.

COURSE DESCRIPTION

The navigation course is divided into three phases: piloting, astronomy and celestial navigation. Piloting covers preliminary definitions, chart projections, use of HO and other publications, the magnetic compass and loran. Astronomy covers the basic motions of the celestial bodies, terms, and definitions. Celestial navigation covers the use of the Nautical Almanac, HO 214, HO 249 and Rude star finder.

The course consists of 48 hours of classroom work, lectures, training films, and problems and 32 hours of practical works including solving problems and plotting.

SYLLABUS

SYLLABUS	Hours
Mechanics: Definitions, Chart Projections, Publications	4
Tide and Current Tables, Light Lists, Nautical Almanac	7
Magnetic Compass, Exact Azimuths	3
Piloting, Loran, Use of Radar	5
Nautical Astronomy, Star Identification; Time	14
Complete Solution and Latitude Sights	8
Duties of Navigator, Voyage Planning	3
Practical Works	36
	80

METEOROLOGY

OBJECTIVE

To present suffcient theoretical and background knowledge concerning the subject of meteorology for interpretation of a weather map and weather conditions and to provide practical utilization of information so gained in application to ship and air operations.

COURSE DESCRIPTION

The first portion of this course is devoted to a study of the elements of the weather and the method of presentation of the weather elements on a weather map. This phase deals with the structure of the atmosphere, atmospheric heat processes. the evaporation-condensation cycle, and atmospheric pressure in relation to wind with the resulting primary, secondary, and local wind circulations. The second phase consists of a discussion of the air mass concept, the theory of fronts, the technique of weather map analysis, the phenomena of the tropical storm, and the inter-tropical front. The final phase covers selected basic principles of weather forecasting, weather application at sea, sources of weather information, and climatology. Practical-works utilized in the course are:

Plotting the station model

Interpreting a weather map

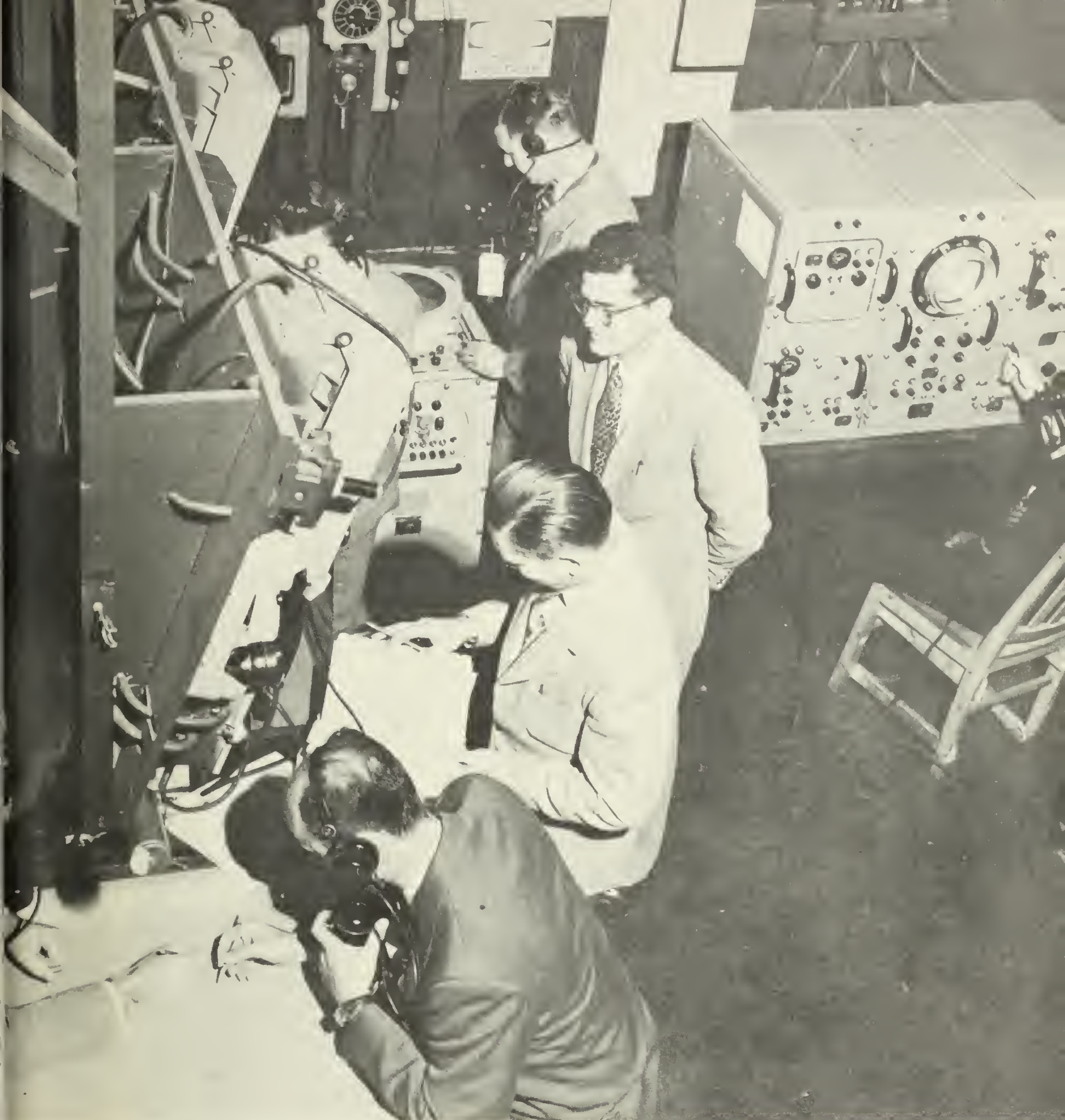
Drawing a weather map (embodies frontal and isobaric analysis)

Constructing a tropical storm danger sector diagram

Weather forcasting

Encoding a weather report.

Time allocated to various items of subject matter contained in course is as follows:



Typical General Line School training equipment.

A General Line School class in engineering. Practical operating courses such as these play an important part in supplementing an officer's former education and experiences, and preparing officers for a variety of future duties.

SYLLABUS

	Hours
Structure of the Atmosphere; the Weather Elements; the Station Model; Atmospheric Heat Processes	2
The Evaporation Condensation Cycle; Weather Map Construction; Clouds; Atmospheric Pressure and Winds; Primary Winds, Secondary Winds, Local Winds	3
Air Masses and Fronts; Cyclone Structure and Movement; Weather Map Analysis; The Inter-tropical Front; Tropical Storms	5
Principles of Forecasting; Sources of Weather Information; Weather Application at Sea; Climatology	6
Total	16

SUBMARINES

OBJECTIVE

To provide a basic knowledge of the capabilities and limitations of submarines.

COURSE DESCRIPTION

The course covers the submarine force organization, construction and operation of submarines, new developments, and tactics, both offensive and defensive.

The above topics are covered in eight hours of class-room lecture. The students are given a three-hour trip on a submarine during which time they observe the activity at various stations in the boat.

SYLLABUS

	Hours
Submarine Construction	3
Submarine Tactics and New Developments	5
	8

NAVAL TACTICS

OBJECTIVE

To familiarize the student with basic tactical doctrines for surface ship formations and dispositions for certain special purpose operations, and to develop student proficiency in the use of the maneuvering board.

COURSE DESCRIPTION

This course is presented by classroom lectures and practical works augumented by movies, slides, and enlarged maneuvering board demonstrations. The student is advised at the outset of the course that insufficient time will be provided to insure complete proficiency in tactical operations on its completion, but that an adequate foundation is offered to the student upon which to build his proficiency through his own application and detailed study at a later time. The course commences with a treatment of maneuvering board fundamentals, on completion of which the student should have gained an adequate knowledge upon which to study more advanced types of maneuvering board problems which will be presented later. The second phase of the course consists of a detailed treatment of general tactical instructions as developed in Allied Maneuvering Instructions, by which time the student should have a knowledge of the tactical rules applied in naval maneuvers. He will then proceed to study advanced maneuvering board problems with special attention to screening operations. Detailed consideration of scouting and air-sea rescue, fast carrier force operations, hunter killer tactics, surface action, amphibious operations, and mine warfare concludes the course.

SYLLABUS

	Hours
Introduction	1
Maneuvering Board	27
General Tactical Instructions	13
Screens and Main Body	20
Scouting and Air-Sea Rescue	11
Cruising Instructions	1
Carrier Task Force Instructions	6
Hunter-Killer Tactics	4
Surface Action	4
Amphibious Warfare	6
Mine Warfare	2
Naval Control of Shipping	1
	96

COMBAT INFORMATION CENTER and ANTI-SUBMARINE WARFARE

OBJECTIVE

To familiarize the student with current capabilities and limitations of shipborne Combat Information Center and anti-submarine warfare equipment; to acquaint the student with airborne Combat Information Center and anti-submarine warfare equipment, and to familiarize the student with their employment within the fleet.

COURSE DESCRIPTION

The course consists of 56 hours divided equally between anti-submarine warfare and Combat Information Center. The time is further divided between lectures and practical works with each receiving approximately the same number of hours. Throughout the course emphasis is placed on aircraft and shipboard organizations, capabilities and limitations of present day equipment, and a general understanding of fleet operational procedures and doctrine. The organization and duties of the Combat Information Center team and the anti-submarine warfare team are stressed. Procedures used in surface plotting, air plotting, air intercept control, radar navigation, shore bombardment, anti-submarine warfare attacks, and simulated task group operations are covered in both lectures and practical works. The basic theory, capabilities, and limitations of radar, surface and airborne submarine detection and attack equipments, electronic countermeasure and recognition systems are covered. Movies, training aids, and the equipment in mock-ups are used where applicable. The subjects are presented in the following order:

SYLLABUS

	Hours
Anti-Submaring Warfare Functions	9
Organization and Operation of ASW	5
Anti-Submarine Warfare Equipments; Practical Works	14
Combat Information Center Functions	9
Organization and Operation of CIC	5
CIC Equipment; Practical Works	14
	56

COMMUNICATIONS

OBJECTIVE

To acquaint the student with the relationship of communications to naval operation including the capabilities, limitations and functioning of naval communications and the responsibilities of command inherent thereto.

COURSE DESCRIPTION

The course is presented by classroom lectures and practical works. In all phases of the course, emphasis is placed on the importance of learning to use the reference texts or books correctly rather than memorizing the subject matter. Naval communication organization and functions including supervision of Navy post offices are described in detail. Standard communication procedure and doctrine for visual, radio telegraph and radio telephone procedure are stressed. Practical works are conducted in message drafting, visual signalling and voice-radio telephone procedure. The major aspects of security control, such as classification, custody, transmission, dissemination and security clearances are covered. The study of operational planning includes actual preparation by the students of sample operation plans, communication and frequency plans. Movies, where applicable, are used. The subjects are presented in the following order:

SYLLABUS

	Hours
Communication Organization and Procedures	20
Security of Classified Matter	6
Operational Planning Methods and Procedures	7
Basic Rapid Communication and Frequency Plans	7
	40

MATHEMATICS REVIEW

OBJECTIVE

To provide a review course in order to equip the student for studies and duties requiring knowledge and use of mathematics.

COURSE DESCRIPTION

This course covers enough of the fundamentals of mathematics up to, but not including, the calculus to provide background for all technical subjects to be studied in the line curriculum, the following topics being stressed: slide rule, roots, exponents, factoring, graphs, vectors, and trignometric functions.

SYLLABUS

	Hours
Slide Rule	1
Arithmetical Fundamentals	2
Algebraic Fundamentals	5
Equations, Graphs, Applications	6
Trigonometric Fundamentals	5
	19

MECHANICS REVIEW

OBJECTIVE

To provide a review course in order to equip the student for studies and duties requiring knowledge of, and use of, mechanics.

COURSE DESCRIPTION

This course covers basic units, velocity and acceleration, law of motion, power and energy, pressure and various types of forces.

SYLLABUS

	Hours
Unit and Laws of Motion	3
Power, Energy and Moment of Inertia	3
Miscellaneous Forces	2
	8

ELECTRICAL ENGINEERING

OBJECTIVE

To provide enough of the fundamentals of electrical circuits and machinery to aid the student in understanding the characteristics and operation of ship and aircraft electrical installations and equipment.

COURSE DESCRIPTION

Basic fundamentals of DC and AC circuits are studied as a preparation for the fields of electrical power, naval engineering, communications, CIC, and ordnance and gunnery; in DC and AC machinery, the students are acquainted with the operating characteristics of electrical equipment, such as shunt and compound generators, shunt, series, and compound motors, alternators, transformers, synchronous and induction motors. Laboratory exercises and problems are utilized wherever practicable.

SYLLABUS

	Hours
Resistance; Ohm's Law; Power, Energy; Voltage and Current	4
Voltmeter; Ammeter; DC Measurements	4
Magnetism; Electromagnetism; Inductance; Applications	4
Shunt Generator; Armature Reaction; Characteristics	4
Shunt, Series, and Compound Motor; Applications	4
Alternating Emf; AC Units; AC Power	4
RLC Circuits; Series Resonance	3
Parallel Circuits; AC Instruments	4
Polyphase Systems; Three Phase Power	4
Alternator; Characteristics; Applications	3
Transformers; Connections	2
Induction Motors; Synchronous Motors; Applications	5
	45

ELECTRONICS SURVEY

OBJECTIVE

To provide a survey of electronic devices in order to give the student an elementary knowledge of the fundamentals of electronics and associated equipment.

COURSE DESCRIPTION

This course, utilizing lectures and laboratory work, includes basic theory of electron emission and the operation of the principal common elements of electronic devices.

SYLLABUS

	Hours
Electronic Emission and Power Supplies	2
Multi-element Tubes and Applications	3
Cathode Ray and Gas Tubes	3
Transistors; Oscillators; Modulators	3
R. F. Amplifiers and Detectors	2
Frequency Conversion; Receivers; Control Devices	3
	16

NAVAL ENGINEERING

OBJECTIVES

To give the officer student a basic knowledge of the operation and maintenance of shipboard machinery installations and the effective administration of the Engineering Department so that the student may more efficiently and intelligently discharge his prospective duty as O.O.D., engineering department department officer, executive officer, or commanding officer.

COURSE DESCRIPTION

The Naval Engineering course consists of 48 hours of instruction for all officer students, and an additional 12 hours of instruction for non-aviators. The course covers the entire shipboard machinery installation with special emphasis being placed upon the main propulsion machinery, boilers, and auxiliaries associated with the boilers and propulsion machinery. In addition, distilling plants, diesel engines, refrigeration, electric power distribution and machinery outside of the regular engineering spaces are covered during the course. All instruction is of the lecture type. Extensive use is made of charts, drawings, sectionalized machinery, mock-ups and special training devices. Motion pictures, where applicable, are used throughout the course. The importance of safety precautions, check-off sheets and operating instructions is covered throughout the course. Engineering casualty control is emphasized. In so far as practicable, the instructors relate the material being taught to the experiences of the officer students.

SYLLABUS

Basic Course	Hours
Thermodynamics and the Eng. Plant	4
Boilers and Related Auxiliaries	9
Turbines and Related Auxiliaries	13
Fundamentals of Engineering Plant	8
Distilling Plants, Diesel Engines, Etc.	7
Electrical Installations	3
Administration and Operational Procedures	4
	48

Augumented Course	Hours
Organization, Inspections, Records and Reports	5
Gyro Compass and Degaussing	3
Boiler Maintenance	1
Engineering Trends and Developments	3
	12

DAMAGE CONTROL

OBJECTIVES

To give the officer student a basic knowledge of the principles of damage and casualty control, stability and buoyancy of ships, radiological defense, bological warfare defense and chemical warfare defense; to instruct the officer student in the methods of operation and administration of the Damage Control Department and the maintenance of all material assigned to it.

COURSE DESCRIPTION

The Damage Control course consists of 48 hours of instructions (Basic Course) for all officer students, and an additional 12 hours of instruction (Augmented Course) for non-aviators. The course is divided into three parts, the principles of stability and buoyancy of ships and analysis of impaired stability with corrective measures necessary to restore lost stability; shipboard organization and the material preparedness for damage and casualty control; and radiological, biological and chemical warfare defense. All instruction is of the lecture type. Extensive use is made of charts, drawings, models and motion pictures. The student is required to do various practical stability problems and analyze various stability situations in order to gain a thorough understanding of the problems he might be faced with in the event his own ship were to be seriously damaged. Administration of a damage control organization and its proper functioning is emphasized.

SYLLABUS

Basic Course	Hours
Introduction to Damage Control	1
Nomenclature	1
Stability and Buoyancy	14
Analysis of Damage and Corrective Measures	5
Practical Damage and Casualty Control, Organization and Maintenance of Assigned Material	8
Chemical, Biological and Radiological Warfare Defense	19
	48

Augmented Course	Hours
Warship Construction, Design, and Material Upkeep	2
Stability	4
Analysis of Stability	3
Nucleonics, Chemical, Biological and Radiological Warfare, Etc.	3
	12

ORDNANCE AND GUNNERY

OBJECTIVES

To present a course in ordnance and gunnery, including surface, air, and underwater aspects in order to prepare the officer student for duties directly or indirectly involving armament and its utilization.

COURSE DESCRIPTION

The course is presented to the student by classroom lectures, supplemented by the use of textbooks, motion pictures, classroom training aids and laboratory periods in the Gun and Mount Building. The basic course of 56 hours is given to all students, and covers the theory of the naval gunfire control problem and its application in certain fundamental fire control systems; the various types of naval shipboard and aircraft armament and its control; the care and handling of ammunition, safety precautions, and fundamental operating principles of surface and air-launched rockets and guided missiles. The inspection and observation, in operation, of guns and fire control installations is afforded the student during a short cruise aboard ship in addition to the laboratory hours devoted to individual mount and director study throughout the course. Atomic weapons are covered by a series of special lectures.

An augmented course of 24 hours for non-aviators is designed to offer instruction in and provide discussion time for the consideration of the duties of the gunnery officer afloat.

Problems concerning the precommissioning period, commissioning, shakedown, the training cycle and the regular navy yard overhaul are discussed. The situation is that of an average gunnery officer successfully meeting the problems in a typical combatant ship organization.

SYLLABUS

	Hours
Basic Course	
Introduction	1
Elements of Fire Control	9
Fire Control Systems and Equipment	5
Employment of Shipboard Fire Control	3
Ammunition and Safety Instruction	4
Guns and Assemblies	11
Underwater Ordnance	5
Aviation Ordnance	5
Rockets and Guided Missiles	7
Examinations	6
	56
Augumented Course	
Precommissioning Problems of the Gunnery Officer	1
Gun Mounts and Directors	2
Planning of the Training Program	1
Safety Precaution Instruction	1
Ammunition Handling Instructions	1
Landing Party Organization	1
Battery Alignment Problems	3
Formal Shipboard Inspections	2
Spotting Procedure and Drill	1
Required Exercises and Reports	1
Computation of Initial Ballistics	2
Post Firing Analysis	2
Yard Overhaul Preparations	1
Small Arms	1
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4. Mechanical and Aeronautical Engineering Laboratories—(Building 234)
5. Library and Classroom Building—Mathematics, Aeronautics, Aerology, Mechanical Engineering, Communications—(Building 235)
6. Administration, Open, Closed and General Messes, BOQ—(Building 220)
7. Administrative Offices, General Line School, and BOQ—(Building 222)
8. Interim Classrooms and Offices—(Building 221)
9. Powers Hall—Classrooms—(Building 300)
10. Fleming Hall—Classrooms—(Building 301)
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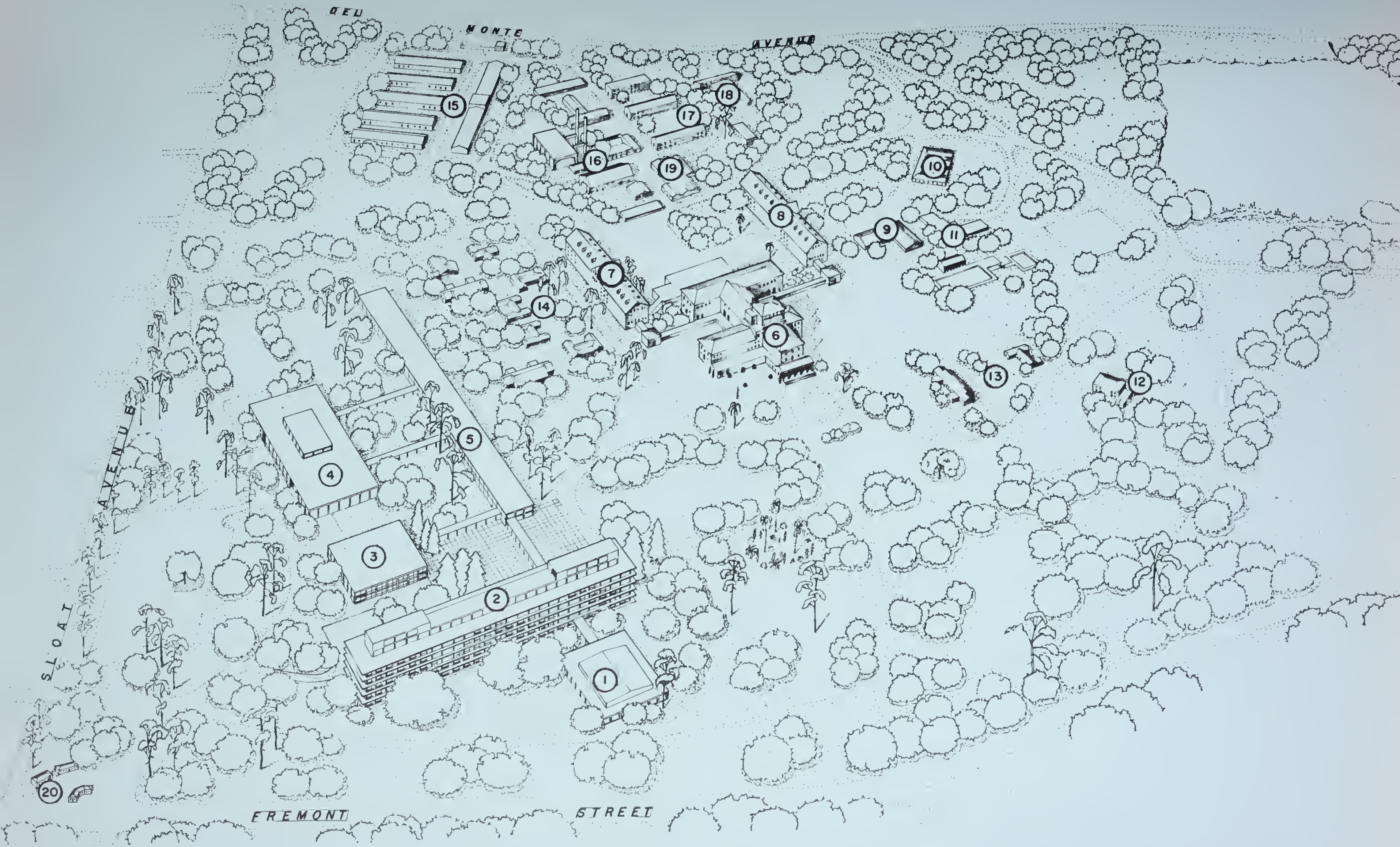
18. Criscuolo Hall—Enlisted Men's Recreation Hall—(Building 211)
19. Supply Department—(Building 206)
20. Navy Exchange Service Station—(Buildings 407, 408, 409)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