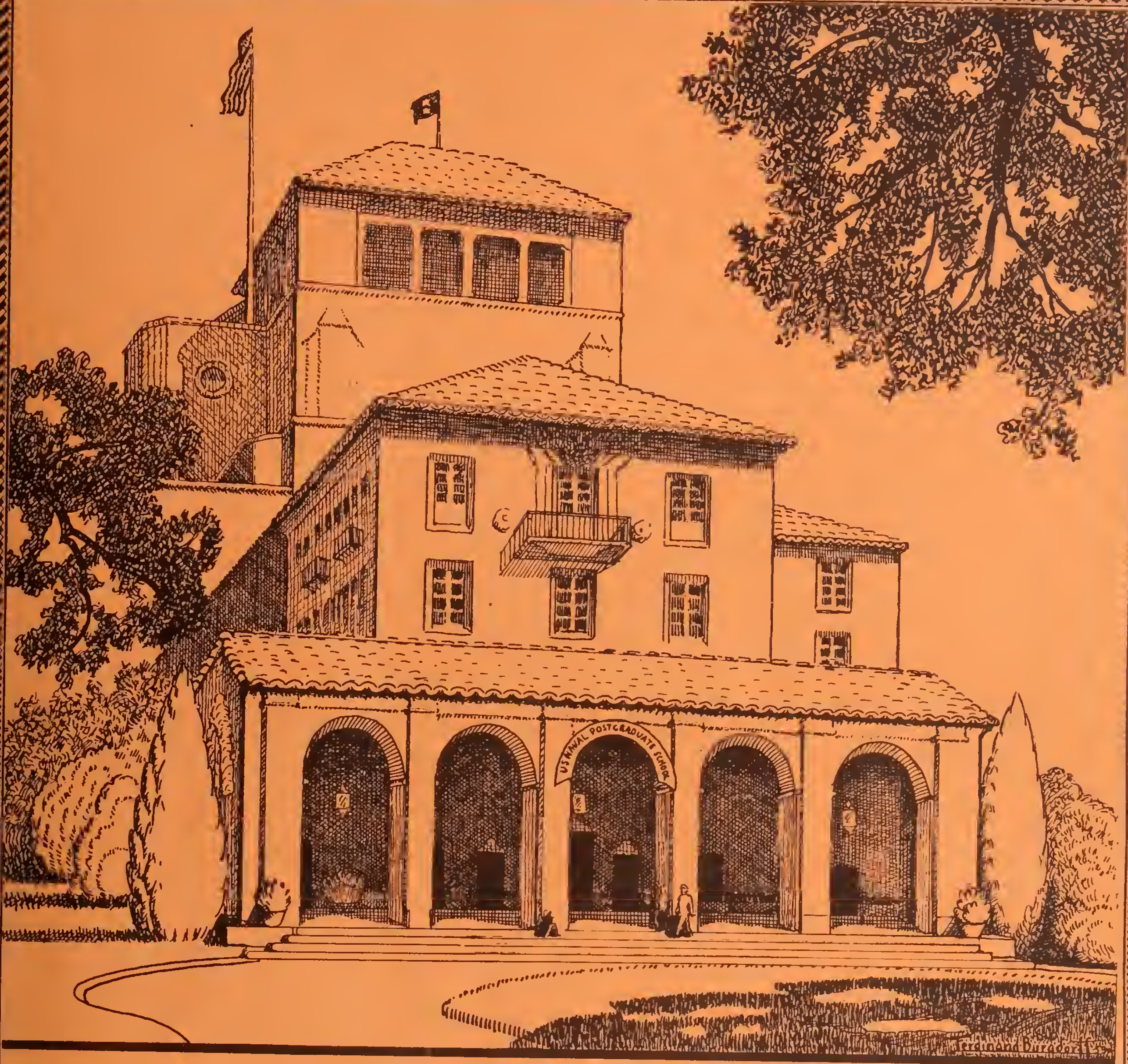
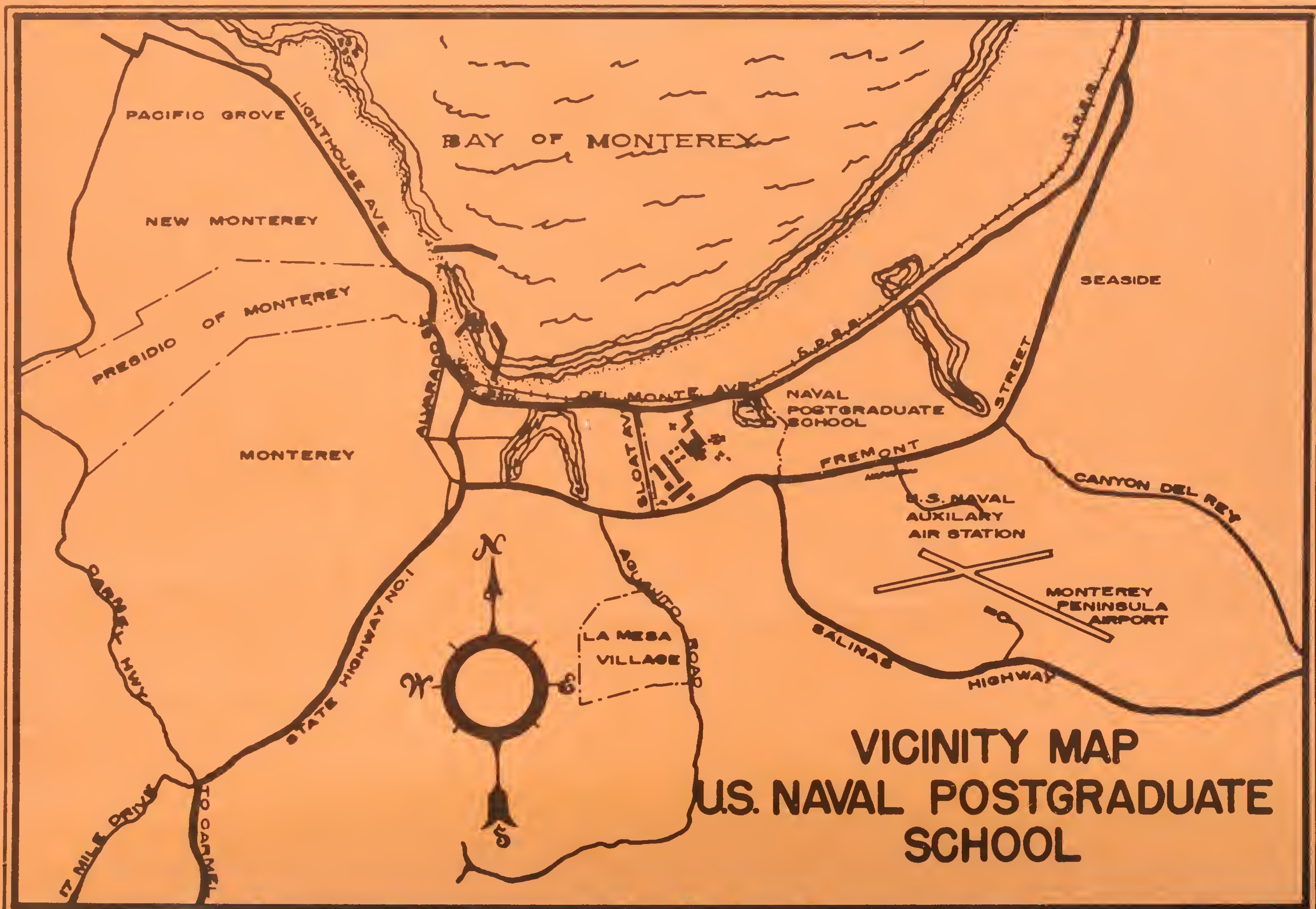


Catalogue of

U. S. NAVAL POSTGRADUATE SCHOOL

Monterey, California

Academic Year 1956-1957



VICINITY MAP
U.S. NAVAL POSTGRADUATE SCHOOL
BAY OF MONTEREY
PACIFIC GROVE
LIGHTHOUSE AVE.
NEW MONTEREY
PRESIDIO OF MONTEREY
MONTEREY
ALVARADO
DEL MONTE AVE
S.P.R.R.
SLOAT AV
NAVAL POSTGRADUATE SCHOOL
FREMONT
STREET
SEASIDE
CANYON DEL REY
U.S. NAVAL AUXILARY AIR STATION
MONTEREY PENINSULA AIRPORT
SALINAS
HIGHWAY
AGUAJITO ROAD
LA MESA VILLAGE
STATE HIGHWAY NO. 1
CARMEL HWY
17 MILE DRIVE
TO CARMEL
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UNITED STATES NAVAL POSTGRADUATE SCHOOL

CATALOGUE for the Academic Year 1956 - 1957

MONTEREY, CALIFORNIA

1 JUNE 1956

12ND P1664

2710—12NDMI 2-20-56—3M

PRINTED BY
TWELFTH NAVAL DISTRICT
PUBLICATIONS AND PRINTING OFFICE

United States Naval Postgraduate School Calendar

Academic Year 1956—1957

1956

General Line School Graduation (Class 1955B and Class 1956A(W))	Wednesday, 20 June
General Line School Registration (Class 1956B(W))	Thursday, 28 June
Independence Day (Holiday)	Wednesday, 4 July
Engineering School First Term Begins	Monday, 6 August
Labor Day (Holiday)	Monday, 3 September
General Line School Registration (Class 1957A and Class 1957A(W))	Tuesday, 4 September
General Line School First Term Begins (Class 1957A)	Monday, 10 September
Engineering First Term Ends	Thursday, 11 October
Engineering School Second Term Begins	Tuesday, 16 October
Veterans Day (Holiday)	Monday, 12 November
General Line School Graduation (Class 1956 and Class 1956B(W))	Wednesday, 14 November
Thanksgiving Day (Holiday)	Thursday, 22 November
Engineering School Second Term Ends	Friday, 21 December
Christmas Leave Period Begins	

• CALENDAR FOR 1956 •

JANUARY

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• CALENDAR FOR 1957 •

JANUARY

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JULY

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AUGUST

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NOVEMBER

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DECEMBER

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1957

Engineering School Third Term Begins	Monday, 7 January
General Line School Classes Resume	
General Line School Registration (Class 1957B and Class 1957B(W))	Tuesday, 29 January
General Line School Graduation (General Line School Class 1957A(W))	Thursday, 31 January
General Line School First Term Begins (Class 1957B)	Monday, 4 February
Washington's Birthday (Holiday)	Friday, 22 February
Engineering School Third Term Ends	Friday, 15 March
Engineering School Fourth Term Begins	Monday, 25 March
Memorial Day (Holiday)	Thursday, 30 May
Engineering School Fourth Term Ends	Friday, 31 May
Engineering School Graduation	Thursday, 6 June
General Line School Graduation (Class 1957A and Class 1957B(W))	Wednesday, 19 June
General Line School Registration (Class 1957C(W))	Thursday, 27 June
Engineering School Academic Year 1957-1958 Begins	Monday, 5 August

TABLE OF CONTENTS

Section I

U. S. NAVAL POSTGRADUATE SCHOOL

Section II

THE ENGINEERING SCHOOL

Section III

THE GENERAL LINE SCHOOL

INDEX

U. S. NAVAL POSTGRADUATE SCHOOL

Superintendent

Earl Everett STONE, Rear Admiral, U. S. Navy

Chief of Staff

Williston Lamar DYE, Captain, U. S. Navy

Academic Dean

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

Director, Engineering School

Earl Tobias SCHREIBER, Captain, U. S. Navy

Director, General Line School

Everett Milton BLOCK, 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 engineering education through its own facilities at Monterey and through a branch at the Submarine School, New London, 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 graduate education.

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

The General Line School offers a nine and one-half month program similar to that which existed prior to World War II and designed to broaden and enhance the mental outlook and professional knowledge of all career line officers upon completion of five to seven years' commissioned service.

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

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

The Electrical Engineering Laboratory.

The Mechanical Engineering Laboratory.

The Aeronautical Engineering Laboratory.

The classroom building is a long, two-story building that also provides space for the Computer Laboratory and for the departments of Aeronautics, Mechanical Engineering, Aerology, and Mathematics and Mechanics. One end of this building houses 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 in the east end of the classroom building (No. 235), is on active collection of some 144,000 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 is a collection of about 4,500 books relating mainly to naval history or to subjects connected with the sea. It contains, among these, many rare or otherwise valuable books, including Sir Walter Raleigh's "Excellent Observations and Notes, Concerning the 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 has been donating books to the School for this Library since 1949.

The Textbook Service contains approximately 80,000 textbooks, reference books and pamphlets in multiple copies, which are issued to students on a term-loan basis and to instructors for an unlimited period. Students are assigned certain specified texts for their courses but may use this Library to obtain related material to use in conjunction with them.

HISTORICAL

The U. S. Naval Postgraduate School had a modest beginning at the Naval Academy at Annapolis in 1909, at which time the first class of ten officers enrolled in a Marine Engineering curriculum. Today, in its location at Monterey, California, approximately 1,000 officer students are enrolled in approximately forty curricula in engineering and related subjects, in the Engineering School and the General Line School. Facilities are being planned and implemented to accommodate a total of 1400 officer students—600 in the Engineering School and 800 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

Secretary of the Navy established a School of Marine Engineering at the Naval Academy in Annapolis. In 1912 the School was designated the Postgraduate Department of the U. S. Naval Academy.

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

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

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

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

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

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

On 22 December 1951, by order of the Secretary of the Navy, the United States Naval Postgraduate School was officially disestablished at Annapolis, Maryland, and established at Monterey, California. This completed the transfer of the School from the East to the West Coast, which had begun in 1948 when the Aerology Department and Curricular office were moved to the new location. Concurrently with this relocation, the U. S. Naval School (General Line) at Monterey was disestablished as a separate military command and its functions and facilities were assumed by the U. S. Naval Postgraduate School. At the same time, there was established the U. S. Naval Administrative Command, U. S. Naval Postgraduate School, Monterey, to provide logistic support, including supply, public works, medical and dental functions, for the Naval Postgraduate School and its components.

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

Earl Tobias SCHREIBER, Captain, U. S. Navy
B.S., USNA, 1929;
Graduate, USNPGS, 1938, Marine Engineering;
U. S. Naval War College, 1950

Assistant to the Director

(To be ordered)

NAVAL STAFF

AEROLOGY CURRICULA

Arthur Albert CUMBERLEDGE
Captain, U. S. Navy
Officer in Charge
B.S., USNA, 1931; M.S., Massachusetts Institute of Technology, 1941.

Charles Ellis TILDEN
Commander, U. S. Navy
Assistant Officer in Charge
Instructor in Aerology
M.S., USNPGS, 1951.

Harvey Franklin SMITH, Jr.
Commander, U. S. Navy
Instructor in Aerology
B.A., LaVerne College, 1941;
M.S., California Institute of Technology, 1946.

Richard Michael CASSIDY
Lieutenant Commander, U. S. Navy
Instructor in Aerology
USNPGS, 1945, Aerological Engineering.

William Wheeler ELAM
Lieutenant Commander, U. S. Navy
Instructor in Aerology
B.S., Ohio University, 1945; M.S., USNPGS, 1948.

John LaCAVA, Jr.
Lieutenant Commander, U. S. Navy
Instructor in Aerology
B.S., Connecticut State Teachers College, 1943; USNPGS, 1950.

Thomas Hall Robinson O'NEILL
Lieutenant, U. S. Navy
Instructor in Aerology
B.A., Mt. St. Mary's College, 1942;
M.S., USNPGS, 1954.

Lester Donald FROM
Chief Aerographer, U. S. Navy
Instructor in Aerology

AERONAUTICAL ENGINEERING CURRICULA

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

John Paul WHEATLEY
Commander, U. S. Navy
Assistant Officer in Charge
B.S., University of Washington, 1938;
M.S., Harvard University, 1939;
Ae. E., California Institute of Technology, 1947.

COMMUNICATIONS CURRICULA

Henry Otto HANSEN
Captain, U. S. Navy
Officer in Charge
B.S., USNA, 1930; USNPGS, 1938, Applied Communications.

Charles Alexander DARRAH
Commander, U. S. Navy
Assistant Officer in Charge
USNPGS, 1944, Applied Communications.

Ned Allen GARDNER
Commander, U. S. Navy
Instructor in Communications

Karl John CHRISTOPH, Jr.
Lieutenant, U. S. Navy
Instructor in Communications
B.S., USNA, 1947 (1948A); USNPGS, 1953, Applied Communications.

ENGINEERING ELECTRONICS CURRICULA

John McGavock GRIDER
Captain, U. S. Navy
Officer in Charge
B.S., USNA, 1932; USNPGS, 1940, Radio Engineering; M.S., Harvard University, 1941.

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

Forrest John GODFREY
Lieutenant (junior grade), U. S. Navy
Electronics Laboratory Officer

NAVAL ENGINEERING CURRICULA

Harold Millar HEMING
Captain, U. S. Navy
Officer in Charge
B.S., USNA, 1930; USNPGS, 1939, Marine Engineering; U. S. Naval War College, 1950.

Schuyler Wilshear BACON
Commander, U. S. Navy
Assistant Officer in Charge
BME, Rensselaer Polytechnic Institute, 1939; M.S., USNPGS, 1950.

Ernest Kenneth BOOTH
Lieutenant Commander, U. S. Navy
Laboratory and Machine Shop Officer

ORDNANCE ENGINEERING CURRICULA

Carter Lowe BENNETT
Captain, U. S. Navy
Officer in Charge
B.S., USNA, 1933; M. S., Massachusetts Institute of Technology, 1942; Industrial College of the Armed Forces, 1953.

Thomas Roderick EDDY
Commander, U. S. Navy
Assistant Officer in Charge and Instructor in Ordnance Engineering
B.S., USNA, 1939; M.S., Massachusetts Institute of Technology, 1947.

George Thomas RAGON
Lieutenant, U. S. Navy
Instructor in Mine Warfare
B.S., NSMMA, 1944; Univ. of Texas, 1951.

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

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

Frank Lionel MARTIN
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 University, 1942; M.S., 1947.

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

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

DEPARTMENT OF AERONAUTICS

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

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

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

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

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

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

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

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

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

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

DEPARTMENT OF ELECTRONICS

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

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

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.
(On leave of absence.)

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.

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.

Marvin Paul PASTEL
Assistant Professor of Electronics (1955)
B.S., Principie College, 1947; M.S. Washington University, 1948.

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.

John Benjamin TURNER, Jr.
Assistant Professor of Electronics (1955)
B.S., University of Arkansas, 1941; M. S., University of California, 1948.

DEPARTMENT OF MATHEMATICS AND MECHANICS

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

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

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

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

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

Hugo Murua MARTINEZ
Assistant Professor; Supervisor of Computation Laboratory (1955)
B.A., Univ. of California, 1952.

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

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

Clay Lamont PERRY, Jr.
Professor of Mathematics and Mechanics (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.

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

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

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.

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

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

Eugene Elias DRUCKER
Associate 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.

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

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

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.

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.Eng., McGill Univ., 1946; M.S., Carnegie Institute of Technology, 1947; Ph.D., University of California, 1955.

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

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

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

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
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.
(On leave of absence.)

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; Ph.D., 1938.

William Peyton CUNNINGHAM
Professor of Physics (1946) Acting Chairman
B.S., Yale Univ., 1928; Ph.D., 1932.

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

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

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

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

Norman Lee OLESON
Professor of Physics (1948)
B.S., Univ. of Michigan, 1935; M.S., 1937; Ph.D., 1940.
(On leave of absence.)

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.

Robert Wingert COOVER
Head Catalog Librarian (1955)
A.B., Univ. of Maryland, (1949)

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

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

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

Marie M. SAKAGUCHI
Acquisitions Librarian (1954)
A.B., San Jose State College, 1953.

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

Mabel C. VAN VORHIS
Technical Reports Cataloger (1955)
A.B., Univ. of California, 1926.

FUNCTIONS

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

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

ORGANIZATION

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

Under the director, the naval administration is provided by 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.

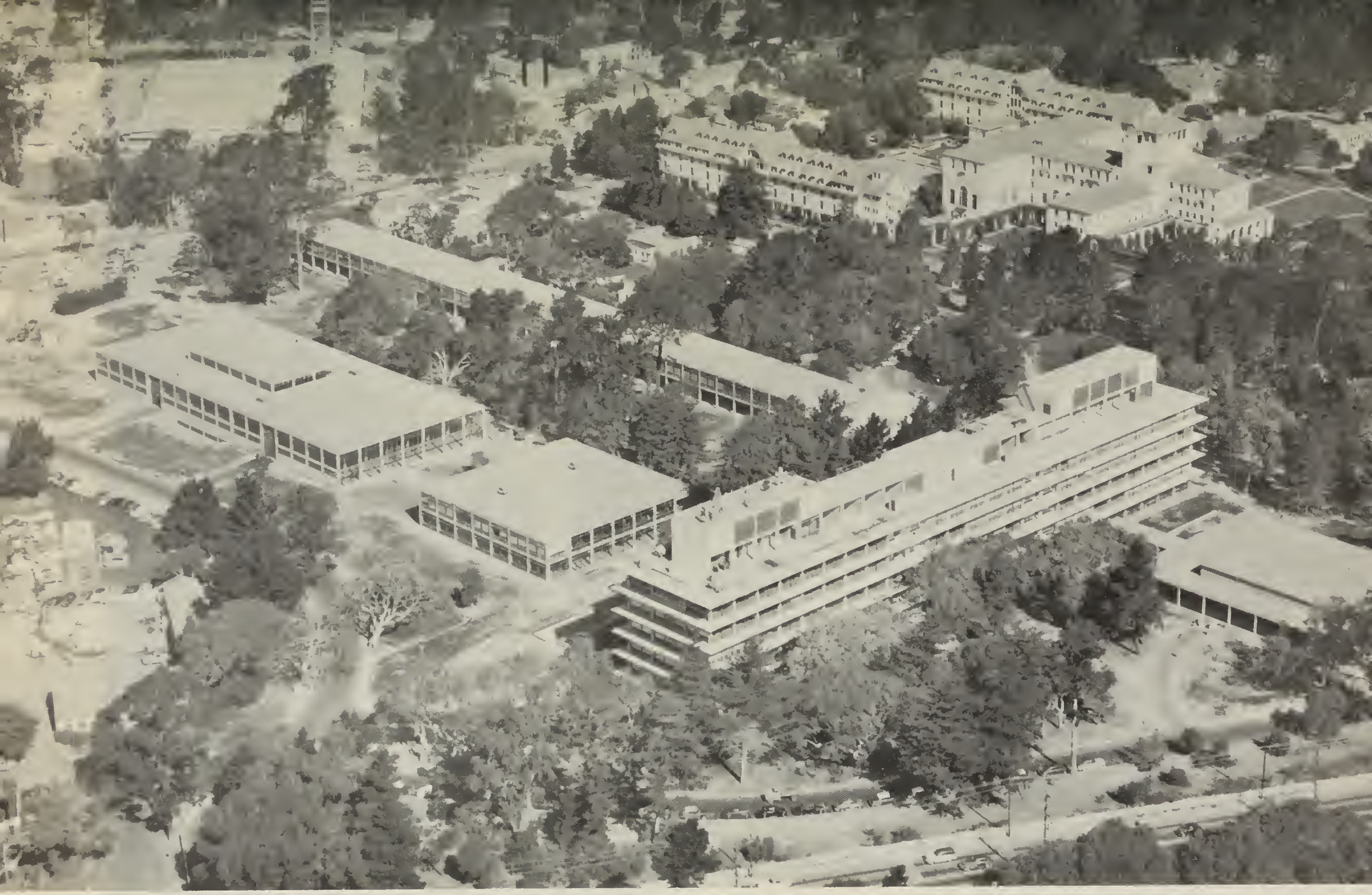
ACADEMIC RECORDS

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).

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.

The Naval Postgraduate School is ideally located on 293 acres extending to Monterey Bay. The new Engineering School buildings are seen on the left and the Administration building at the right.



Aerial photograph of the School showing in the foreground the five new Engineering School buildings, and in the background the Administration Building, General Line School, and Bachelor Officers Quarters.

THE CHAPEL

The letters in parentheses are a measure of the graduate standing of the course as follows:

(A) Full graduate course;
(B) Partial graduate course;
(C) Undergraduate course;
(L) Lecture course—no academic credit.

Course listings include the hours assigned, the hours of recitation first and laboratory second, separated by a dash; e.g., CH-412(C) 3-2. This means three hours of lecture and two hours of laboratory work per week. For credit purposes laboratory hours are 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 deficiencies from this figure may be waived at the discretion of the Academic Council.

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

(2) Requirements for the Master of Science Degree:

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

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

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

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

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

(f) A reasonable proportion of the graduate work leading to the Master's degree shall be composed of research and a thesis reporting the results obtained. The thesis topic 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.

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

LABORATORY FACILITIES AND EQUIPMENT OF THE ENGINEERING SCHOOL

Extensive laboratory experimentation is carried on at the Engineering School in connection with the instructional and research programs of the various departments. The experimental facilities 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, bio-physics, and solid state physics.

The laboratory facilities include a two-million volt Van de Graaff nuclear accelerator, a Collins liquid helium cryostat, a large grating spectrograph having a resolving power of 170,000, a completely automatic infra-red spectrograph, a medium size anechoic (echo-free) chamber, a small reverberation chamber, and a multiple-unit acoustics laboratory for student experimentation in airborne acoustics.

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

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

Facilities for the study of subsonic technical aerodynamics are centered about 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.

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

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

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

In the **Electrical Engineering** laboratories, facilities are provided for instruction and research in servomechanisms, electronics, electrical machinery and circuits. The laboratories are equipped with many duplicate sets of equipment for performing all standard experiments. Additional items of special equipment include a five-unit harmonic set, a high-voltage set, a Schering Bridge, an analog computer (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 **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.

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

The equipment of the Mathematics and Mechanics Department includes comprehensive computation facilities for use in the instruction and research program of the 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 above the surface; radiosonde equipment whereby pressure, temperature and humidity information is transmitted to ground via radio signals from heights that may extend above 100,000 feet; a wiresonde that measures air temperature and humidity conditions in the lower strata of the atmosphere, an inversion meter designed for remote recordings of free air temperature at designated heights in the boundary layer; a bathythermograph for recording sea temperature gradients; a weather configurated aircraft equipped as a flying classroom; and a shore wave recorder for measuring wave heights and periods.

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. Coonan
Mathematics (Applied)	RM	3 yrs.	Engineering Electronics	Prof. Church
Metallurgy	RMt	3 yrs.	Engineering Electronics	Prof. Coonan
Physics (General)	RP	3 yrs.	Engineering Electronics	Prof. Frey
Physics (Nuclear)	RX	3 yrs.	Engineering Electronics	Prof. Frey
Aerology	M	1 yr.	Aerology	Prof. Duthie
Aerology	MA	1½ yrs.	Aerology	Prof. Duthie
Aerology	MM	2 yrs.	Aerology	Prof. Duthie
Advanced Aerology	MS	1½ yrs.	Aerology	Prof. Duthie
Advanced Aerology	MMS	2 yrs.	Aerology	Prof. Duthie
Aeronautical Engineering				
Aerodynamics	AC	3 yrs.	Aeronautical Engineering	Prof. Coates
Aero-Hydrodynamics	AH	3 yrs.	Aeronautical Engineering	Prof. Coates
Electrical	AE	3 yrs.	Aeronautical Engineering	Prof. Vivell
Flight Performance	AF	3 yrs.	Aeronautical Engineering	Prof. Higgins
General	AG	2 yrs.	Aeronautical Engineering	Prof. Coates
General	A	3 yrs.	Aeronautical Engineering	Prof. Coates
Guided Missiles and Armament Control	AR	3 yrs.	Aeronautical Engineering	Prof. Thaler
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
Structures	AS	3 yrs.	Aeronautical Engineering	Prof. Coates
Command Communications	C	2 yrs.	Communications	Prof. Giet
Elements of Management and Industrial Engineering	IE	6, 8 wks.	Aeronautical Engineering	
Engineering Electronics	E	3 yrs.	Engineering Electronics	Prof. Giet
Engineering Electronics (Acoustics)	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
(Nuclear Power)	NN	3 yrs.	Naval Engineering	Prof. Drucker
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	O	2 yrs.	Ordnance Engineering	Prof. Bleick
Guided Missiles	OG	3 yrs.	Ordnance Engineering	Prof. Faulkner
Industrial	OI	3 yrs.	Ordnance Engineering	
Jet Propulsion	OJ	3 yrs.	Ordnance Engineering	Prof. Bleick
Special Physics	OX	3 yrs.	Ordnance Engineering	Prof. Frey
Underwater Ordnance	OU	3 yrs.	Ordnance Engineering	Prof. Kinsler

TABLE II

CURRICULA CONDUCTED ENTIRELY AT OTHER INSTITUTIONS

Curriculum	Group Desig.	Length	Institution	Cognizant Curr. Officer	Liaison Official
Business Administration	ZKH	2 yrs.	Harvard	Communications	PNS
Business Administration	ZKM	1 yr.	Michigan	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	Communications	PNS
Comptrollership	ZS	10 mos.	GWU	Communications	Prof. A. R. Johnson
Hydrographic Engineering	ZV	1 yr.	Ohio State	Aerology	PNS
Management & Industrial Engineering	ZT	1 yr.	RPI	Naval Engineering	PNS
Metallurgical Engineering	ZNM	9 mos.	Carnegie Inst. of Tech.	Naval Engineering	Assoc. Prof. J. W. Ludewig
Naval Construction and Marine Engineering	ZNB	3 yrs.	Webb Inst.	Naval Engineering	Capt. F. X. Forrest, USN (Ret.)
Naval Construction and Engineering	ZNB	3 yrs.	MIT	Naval Engineering	CO, NavAdmin Unit
Naval Intelligence	ZI	6 mos.	Naval Intell. School	Staff Secretary	CO
Nuclear Engineering (Advanced)	ZNE	15 mos.	MIT	Naval Engineering	CO, NavAdmin Unit
Oceanography	ZO	1 yr.	Univ. of Washington	Aerology	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	1 yr.	Various	Communications	Various
Special Mathematics	ZMI	2 yrs.	Illinois	Communications	PNS
Textile Engineering	ZM	2 yrs.	Georgia Inst. of Tech.	Communications	PNS

NOTE: CO signifies the Commanding Officer.
PNS signifies the Professor of Naval Science.
An outline of each curriculum listed above is given on page 74 et seq.

THE ENGINEERING SCHOOL

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.

ADVANCED MATHEMATICS

Officer students in any of the Engineering School curricula may, under special conditions, be afforded the opportunity to qualify for the degree of Master of Science with major in mathematics. This will require minor modifications, consistent with the objective of the officer's curriculum, designed to provide a working knowledge of one field of mathematics, a well-rounded background in three of the major fields of mathematics, and a well-founded study of some related field. Request for such modification should show that it is consistent with the objective of the officer student's curriculum and is of benefit to the Navy, and it must be approved by the Superintendent and the Chief of Naval Personnel.

1. To be eligible for this modification of curriculum the student should have passed one of the basic four-term engineering-mathematics sequences (e.g. Ma-120, Ma-121, Ma-122, Ma-123, Ma-124), or equivalent, with satisfactory grades (QPA of 2.0 or better). Courses in these sequences, designated as partial or whole graduate credit courses toward engineering degrees, will not be so considered in meeting the following requirements unless approved for such credit by the chairman of the department before commencing the course.

2. The required minimum of 48 term hours of courses at the graduate level will be distributed as nearly as practicable in the following way:

   A. A minimum of 15 term hours of graduate credit in courses so chosen that not less than four term hours of graduate credit will be earned in each of three of the following branches of mathematics: a. algebra, b. geometry, c. analysis, and d. applied mathematics (statistics, probability, computational methods, game theory, etc.).

   B. In addition to the above, two or more courses in the general subject chosen for specialization, carrying a total of not less than six term hours of graduate credit. It is expected that the thesis will be written on a topic in the field of this subject, and these courses may be taken fairly late in the curriculum.

   C. A thesis, demonstrating the student's ability to locate and master with very little assistance the subject matter directly involved in the thesis topic, to organize it, to add to it if possible, and to present it systematically in appropriate literary, scientific, and scholarly form. The work on this project will, in general, be spread over two terms and receive eight term hours of graduate credit.

   D. Not less than twelve graduate credit term hours in some related field which the candidate shall present as a minor.

3. The thesis director, topic, and subject of specialization shall be chosen, with the consent of the chairman of the department, as early as possible (but in all events, not later than two terms prior to the time for granting the degree). Minor departures from the preceding requirements may be authorized by the Chairman of the Department of Mathematics and Mechanics.

ADVANCED SCIENCE CURRICULA

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

OBJECTIVE

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

(GROUP DESIGNATOR MA)

OBJECTIVE

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

FIRST YEAR (MA1)

FIRST TERM

Ma-161(C)	Algebra, Trigonometry, and Analytic Geometry	5-0
Mr-200(C)	Introduction to Meteorology	3-0
Mr-201(C)	Weather Codes and Elementary Map Analysis	3-9
Ph-190(C)	Survey of Physics I	3-0
		14-9

SECOND TERM

Ma-162(C)	Introduction to Calculus	5-0
Mr-202(C)	Weather-Map Analysis	3-9
Mr-510(C)	Climatology	2-0
Ph-191(C)	Survey of Physics II	3-0
		13-9

THIRD TERM

Ma-163(C)	Calculus and Vector Analysis	4-0
Mr-203(C)	Weather Analysis and Prognosis	2-9
Mr-301(B)	Elementary Dynamic Meteorology I	4-0
Mr-402(C)	Introduction to Meteorological Thermodynamics	3-2
IT-101(L)	Industrial and Technical Lectures I	0-1
		13-12

FOURTH TERM

Ma-381(C)	Elementary Probability and Statistics	4-2
Mr-204(C)	Upper-Air Analysis and Forecasting	2-9
Mr-302(B)	Elementary Dynamic Meteorology II	3-0
Oc-120(B)	General Oceanography	4-0
IT-102(L)	Industrial and Technical Lectures II	0-1
		13-12

During intersessional period students engage in synoptic laboratory work and visit naval and civilian installations.

SECOND YEAR (MA2)

FIRST TERM

Mr-215(B)	Advanced Weather Analysis and Forecasting	2-12
Mr-220(B)	Selected Topics in Applied Meteorology	4-0
Mr-403(B)	Introduction to Micro-meteorology	3-0
Mr-410(C)	Meteorological Instruments	2-2
Mr-610(B)	Sea and Swell Forecasting	2-2
		13-16

SECOND TERM

Mr-110(C)	Aerological Aspects of ABC Warfare	3-0
Mr-216(B)	Advanced Weather Analysis and Forecasting	3-0
Mr-217(B)	Advanced Weather Analysis and Forecasting	0-16
Oc-213(B)	Shallow-Water Oceanography	3-0
Oc-620(B)	Oceanography Factors in Underwater Sound	3-0
		12-16

Interested officer students who have the necessary academic qualifications will be reassigned to the MM Curriculum listed on page 31.

AEROLOGY

(GROUP DESIGNATOR M)

OBJECTIVE

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

FIRST YEAR (M1)

FIRST TERM

Ma-163(C)	Calculus and Vector Analysis	4-0
Mr-200(C)	Introduction to Meteorology	3-0
Mr-211(C)	Weather Codes, Maps, and Elementary Map Analysis	2-12
Mr-402(C)	Introduction to Meteorological Thermodynamics	3-2
Mr-400(C)	Introduction to Meteorological Instruments	2-0
		14-14

SECOND TERM

Ma-381(C)	Elementary Probability and Statistics	4-2
Mr-212(C)	Surface and Upper-Air Analysis	4-12
Mr-311(B)	Introduction to Dynamic Meteorology	5-0
		13-14

THIRD TERM

Mr-213(C)	Upper Air and Surface Prognosis	3-12
Mr-220(B)	Selected Topics in Applied Meteorology	4-0
Mr-403(B)	Introduction to Micro-meteorology	3-0
Mr-500(C)	Introduction to Climatology of the Oceans and Atmosphere	3-0
		13-12

FOURTH TERM

Mr-110(C)	Aerological Aspects of ABC Warfare	3-0
Mr-205(C)	Forecasting Weather Elements and Operational Routines	4-4
Mr-217(B)	Advanced Weather Analysis and Forecasting	0-16
Mr-610(B)	Sea and Swell Forecasting	2-2
		9-22

A certificate is awarded upon satisfactory completion of this curriculum.

AEROLOGY

(GROUP DESIGNATOR MM)

OBJECTIVE

To prepare officers to become qualified aerologists with a working knowledge of oceanography as applied to naval operations and to enable them through advanced study to devise and carry out aerological investigations.

Designed for officers students chosen from the MA Curriculum listed on page 30 whose academic performance and records qualify them for advanced studies.

(FIRST YEAR MM1)

FIRST TERM

Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-121(C)	Introduction to Engineering Mathematics	3-1
Mr-200(C)	Introduction to Meteorology	3-0
Mr-201(C)	Weather Codes and Elementary Map Analysis	3-9
Ph-197(C)	Review of Physics I	3-0
		14-11

SECOND TERM

Ma-122(B)	Differential Equations and Vector Calculus	5-0
Mr-202(C)	Weather-Map Analysis	3-9
Mr-510(C)	Climatology	2-0
Ph-198(C)	Review of Physics II	3-0
		13-9

THIRD TERM

Ma-123(A)	Orthogonal Functions and Partial Differential Equations	5-0
Mr-203(C)	Weather Analysis and Prognosis	2-9
Mr-411(B)	Thermodynamics of Meteorology	5-2
Oc-110(C)	Introduction to Oceanography	3-0
IT-101(L)	Industrial and Technical Lectures I	0-1
		15-12

FOURTH TERM

Ma-330(C)	Introduction to Statistics	2-0
Ma-125(B)	Numerical Methods for Digital Computers	2-2
Mr-204(C)	Upper-Air Analysis and Forecasting	2-9
Mr-321(A)	Dynamic Meteorology I	3-0
Mr-412(A)	Physical Meteorology	3-0
Mr-410(C)	Meteorological Instruments	2-2
Oc-210(B)	Physical Oceanography	2-1
IT-102(L)	Industrial and Technical Lectures II	0-1
		13-15

During intersessional period students engage in synoptic laboratory work and visit naval and civilian installations.

SECOND YEAR (MM2)

FIRST TERM

Ma-331(A)	Statistics	4-2
Mr-215(B)	Advanced Weather Analysis and Forecasting	2-9
Mr-322(A)	Dynamic Meteorology II	3-0
Mr-412(A)	Physical Meteorology	3-0
Oc-620(B)	Oceanographic Factors in Underwater Sound	3-0
		15-11

SECOND TERM

Mr-216(B)	Advanced Weather Analysis and Forecasting	3-0
Mr-217(B)	Advanced Weather Analysis and Forecasting	0-16
Mr-229(B)	Selected Topics in Meteorology	2-0
Mr-323(A)	Dynamic Meteorology III	3-0
Mr-520(B)	Applied Climatology	2-2
		10-18

THIRD TERM

Ma-421(A)	Digital and Analog Computation	3-2
Mr-110(C)	Aerological Aspects of ABC Warfare	3-0
Mr-422(A)	The Upper Atmosphere	5-0
Mr-610(B)	Sea and Swell Forecasting	2-2
	Thesis I	2-6
IT-101(L)	Industrial and Technical Lectures I	0-1
		15-11

FOURTH TERM

Mr-218(B)	Tropical Analysis and Forecasting	0-9
Mr-228(B)	Southern Hemisphere and Tropical Meteorology	2-0
Mr-810(A)	Seminar in Meteorology and Oceanography	2-0
Oc-213(B)	Shallow-Water Oceanography	3-0
	Thesis II	4-0
IT-102(L)	Industrial and Technical Lectures II	0-1
		11-10

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

ADVANCED AEROLOGY

(GROUP DESIGNATOR MMS)

OBJECTIVE

To prepare officers to become qualified aerologists with a working knowledge of oceanography as applied to naval operations and to enable them through advanced study to devise and carry out aerological investigations.

FIRST YEAR (MMS1)

FIRST TERM

Ma-163(C)	Calculus and Vector Analysis	4-0
Mr-200(C)	Introduction to Meteorology	3-0
Mr-211(C)	Weather Codes, Maps, and Elementary Map Analysis	2-12
Mr-402(C)	Introduction to Meteorological Thermodynamics	3-2
Mr-410(C)	Meteorological Instruments	2-2
		14-16

SECOND TERM

Ma-381(C)	Elementary Probability and Statistics	4-2
Mr-212(C)	Surface and Upper-Air Analysis	4-12
Mr-311(B)	Introduction to Dynamic Meteorology	5-0
		13-14

THIRD TERM

Oc-120(B)	General Oceanography	4-0
Mr-213(C)	Upper-Air and Surface Prognosis	3-12
Ma-131(C)	Algebraic Equations and Series	3-0
Ma-132(C)	Topics in Engineering Mathematics	5-0
		15-12

FOURTH TERM

Ma-123(A)	Orthogonal Functions and Partial Differential Equations	5-0
Mr-411(B)	Thermodynamics of Meteorology	5-2
Mr-412(A)	Physical Meteorology	3-0
Oc-620(B)	Oceanographic Factors in Underwater Sound	3-0
		16-2

During intersessional period students will be instructed in aerological organization and operational routines, engage in synoptic laboratory work, and visit naval and civilian installations.

SECOND YEAR (MMS2)

FIRST 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-610(B)	Sea and Swell Forecasting	2-2
IT-101(L)	Industrial and Technical Lectures I (Lecture)	0-1
		14-12

SECOND TERM

Ma-331(A)	Statistics	4-2
Mr-227(B)	Upper-Air Analysis and Forecasting	2-9
Mr-229(B)	Selected Topics in Meteorology	2-0
Mr-322(A)	Dynamic Meteorology II	3-0
Mr-323(A)	Dynamic Meteorology III	3-0
IT-102(L)	Industrial and Technical Lectures II (Lecture)	0-1
		14-12

THIRD TERM

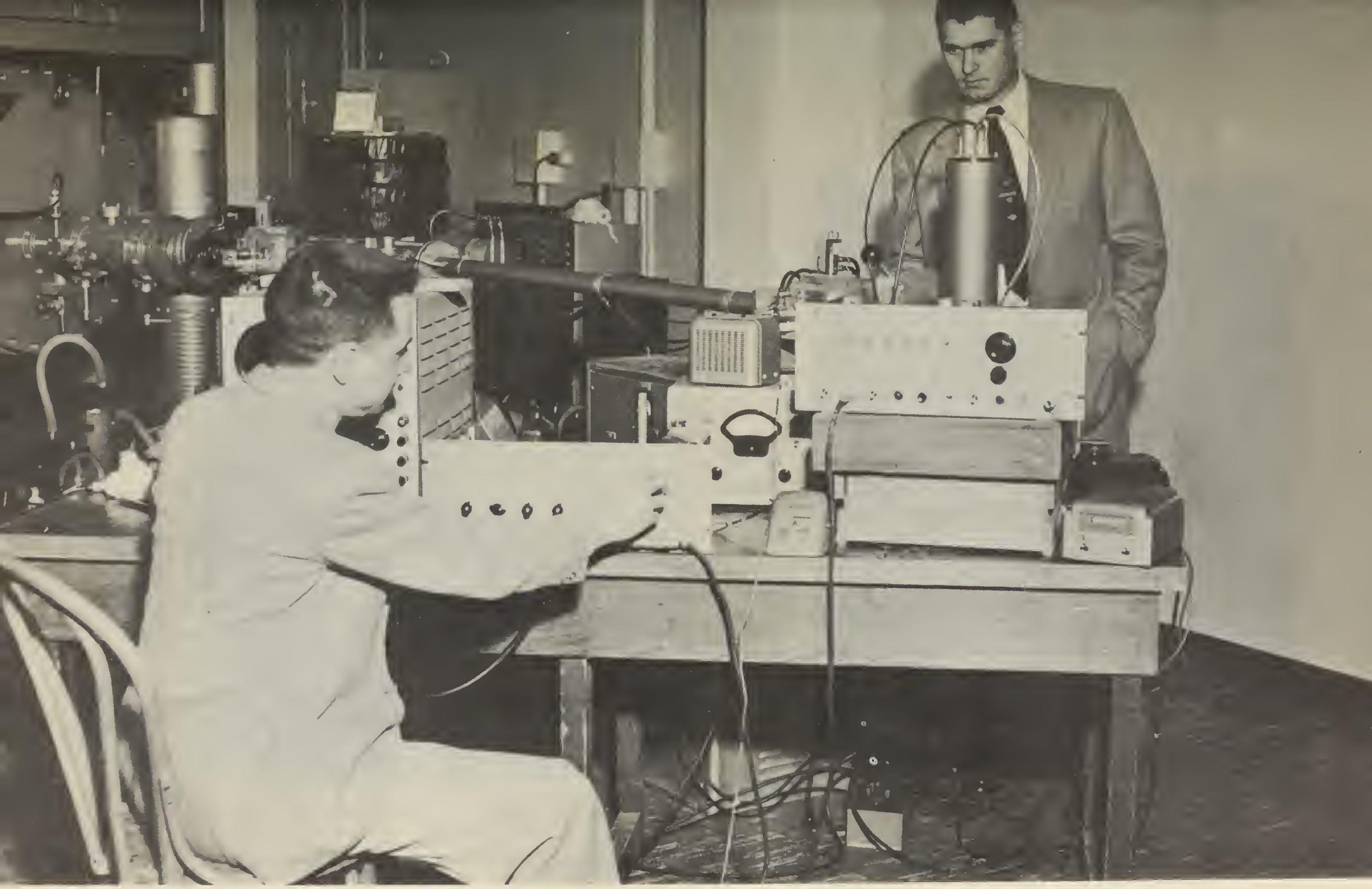
Ma-135(B)	Differential Equations and Numerical Methods	4-1
Mr-422(A)	The Upper Atmosphere	5-0
Mr-520(B)	Applied Climatology	2-2
	Thesis I	2-6
		13-9

FOURTH TERM

Mr-110(C)	Aerological Aspects of ABC Warfare	3-0
OC-213(B)	Shallow-Water Oceanography	3-0
Mr-230(A)	Operational Forecasting	0-10
Mr-810(A)	Seminar in Meteorology and Oceanography	2-0
	Thesis II	4-0
		12-10

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

The only group of students to be enrolled in this curriculum convened in January 1956.



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

Taking measurements of sound in the Anechoic Chamber.

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

AEROLOGY CURRICULUA

ADVANCED AEROLOGY

(GROUP DESIGNATOR MS)

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 (MS1)

FIRST TERM

Ma-131(C)	Algebraic Equations and Series	3-0
Ma-132(C)	Topics in Engineering Mathematics	5-0
Oc-120(B)	General Oceanography	4-0
Ph-196(C)	Review of General Physics	5-0
		17-0

SECOND TERM

Ma-123(A)	Orthogonal Functions and Partial Differential Equations	5-0
Mr-411(B)	Thermodynamics of Meteorology	5-2
Mr-412(A)	Physical Meteorology	3-0
Oc-620(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-610(B)	Sea and Swell Forecasting	2-2
IT-101(L)	Industrial and Technical Lectures 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-229(B)	Selected Topics in Meteorology	2-0
Mr-322(A)	Dynamic Meteorology II	3-0
Mr 323(A)	Dynamic Meteorology III	3-0
IT-102(L)	Industrial and Technical Lectures II (Lecture)	0-1
		14-12

During intersessional period students engage in research investigations and visit naval and civilian installations.

SECOND YEAR (MS2)

FIRST TERM

Ma-135(B)	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	3-0
Oc-213(B)	Shallow-Water Oceanography	3-0
Mr-230(A)	Operational Forecasting	0-10
Mr-810(A)	Seminar in Meteorology and Oceanography	2-0
	Thesis II	4-0
		12-10

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

The last group of students to be enrolled in this curriculum convened in January 1956.

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

(GROUP DESIGNATOR A OR AG)

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. The last two terms at Monterey are modified to provide preparation for these specialty studies. Satisfactory completion of two years at the Naval Postgraduate School normally leads to the award of a B.S. degree in Aeronautical Engineering. The three-year curricula afford the opportunity to qualify for graduate degrees.

FIRST YEAR (A1)
(Includes AG)

FIRST TERM

Ae-200(C)	Rigid Body Statics	3-2
Ch-121 B)	General and Petroleum Chemistry	4-2
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
		15-8

SECOND TERM

Ae-100(C)	Basic Aerodynamics	3-4
Ae-211(C)	Strength of Materials	4-0
Ma-112(B)	Differential Equations and Infinite Series	5-0
Mc-102(C)	Engineering Mechanics II	2-2
Mt-201(C)	Introduction to Physical Metallurgy	3-2
Ae-001(L)	Aeronautical Lecture	0-1
		17-9

THIRD TERM

Ae-121(C)	Technical Aerodynamics	3-2
Ae-212(C)	Stress Analysis I	4-2
EE-111(C)	Fundamentals of Electrical Engineering	3-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
IT-101(L)	Industrial and Technical Lectures I	0-1
		16-9

FOURTH TERM

Ae-131(C)	Technical Aerodynamics, Performance I	4-2
Ae-213(B)	Stress Analysis II	4-2
Ae-409(C)	Thermodynamics I (Aeronautical)	4-2
Ma-114(A)	Functions of a Complex Variable and Vector Analysis	3-0
ME-601(C)	Materials Testing Laboratory	0-2
IT-102(L)	Industrial and Technical Lectures II	0-1
		15-9

Note: Approximately four weeks of the intersessional period will be spent in the field at aviation activities.

SECOND YEAR (AG2 and AI2)

FIRST TERM

Ae-132(B)	Technical Aerodynamics, Performance II	3-2
Ae-311(C)	Airplane Design I	2-4
Ae-410(B)	Thermodynamics II (Aeronautical)	3-2
Ae-501(A)	Hydro-Aero Mechanics I	4-0
EE-241(C)	AC Circuits	3-2
		15-10

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
IT-101(L)	Industrial and Technical Lectures I	0-1
		11-15

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
IT-102(L)	Industrial and Technical Lectures II	0-1
		8-13

Intersessional period: Course IE-102(C)—Elements of Management and Industrial Engineering at USNPGS, Monterey.

SECOND YEAR (A2)

FIRST TERM

Ae-132(B)	Technical Aerodynamics, Performance II	3-2
Ae-311(C)	Airplane Design I	2-4
Ae-410(B)	Thermodynamics II (Aeronautical)	3-2
Ae-501(A)	Hydro-Aero Mechanics I	4-0
Ma-115(A)	Differential Equations for Automatic Control	3-0
		15-8

SECOND TERM

Ae-141(A)	Aircraft Dynamics I	3-4
Ae-214(A)	Stress Analysis III	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

(AC-2, AF-2, AH-2, A2*)

Ae-142(A)	Aircraft Dynamics	3-4
Ae-421(B)	Aircraft Propulsion	3-2
Ae-503(A)	Compressibility I	4-0
EE-241(C)	AC Circuits	3-2
Ma-125(B)	Numerical Methods for Digital Computers	2-2
IT-101(L)	Industrial and Technical Lectures I	0-1
		15-11

FOURTH TERM

(AC-2, AF-2, AH-2, A2*)

Ae-431(A)	Aerothermodynamics of Turbomachines	4-1
Ae-504(A)	Compressibility II	3-2
EE-711(C)	Electronics	3-2
Ma-421(A)	Digital and Analog Computation	3-2
Mc-311(A)	Vibrations	3-2
IT-102(L)	Industrial and Technical Lectures II	0-1
		16-10

*See Table I for Curricula Titles.

THIRD TERM

(AN-2*)

Ae-142(A)	Aircraft Dynamics II	3-4
Ae-421(B)	Aircraft Propulsion	3-2
Ch-541(A)	Reaction Motors	2-2
Mt-301(A)	High Temperature Metals	3-0
Ph 640(B)	Atomic Physics	3-0
Ph-641(B)	Atomic Physics Lab	0-3
IT-101(L)	Industrial and Technical Lectures	0-1
		14-12

FOURTH TERM

(AN-2*)

Ae-431(A)	Aerothermodynamics of Turbomachines	4-1
Ae-508(A)	Compressibility	3-2
Ch-561(A)	Physical Chemistry	3-2
Mc-311(A)	Vibrations	3-2
Ph-642(B)	Nuclear Physics	4-0
IT-102(L)	Industrial and Technical Lectures	0-1
		17-8

THIRD TERM

(AP-2, AJ-2*)

Ae-142(A)	Aircraft Dynamics II	3-2
Ae-421(B)	Aircraft Propulsion	3-2
Ae-503(A)	Compressibility I	4-0
Ch-541(A)	Reaction Motors	2-2
Ma-125(B)	Numerical Methods for Digital Computers	2-2
IT-101(L)	Industrial and Technical Lectures I	0-1
		14-11

FOURTH TERM

(AP-2, AJ-2*)

Ae-431(A)	Aerothermodynamics of Turbomachines	4-1
Ae-504(A)	Compressibility II	3-2
Ch-581(A)	Chemistry of Special Fuels	2-2
Ma-421(A)	Digital and Analog Computation	3-2
Mc-311(A)	Vibrations	3-2
IT-102(L)	Industrial and Technical Lectures II	0-1
		15-10

THIRD TERM

(AS-2*)

Ae-142(A)	Aircraft Dynamics II	3-4
Ae-421(B)	Aircraft Propulsion	3-2
Ae-508(A)	Compressibility	3-2
Ma-125(B)	Numerical Methods for Digital Computers	2-2
IT-101(L)	Industrial and Technical Lectures I	0-1
		11-11

FOURTH TERM

(AS-2*)

Ae-431(A)	Aerothermodynamics of Turbomachines	4-1
Ae-215(A)	Advanced Stress Analysis	4-0
Ma-421(A)	Analog and Digital Computation	3-2
Mc-311(A)	Vibrations	3-2
Me-622(B)	Experimental Stress Analysis	2-2
IT-102(L)	Industrial and Technical Lectures II	0-1
		16-8

*See Table I for Curricula Titles.

Intersessional period: Course IE-102(C)—Elements of Management and Industrial Engineering at USNPGS, Monterey.

THIRD YEAR CURRICULA

Aeronautical Engineering, General

THIRD YEAR (A3) AT THE UNIVERSITY OF MICHIGAN

Ae-102 Advanced Design
115 Theory of Thin Airfoils
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 to Nuclear Engineering
201 Dynamics of Viscous Fluids
202 Dynamics of Compressible Fluids
210 Advanced Engineering Measurements
212 Control of Guidance 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 and Solution of Nonlinear Systems
261 Gas Dynamics
262 Combustion and Flame Propagation
275 Advanced Applications of the Differential Analyzer
295 Theory of Nuclear Reactors

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 YEARS (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) AT 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 Aeroelasticity
AE-565 Airplane Dynamics
AE-567 Helicopter Analysis
AE-594 Advanced Airplane Performance
Thesis

SPRING TERM

AE-566 Airplane Dynamics
AE-594 Advanced Stability and Control
*AE-562 Aeroelasticity
*AE-568 Helicopter Analysis
*EE-518 Servomechanisms
*Instrumentation Seminar
Thesis

*Elect any two.

Aeronautical Engineering, Aero-Hydrodynamics

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

FALL TERM

Ae-229 Aircraft Vibration and Flutter (NYU)
FD-279 Mechanics of Compressible Fluids
FD-400a Hydrodynamic Design of Seaplane I
FD-400 Special Problems in Fluid Dynamics
FD-500 Thesis in Fluid Dynamics

SPRING TERM

Ae-230 Aircraft Vibration and Flutter (NYU)
FD-280 Application of Supersonic Fluid Dynamics
FD-400b Hydrodynamic Design of Seaplane II
FD-400 Special Problems in Fluid Dynamics
FD-500 Thesis in Fluid Dynamics

This curriculum is subject to further revision when a sufficient number of students makes presentation of certain specialized courses possible.

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-592 Adv. Industrial Engineering Problems
PSY-574 Psychology of Industrial Training
GE-698 Thesis
*GE-583 Plant Layout
*GE-576 Adv. Motion and Time Study
*GE-694 Research in Industrial Relations

*Elect one.

THIRD YEAR (AI3) AT RENSSELAER POLYTECHNIC INSTITUTE

SUMMER TERM

T 6.32 Motion and Time Study
G 6.30 Law for Engineers

FALL TERM

T 6.27 Statistical Methods
T 6.28 Cost Finding and Control
T 6.34 Production Planning and Control
G 6.60 Organization Planning and Development
T 3.26 Personnel Tests and Measurements

SPRING TERM

G 6.21 Cost Analysis
G 6.40 Advanced Motion and Time Study
G 6.45 Industrial Relations
G 6.80 Seminar in Management
or
G 6.90 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.

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 Analysis	180 hours
Reactor Chemical Technology	54 hours
Reactor Component Design Engineering	36 hours
Reactor Controls and Systems	54 hours
Reactor Engineering	108 hours
Experimental Reactor Physics	72 hours
Reactor Materials	72 hours
Reactor Shielding	36 hours
Reactor Design Problems (Group Thesis)	

Aeronautical Engineering, Propulsion Systems

THIRD YEAR (AP3) AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY

FALL TERM

2.213 Gas Turbines
16.105 Applied Aerodynamics
Thesis
* 2.82 Combustion
* 2.49 Advanced Fluid Mechanics
* 2.521 Advanced Heat Transfer
*10.311 Heat Transfer
*Electives

SPRING TERM

2.214 Gas Turbines
16.56 Jet Propulsion Engines
Thesis
* 2.212 Advanced Mechanics
* 2.491 Compressible Fluid Mechanics
* 2.522 Advanced Heat Transfer
* 3.44 Behavior of Metals at Elevated Temperatures

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

(GROUP DESIGNATOR APC)

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. This curriculum is flexible and will be tailored at the Postgraduate School to fit the requirements of the specialty and the background of the student.

AERONAUTICAL ENGINEERING, GUIDED MISSILES AND ARMAMENT CONTROL

(GROUP DESIGNATOR AR or AM)

The curriculum consists of two-years study at the Postgraduate School. Selected students will continue for a third year of study at civilian educational institutions. This curriculum covers electrical, aeronautical, and mechanical engineering subjects and related mathematics, metallurgy, electronics, and ordnance courses. The third year for eligible volunteers offers specialization in airborne weapons control at MIT, or guided missiles control and guidance at Univ. of Mich. or Univ. of Minn. These third-year specializations offer the opportunity to qualify for a graduate degree.

FIRST YEAR (AR1 and AM1)

FIRST TERM

Ae-200(C)	Rigid Body Statics	3-2
EE-151(C)	DC Circuits and Fields	3-4
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-3
		14-11

SECOND TERM

Ae-100(C)	Basic Aerodynamics	3-4
Ae-211(C)	Strength of Materials	4-0
EE-241(C)	AC Circuits	3-2
Ma-112(B)	Differential Equations and Boundary Value Problems	5-0
Mc-102(C)	Engineering Mechanics II	2-2
Ae-001(L)	Aeronautical Lecture	0-1
		17-9

THIRD TERM

Ae-121(C)	Technical Aerodynamics	3-2
Ae-212(C)	Stress Analysis I	4-2
EE-463(C)	Transformers and Special Devices	3-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Mt-201(C)	Introductory Physical Metallurgy	3-2
IT-101(L)	Industrial and Technical Lectures I	0-1
		16-9

FOURTH TERM

Ae-136(B)	Aircraft Performance	3-2
Ae-213(B)	Stress Analysis II	4-2
Ae-409(C)	Thermodynamics I (Aero)	4-2
Ma-114(A)	Functions of a Complex Variable and Vector Analysis	3-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
IT-102(L)	Industrial and Technical Lectures II	0-1
		16-9

Intersessional period: four weeks will be spent in the field at aviation activities.

SECOND YEAR (AR2 and AM2)

FIRST TERM

Ae-311(C)	Airplane Design I	2-4
Ae-410(B)	Thermodynamics II (Aero)	3-2
Ae-501(A)	Hydro-Aero Mechanics I	4-0
EE-551(B)	Transmission Lines and Filters	3-2
Ma-115(A)	Differential Equations for Automatic Control	3-0
		15-8

SECOND TERM

Ae-502(A)	Hydro-Aero Mechanics II	4-0
EE-771(B)	Electronics	3-2
Ma-125(B)	Numerical Methods for Digital Computers	2-2
Mc-311(A)	Vibrations	3-2
Mc-402(A)	Mechanics of Gyroscopic Instruments	3-0
Ae-001(L)	Aeronautical Lecture	0-1
		15-7

THIRD TERM

Ae-146(C)	Aircraft Dynamics	3-2
Ae-508(A)	Compressibility	3-2
EE-671(A)	Transients	3-4
EE-772(B)	Electronics	3-2
Mc-401(A)	Exterior Ballistics	3-0
IT-101(L)	Industrial and Technical Lectures I	0-1
		15-11

FOURTH TERM

EE-745(A)	Electronic Control and Measurement	3-3
EE-672(A)	Servomechanisms	3-3
Ma-421(A)	Analog and Digital Computation	3-2
*Ph-240(C)	Geometrical and Physical Optics	3-3
IT-102(L)	Industrial and Technical Lectures II	0-1
		12-12

*(AM2) Substitute:
Ma-301(B) Statistics 3-2

Intersessional period: Course IE-102(C)—Elements of Management and Industrial Engineering at USNPGS, Monterey.

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

THIRD YEAR (AM3) AT UNIVERSITY OF MICHIGAN

FALL TERM

*Ae-119 Advanced Fluid Mechanics
Ae-142 Mechanics of Flight II
Ae-248 Advanced Feedback Control
Ae-250 Theory of Oscilations of Nonlinear Systems
Ae-252 Seminar on Simulation and Solution of Nonlinear Systems
*EE-238 Digital Computer Applications
Thesis

*Elect one.

SPRING TERM

Ae-102 Advanced Design
Ae-212 Control and Guidance of Pilotless Aircraft
Ae-214 Information Theory and Radio Telemetry
Ae-215 Radio Telemetry Laboratory
Thesis

AERONAUTICAL ENGINEERING, ELECTRICAL

GROUP DESIGNATOR (AE)

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. 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 (AE1)

FIRST TERM

Ae-200(C)	Rigid Body Statics	3-2
EE-171(C)	Electric Circuits and Fields	3-4
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
		14-10

SECOND TERM

Ae-100(C)	Basic Aerodynamics	3-4
Ae-211(C)	Strength of Materials	4-0
EE-271(C)	Alternating-Current Circuits	3-2
Ma-112(B)	Differential Equations and Boundary Value Problems	5-0
Mc-102(C)	Engineering Mechanics II	2-2
Ae-001(L)	Aeronautical Lecture	0-1
		17-9

THIRD TERM

Ae-121(C)	Technical Aerodynamics I	3-2
Ae-212(C)	Stress Analysis I	4-2
EE-272(B)	Alternating-Current Circuits	2-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Mt-201(C)	Introductory Physical Metallurgy	3-2
IT-101(L)	Industrial and Technical Lectures I	0-1
		15-9

FOURTH TERM

Ae-136(B)	Aircraft Performance	3-2
Ae-213(B)	Stress Analysis II	4-2
EE-371(C)	Direct-Current Machinery	3-2
Ma-114(A)	Functions of a Complex Variable and Vector Analysis	3-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
IT-102(L)	Industrial and Technical Lectures II	0-1
		16-9

Intersessional period: four weeks will be spent 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)	Alternating-Current Machinery	3-4
Ma-115(A)	Differential Equations for Automatic Control	3-0
Ma-125(B)	Numerical Methods for Digital Computers	2-2
		14-10

SECOND TERM

Ae-502(A)	Hydro-Aero Mechanics II	4-0
EE-472(C)	Alternating-Current Machinery	3-4
EE-971(A)	Seminar	1-0
Ma-421(A)	Analog and Digital Computation	3-2
Mc-311(A)	Vibrations	3-2
Ae-001(L)	Aeronautical Lecture	0-1
		14-9

THIRD TERM

Ae-146(A)	Aircraft Dynamics	3-2
Ae-508(A)	Compressibility	3-2
EE-671(A)	Transients	3-4
EE-771(B)	Electronics	3-2
EE-971(A)	Seminar	1-0
IT-101(L)	Industrial and Technical Technical Lectures I	0-1
		13-11

FOURTH TERM

Ch-521(A)	Plastics	3-2
EE-672(A)	Servomechanisms	3-3
EE-772(B)	Electronics	3-2
EE-971(A)	Seminar	1-0
EE-745(A)	Electronic Control and Measurement	3-3
IT-102(L)	Industrial and Technical Lectures II	0-1
		13-8

Intersessional period: Course IE-101(C)—Elements of Management and Industrial Engineering at USNPGS, Monterey.

THIRD YEAR (AE3)

FIRST TERM

EE-571(B)	Transmission Lines and Filters	3-4
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
		13-12

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

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

COMMAND COMMUNICATIONS

(GROUP DESIGNATOR 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.

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-141(C)	Public Speaking	0-1
Co-161(C)	Naval Fiscal Management	2-0
Es-281(C)	Electronics Fundamentals	3-3
Ma-162a(C)	Introduction to Calculus	3-0
		17-9

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-142(C)	Public Speaking	0-1
Co-162(C)	Administration and Management	3-0
Es-282(C)	Vacuum Tube Circuits I	3-3
Ma-162b(C)	Introduction to Calculus	2-0
		16-10

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
Es-386(C)	Transmitters and Receivers	3-3
Es-786(C)	RF Energy Transmission	3-3
IT-101(L)	Industrial and Technical Lectures I	0-1
		14-13

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-154(C)	Military Communication Organizations	0-2
Es-586(C)	Special Systems	3-3
IT-102(L)	Industrial and Technical Lectures II	0-1
Ma-320(C)	Introduction to Statistics and Operations Analysis	4-0
		14-13

A certificate is awarded upon satisfactory completion of this course.

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)

(GROUP DESIGNATOR NL)

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 (NL1)

FIRST TERM

Ch-121(B)	General and Petroleum Chemistry	4-2
EE-171(C)	Electrical Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
		14-10

SECOND TERM

EE-271(C)	Alternating-Current Circuits	3-2
Ma-112(B)	Differential Equations and Infinite Series	5-0
Mc-102(C)	Engineering Mechanics II	2-2
ME-500(C)	Strength of Materials	3-0
Mt-201(C)	Introductory Physical Metallurgy	3-2
		16-6

THIRD TERM

EE-272(B)	Alternating-Current Circuits	2-2
EE-273(C)	Electrical Measurement I	2-3
Ma-113(B)	Introduction to Partial Differential Equations and Functions	3-0
Mc-201(A)	Methods in Dynamics	2-2
Mt-208(C)	Ferrous Physical Metallurgy	4-2
IT-101(L)	Industrial and Technical Lectures I	0-1
		13-10

FOURTH TERM

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

Intersessional period: Course IE-101(C) Elements of Management and Industrial Engineering at USNPGS, Monterey.

SECOND YEAR (NL2)

FIRST TERM

EE-274(B)	Electrical Measurements II	2-3
EE-471(C)	Alternating-Current Machinery	3-4
Ma-115(A)	Differential Equations for Automatic Control	3-0
ME-122(C)	Engineering Thermodynamics	3-2
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
		13-11

SECOND TERM

EE-472(C)	Alternating-Current Machinery	3-4
EE-971(A)	Seminar	1-0
ME-421(C)	Hydromechanics	3-2
ME-221(C)	Marine Power Plant Equipment	3-2
Ph-610(B)	Survey of Atomic and Nuclear Physics	3-0
		13-8

THIRD TERM

EE-571(B)	Transmission Lines and Filters	3-4
EE-771(B)	Electronics	3-2
EE-971(A)	Seminar	1-0
ME-222(C)	Marine Power Plant Equipment	3-4
IT-101(L)	Industrial and Technical Lectures I	0-1
		10-11

FOURTH TERM

EE-651(B)	Transients and Servomechanisms	3-4
EE-772(B)	Electronics	3-2
EE-971(A)	Seminar	1-0
	Elective	4-0
ME-240(B)	Nuclear Power Plants	4-0
IT-102(L)	Industrial and Technical Lectures II	0-1
		15-7

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

ADVANCED CURRICULUM (THREE YEARS)

(GROUP DESIGNATOR NLA)

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 First Year (NL1)

Intersessional period: Course IE-101(C)—Elements of Management and Industrial Engineering at USNPGS, Monterey.

SECOND YEAR (NLA2)

FIRST TERM

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

SECOND TERM

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

THIRD TERM

EE-571(B)	Transmission Lines and Filters	3-4
EE-771(B)	Electronics	3-2
EE-971(A)	Seminar	1-0
EE-671(A)	Transients	3-4
Ph-361(A)	Electromagnetism	3-0
IT-101(L)	Industrial and Technical Lectures I	0-1-
		13-11

FOURTH TERM

EE-672(A)	Servomechanisms	3-3
EE-971(A)	Seminar	1-0
EE-772(B)	Electronics	3-2
ME-310(B)	Heat Transfer (or elective)	4-2
Ph-362(A)	Electromagnetic Waves	3-0
IT-102(L)	Industrial and Technical Lectures II	0-1
		14-8

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

THIRD YEAR (NLA3)

FIRST TERM

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

SECOND TERM

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

THIRD TERM

EE-873(A)	Electrical Machine Design	4-0
EE-971(C)	Seminar	1-0
ME-222(C)	Marine Power Plant Equipment	3-4
IT-101(L)	Industrial and Technical Lectures I	0-1
	Thesis	-12
		8-17

FOURTH TERM

EE-874(A)	Electrical Machine Design	4-0
EE-971(A)	Seminar	1-0
ME-223(B)	Marine Power Plant Analysis	2-4
ME-240(B)	Nuclear Power Plants	4-0
IT-102(L)	Industrial and Technical Lectures II	0-1
	Thesis	-8
		11-13

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

ENGINEERING ELECTRONICS

The Engineering Electronics curricula includes:

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 partly at the graduate level for general naval electronics applications. Student officers whose first-year grades indicate they will have difficulty completing the three-year curriculum may also be placed in this curriculum and graduated at the end of the second year.

THREE-YEAR CURRICULUM

(GROUP DESIGNATOR E)

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 (E1)

FIRST TERM

Es-111(C)	Basic Electric Circuits	4-2
Es-511(C)	Basic Electrical Laboratory	0-5
Es-616(C)	Basic Electric and Magnetic Fields	3-0
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-121(C)	Introduction to Engineering Mathematics	3-1
		13-9

SECOND TERM

Es-112(C)	Alternating-Current Circuits	3-0
Es-212(C)	Electron Tube Circuits I	4-0
Es-512(C)	Electronic Circuits Laboratory I	0-5
Ma-122(B)	Differential Equations and Vector Calculus	5-0
Ph-240(C)	Optics	3-3
		15-8

THIRD TERM

Es-113(C)	Circuit Analysis and Measurements I	2-6
Es-213(C)	Electron Tube Circuits II	4-3
Ma-123(A)	Orthogonal Functions and Partial Differential Equations	5-0
Ph-141(B)	Analytical Mechanics	4-0
IT-101(L)	Industrial and Technical Lectures I	0-1
		15-10

FOURTH TERM

Es-114(C)	Circuit Analysis and Measurements II	3-0
Es-214(C)	Electron Tube Circuits III	4-0
Es-513(C)	Electronic Circuits Laboratory II	0-5
Ma-124(B)	Complex Variable	3-0
Ma-125(B)	Numerical Methods for Digital Computers	2-2
Ph-610(B)	Survey of Atomic and Nuclear Physics	3-0
IT-101(L)	Industrial and Technical Lectures II	0-1
		15-8

Intersessional period: Course IE-101(C) Elements of Management and Industrial Engineering at USNPGS, Monterey.

SECOND YEAR (E2)

FIRST TERM

Es-126(C)	Radio-Frequency Measurements and Microwave Techniques	2-6
Es-225(B)	Electron Tubes	3-6
Es-621(C)	Electromagnetics I	4-0
Ph-730(A)	Physics of the Solid State	3-3
		12-15

SECOND TERM

Es-121(B)	Advanced Circuit Theory I	4-2
Es-221(A)	Solid-State Devices	3-3
Es-622(B)	Electromagnetics II	5-0
Ph-431(B)	Fundamental Acoustics	4-0
		16-5

THIRD TERM

Es-122(A)	Advanced Circuit Theory II	4-2
Es-623(A)	Electromagnetics III	4-0
Ma-321(B)	Probability and Statistics	4-2
Ph-432(A)	Underwater Acoustics and Sonar Systems	4-3
IT-101(L)	Industrial and Technical Lectures I	0-1
		16-8

FOURTH TERM

Es-127(B)	Pulse Techniques	2-0
Es-128(A)	Information Theory	3-0
Es-226(A)	Microwave Techniques	3-0
Es-321(B)	Communication Systems I	2-0
Es-526(B)	Radiation and Microwave Laboratory	0-6
Es-527(B)	Pulse Techniques and Transmitter Laboratory	0-5
Es-736(B)	Antennas, Transmission Lines	3-0
IT-102(L)	Industrial and Technical Lectures II	0-1
		13-12

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

THIRD YEAR (E3)

FIRST TERM

Es-136(A)	Electronic Computation and Control	3-2
Es-332(B)	Communication Systems II	2-3
Es-431(B)	Radar System Engineering I	3-3
EE-463(C)	Special Machinery	3-2
Oa-121(C)	Survey of Operations Analysis	3-0
		14-10

SECOND TERM

Es-333(B)	Communication Systems III	3-3
Es-432(B)	Radar System Engineering II	3-6
EE-672(A)	Servomechanisms	3-3
	Thesis	2-0
		11-12

THIRD TERM

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

FOURTH TERM

Es-036(L)	Electronics Administration and Programs	0-1
Es-334(B)	Communication Systems IV	2-3
Es-335(B)	Electronic Systems	3-3
Es-836(A)	Project Seminar	2-0
Me-246(B)	Nuclear Power Plants	3-0
	Thesis	4-0
		14-7

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

THREE-YEAR CURRICULUM (ACOUSTICS)

(GROUP DESIGNATOR EW)

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

Same as first year (E1)

SECOND YEAR

Same as second year (E2)

THIRD YEAR (EW3)

FIRST TERM

Es-431(B)	Radar System Engineering I	3-3
EE-463(C)	Special Machinery	3-2
Oa-121(C)	Survey of Operations Analysis	3-0
Ph-461(A)	Transducer Theory and Design	3-3
Ph-530(B)	Thermodynamics	3-0
		15-8

SECOND TERM

Es-432(B)	Radar System Engineering II	3-6
Es-537(B)	Sonar System Engineering Design and Developments	3-3
EE-672(A)	Servomechanisms	3-3
	Thesis	2-0
		11-12

THIRD TERM

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

FOURTH TERM

Es-036(L)	Electronics Administration and Programs	0-1
Es-836(A)	Project Seminar	2-0
Me-246(B)	Nuclear Power Plants	3-0
Ph-433(A)	Propagation of Waves in Fluids	2-0
Ph-442(A)	Shock Waves in Fluids	3-0
Ph-471(A)	Acoustics Research	0-3
	Thesis	4-0
		14-4

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

TWO-YEAR CURRICULUM

(GROUP DESIGNATOR EA)

(Presented partly 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 electronic equipment.

This curriculum is still under development and no description of curriculum is included in the catalogue.

GAS TURBINES
(GROUP DESIGNATOR NJ)

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 first term, from the mechanical engineering (NH) group.

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

(FIRST YEAR (NJ1)

FIRST TERM

Ch-121(B)	General and Petroleum Chemistry	4-2
EE-171(C)	Electrical Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
		14-10

SECOND TERM

Ae-100(C)	Basic Aerodynamics	3-4
EE-251(C)	Alternating-Current Circuits	3-4
Ma-112 (B)	Differential Equations and Infinite Series	5-0
Mc-102(C)	Engineering Mechanics II	2-2
		13-10

THIRD TERM

EE-351(C)	Direct-Current Machinery	2-2
Ae-121(C)	Technical Aerodynamics	3-2
Ch-561(A)	Physical Chemistry	3-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Mc-201(A)	Methods in Dynamics	2-2
IT-101(L)	Industrial and Technical Lectures I	0-1
		13-9

FOURTH TERM

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

Intersessional period: Course IE-101, Elements of Management and Industrial Engineering, will be taken at USNPGS, Monterey.

SECOND YEAR (NJ2)

FIRST TERM

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

SECOND TERM

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

THIRD TERM

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

FOURTH TERM

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

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

THIRD YEAR (NJ3)

FIRST TERM

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

SECOND TERM

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

THIRD TERM

IT-101(L)	Industrial and Technical Lectures I	0-1
Ph-610(B)	Survey of Atomic and Nuclear Physics	3-0
	Thesis	0-16
		3-17

FOURTH TERM

IT-102(L)	Industrial and Technical Lectures II	0-1
ME-223(B)	Marine Power Plant Analysis	2-4
ME-240(B)	Nuclear Power Plants	4-0
Mt-302(A)	Alloy Steels	3-3
	Thesis	0-6
		9-14

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

MECHANICAL ENGINEERING

(GROUP DESIGNATOR NH)

OBJECTIVE

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

BASIC CURRICULUM (TWO YEARS)

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

FIRST YEAR (NH1)

FIRST TERM

Ch-121(B)	General and Petroleum Chemistry	4-2
EE-171(C)	Electrical Circuits and Fields	3-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
		14-10

SECOND TERM

EE-251(C)	Alternating-Current Circuits	3-4
Ma-112(B)	Differential Equations and Infinite Series	5-0
Mc-102(C)	Engineering Mechanics II	2-2
Mt-201(C)	Introductory Physical Metallurgy	3-2
		13-8

THIRD TERM

Ch-561(A)	Physical Chemistry	3-2
EE-351(C)	Direct-Current Machinery	2-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Mc-201(A)	Methods in Dynamics	2-2
Mt-208(C)	Ferrous Physical Metallurgy	4-2
IT-101(L)	Industrial and Technical Lectures I	0-1
		14-9

FOURTH TERM

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

Intersessional period: Course IE-101(C) Elements of Industrial Engineering, will be taken at USNPGS, Monterey.

SECOND YEAR (NH2)

FIRST TERM

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

SECOND TERM

ME-221(C)	Marine Power Plant Equipment	3-2
ME-422(B)	Hydromechanics	2-2
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

EE-751(C)	Electronics	3-4
IT-101(L)	Industrial and Technical Lectures	0-1
ME-222(C)	Marine Power Plant Equipment	3-4
ME-712(A)	Dynamics of Machinery	3-2
Ph-610(B)	Survey of Atomic and Nuclear Physics	3-0
		12-11

FOURTH TERM

Ch-521(A)	Plastics	3-2
IT-102(L)	Industrial and Technical Lectures	0-1
ME-223(B)	Marine Power Plant Analysis	2-4
ME-240(B)	Nuclear Power Plants	4-0
ME-820(C)	Machine Design	2-4
		11-11

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

ADVANCED CURRICULUM (THREE YEARS)

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

FIRST YEAR

Same as first year (NH1)

Intersessional period: Course IE-101(C)—Elements of Management and Industrial Engineering at USNPGS, Monterey.

SECOND YEAR (NHA2)

FIRST TERM

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

SECOND TERM

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

THIRD TERM

ME-212(C) Marine Power Plant Equipment	3-4
ME-412(A) Hydromechanics	4-2
Ma-125(B) Numerical Methods for Digital Computers	2-2
ME-712(A) Dynamics of Machinery	3-2
IT-101(L) Industrial and Technical Lectures I	0-1
	12-11

FOURTH TERM

Ma-421(A) Digital and Analog Computation	3-2
ME-310(B) Heat Transfer	4-2
Mt-204(A) Advanced Physical Metallurgy	3-4
ME-513(A) Theory of Elasticity	3-0
IT-102(L) Industrial and Technical Lectures II	0-1
	13-9

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

THIRD YEAR (NHA3)

FIRST TERM

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

SECOND TERM

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

THIRD TERM

Ph-610(B) Survey of Atomic and Nuclear Physics	3-0
IT-101(L) Industrial and Technical Lectures I	0-1
Thesis	0-16
	3-17

FOURTH TERM

Ch-521(A) Plastics	3-2
ME-240(B) Nuclear Power Plants	4-0
Mt-302(A) Alloy Steels	3-3
IT-102(L) Industrial and Technical Lectures II	0-1
Thesis	0-6
	10-12

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

MECHANICAL ENGINEERING (NUCLEAR POWER)

(GROUP DESIGNATOR NN)

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

Same as First Year (NH1). No group distinction is made until the end of the first year.

Intersessional period: Course IE-101(C)—Elements of Management and Industrial Engineering at USNPGS, Monterey.

SECOND YEAR (NN2)

FIRST TERM

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

SECOND TERM

EE-711(C)	Electronics	3-2
ME-211(C)	Marine Power Plant Equipment	3-2
ME-411(C)	Hydromechanics	3-2
ME-711(B)	Mechanics of Machinery	4-2
Ph-361(A)	Electromagnetism	3-0
		16-8

THIRD TERM

ME-212(C)	Marine Power Plant Equipment	3-4
ME-412(A)	Hydromechanics	4-2
ME-712(A)	Dynamics of Machinery	3-2
Ph 240(C)	Optics and Radiation from Atomic Systems	3-3
IT-101(L)	Industrial and Technical Lectures I	0-1
		13-12

FOURTH TERM

*Ma-421(A)	Digital and Analog Computation (Elective)	3-2
ME-223(B)	Marine Power Plant Analysis	2-4
ME-310(B)	Heat Transfer	4-2
Ph-640(B)	Atomic Physics	3-0
Ph-641(B)	Atomic Physics Laboratory	0-3
IT-102(L)	Industrial and Technical Lectures II	0-1
		12-12

* Students electing this course must take as a prerequisite Ma-125(B), Numerical Methods for Digital Computers, 2-2, during first, second or third term of second year as an additional course.

Intersessional period: A four- or five-week field trip will be arranged to industrial or research activities associated with the development of nuclear power.

THIRD YEAR (NN3) AT U. S. NAVAL POSTGRADUATE SCHOOL

FIRST TERM

EE-651(B)	Transients and Servomechanisms	3-4
ME-811(C)	Machine Design	3-2
Mt-301(A)	High Temperature Materials	3-0
Ph-642(A)	Nuclear Physics	4-0
Ph-643(A)	Nuclear Physics Laboratory	0-3
		13-9

SECOND TERM

Ch-553(A)	Nuclear Chemical Technology	4-3
ME-812(B)	Machine Design	3-4
Ph-651(A)	Reactor Theory	3-0
	Thesis	0-4
		10-11

THIRD TERM

ME-241(A)	Nuclear Power Plants	3-2
IT-101(L)	Industrial and Technical Lectures I	0-1
	Thesis	0-16
		3-19

FOURTH TERM

ME-242(A)	Nuclear Power Plants	3-2
Mt-402(A)	Nuclear Reactor Materials—Effects of Radiation	4-0
Ph-810(C)	Biological Effects of Radiation	3-0
IT-102(L)	Industrial and Technical Lectures II	0-1
	Thesis	0-8
		10-11

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

THIRD YEAR AT OAK RIDGE SCHOOL OF REACTOR TECHNOLOGY

Experimental Reactor Physics	72 hours
Reactor Analysis	180 hours
Reactor Controls and Reactor Systems	54 hours
Reactor Engineering	108 hours
Reactor Materials	72 hours
Reactor Design Problems (Thesis)	
Reactor Component Design Engineering	36 hours
Reactor Chemical Technology	54 hours
Reactor Shielding	36 hours

MINE WARFARE

(GROUP DESIGNATOR RW)

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 (RW1)

FIRST TERM

Ch-101(C)	General Inorganic Chemistry	3-2
Es-141(C)	Fundamentals of Electric Circuits and 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)	Introduction to Circuit Theory	4-3
Ma-112(B)	Differential Equations and Series	5-0
Ma-381(C)	Elementary Probability and Statistics	4-2
Mc-102(C)	Engineering Mech. II	2-2
Or-191(C)	Mines and Mine Mechanisms	2-0
		17-7

THIRD TERM

Ch-561(A)	Physical Chemistry	3-2
Es-261(C)	Electron Tubes and Circuits	3-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Ma-382(A)	Probability and Statistics	3-0
Oa-152(C)	Measures of Effectiveness of Mines	3-0
Or-192(C)	Mining Operations	2-0
IT-101(L)	Industrial and Technical Lectures I	0-1
		17-5

FOURTH TERM

Es-262(C)	Electron Tubes and Circuits	3-2
Ma-114(A)	Functions of a Complex Variable and Vector Analysis	3-0
Oa-153(B)	Game Theory and Its Application to Mine Fields	3-0
Or-104(C)	Ordnance IV	2-1
Or-291(C)	Mine Countermeasures I	3-0
Ph-311(A)	Electrostatics and Magnetostatics	3-0
IT-102(L)	Industrial and Technical Lectures II	0-1
		17-4

Intersessional period: Field trip to representative mine warfare installations.

SECOND YEAR (RW2)

FIRST TERM

Mt-201(C)	Introductory Physical Metallurgy	3-2
Oc-110(C)	Introduction to Oceanography	3-0
Or-292(C)	Mine Countermeasures II	3-2
Ph-312(A)	Applied Electromagnetics	3-0
Ph-421(A)	Fundamental Acoustics	3-0
		15-4

SECOND TERM

Ae-100(C)	Basic Aerodynamics	3-4
Ma-116(A)	Matrices and Numerical Methods	3-2
Mt-202(C)	Ferrous Physical Metallurgy	3-2
Oc-631(B)	Oceanography of Mine Warfare I	3-0
Ph-425(A)	Underwater Acoustics	3-2
		15-10

THIRD TERM

Oc-632(B)	Oceanography of Mine Warfare II	3-0
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
Ma-421(A)	Digital and Analog Computation	3-2
Ph-442(A)	Shock Waves in Fluids	3-0
IT-101(L)	Industrial and Technical Lectures I	0-1
	Thesis	0-8
		11-13

FOURTH TERM

Ch-521(A)	Plastics	3-2
Ch-591(A)	Blast and Shock Effects	3-0
Ms-500(C)	Strength of Materials	3-0
Ms-601(C)	Materials Test Lab	0-2
Or-294(A)	Mine Warfare Seminar	2-0
IT-102(L)	Industrial and Technical Lectures II	0-1
	Thesis	0-8
		11-13

Six months practical work at various mine warfare installations.

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

NUCLEAR ENGINEERING (EFFECTS)

(GROUP DESIGNATOR RZ)

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 (RZ1)

FIRST TERM

Es-271(C)	Electronics I	3-2
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-181(C)	Partial Derivatives and Multiple Integrals	4-1
Mc-101(C)	Engineering Mechanics I	2-2
Ph-240(C)	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
IT-101(L)	Industrial and Technical Lectures I	0-1
		18-5

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
IT-102(L)	Industrial and Technical Lectures II	0-1
		15-8

Intersessional period: Field trip.

SECOND YEAR (RZ2)

FIRST TERM

Ch-315(C)	Organic Chemistry	3-2
Ma-301(B)	Statistics	3-2
Mr-100(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
Ph-750(A)	Physics Seminar	1-0
		18-4

SECOND TERM

Ph-800(C)	General Biology	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
Ph-750(A)	Physics Seminar	1-0
		18-3

THIRD TERM

Ph-801(B)	Animal Physiology*	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
IT-101(L)	Industrial and Technical Lectures I	0-1
Ph-750(A)	Physics Seminar	1-0
	Thesis	0-6
		17-9

FOURTH TERM

Ph-802(A)	Radiation Biology*	6-0
Ge-201(C)	Physical Geology	3-0
ME-350(B)	Heat Transfer	2-2
IT-102(L)	Industrial and Technical Lectures II	0-1
Ph-750(A)	Physics Seminar	1-0
	Thesis	0-10
		12-13

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

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

OPERATIONS ANALYSIS

(GROUP DESIGNATOR RO)

OBJECTIVE

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

FIRST YEAR (RO1)

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
		12-7

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 and Statistics	3-0
Oa-191(C)	Introduction to Operations Analysis	3-0
Ph-142(B)	Analytical Mechanics	4-0
Ph-361(A)	Electromagnetism	3-0
IT-101(L)	Industrial and Technical Lectures I	0-1
		18-1

FOURTH TERM

Ma-125(B)	Numerical Methods for Digital Computers	2-2
Ma-195(A)	Matrix Theory and Integration Theory	5-0
Ma-383(A)	Probability and Statistics	3-2
Oa-192(B)	Theory of Search	3-0
Ph-362(A)	Electromagnetic Waves	3-0
IT-102(L)	Industrial and Technical Lectures II	0-1
		16-5

Intersessional period: 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(B)	Fundamental Acoustics	3-0
Ph-541(B)	Kinetic Theory and Statistical Mechanics	4-0
		17-2

SECOND TERM

Ma-421(A)	Digital and Analog Computation	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)	Underwater Acoustics	3-2
		16-6

THIRD TERM

Oa-195(A)	Optimal Weapon Systems II	3-0
Oa-202(A)	Econometrics	3-0
Ph-641(B)	Atomic Physics	3-3
IT-101(L)	Industrial and Technical Lectures I	0-1
	Thesis	0-10
		9-14

FOURTH TERM

Mr-120(C)	Operational Aspects of Meteorology and Oceanography	3-0
Oa-891(A)	Seminar in Operations Analysis	2-4
Ph-642(A)	Nuclear Physics	4-0
Ph-643(A)	Nuclear Physics Laboratory	0-3
IT-102(L)	Industrial and Technical Lectures II	0-1
	Thesis	0-6
		9-14

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

ORDNANCE ENGINEERING

BASIC OBJECTIVE

To 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.

ORDNANCE ENGINEERING (General)

(GROUP DESIGNATOR O)

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 (O1)

FIRST TERM

Ch-101(C)	General Inorganic Chemistry	3-2
EE-151(C)	DC Circuits and Fields	3-4
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
		14-10

SECOND TERM

Ch-711(C)	Chemical Engineering Calculations	3-2
EE-241(C)	AC Circuits	3-2
Ma-112(B)	Differential Equations and Infinite Series	5-0
Mc-102(C)	Engineering Mechanics II	2-2
Or-101(C)	Ordnance I	2-1
		15-7

THIRD TERM

Ch-631(A)	Chemical Engineering Thermodynamics	3-2
EE-461(C)	Transformers and Synchros	3-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Mc-401(A)	Exterior Ballistics	3-0
Or-103(C)	Ordnance III	2-2
Ph-610(B)	Atomic Physics	3-0
IT-101(L)	Industrial and Technical Lectures I	0-1
		17-7

FOURTH TERM

Ch-401(A)	Physical Chemistry (Ord.)	3-2
EE-462(B)	Asynchronous Motors and Special Machines	4-2
Ma-114(A)	Functions of a Complex Variable and Vector Analysis	3-0
Or-104(C)	Ordnance IV	2-1
Ph-450(B)	Underwater Acoustics	3-2
IT-102(L)	Industrial and Technical Lectures II	0-1
		15-8

Intersessional period: Field trip to representative ordnance installations.

SECOND YEAR (O2)

FIRST TERM

Ch-571(A)	Explosives	3-2
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
		15-10

SECOND TERM

EE-745(A)	Electronic Control and Measurement	3-3
Ma-125(B)	Numerical Methods for Digital Computers	2-2
Mc-402(A)	Mechanics of Gyroscopic Instruments	3-0
Mc-421(A)	Interior Ballistics	2-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
Ph-240(C)	Geometric and Physical Optics	3-3
		16-10

THIRD TERM

EE-665(B)	Lines, Filters, and Transients	4-2
Es-446(C)	Introduction to Radar	2-2
Ma-351(B)	Industrial Statistics I	3-2
Ma-421(A)	Digital and Analog Computation	3-2
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
IT-101(L)	Industrial and Technical Lectures	0-1
		14-11

FOURTH TERM

Ch-541(A)	Reaction Motors	2-2
EE-672(A)	Servomechanisms	3-3
Ma-352(B)	Industrial Statistics II	2-2
Ma-401(A)	Analog Computers	2-2
Mt-301(A)	High Temperature Materials	3-0
Oa-151(B)	Survey of Weapons Evaluation	3-0
IT-102(L)	Industrial and Technical Lectures II	0-1
		15-10

Intersessional period: IE-102(C)—Elements of Management and Industrial Engineering at USNPGS, Monterey.

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

ORDNANCE ENGINEERING (Aviation)
(GROUP DESIGNATOR OE)

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 (OE1)

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
		13-10

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 Infinite Series	5-0
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
Ch-631(A)	Chemical Engineering Thermodynamics	3-2
EE-461(C)	Transformers and Synchros	3-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Mc-401(A)	Exterior Ballistics	3-0
IT-101(L)	Industrial and Technical Lectures I	0-1
		15-7

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)	Functions of a Complex Variable and Vector Analysis	3-0
Or-104(C)	Ordnance IV	2-1
IT-102(L)	Industrial and Technical Lectures II	0-1
		15-8

Intersessional period: Field trip to representative ordnance installations.

SECOND YEAR (OE2)

FIRST TERM

Ae-501(A)	Hydro-Aero Mechanics I	4-0
Ch-571(A)	Explosives	3-2
EE-751(C)	Electronics	3-4
Ma-115(A)	Differential Equations for Automatic Control	3-0
Mt-201(C)	Introductory Physical Metallurgy	3-2
		16-8

SECOND TERM

Ae-502(A)	Hydro-Aero Mechanics II	4-0
EE-745(A)	Electronic Control and Measurement	3-3
Ma-125(B)	Numerical Methods for Digital Computers	2-2
Mc-402(A)	Mechanics of Gyroscopic Instruments	3-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
Or-101(C)	Ordnance I	2-1
		17-8

THIRD TERM

Ae-146(A)	Dynamics	3-2
Ae-508(A)	Compressibility	3-2
EE-665(B)	Lines, Filters, and Transients	4-2
Ma-421(A)	Digital and Analog Computation	3-2
Or-241(C)	Guided Missiles I	2-0
IT-101(L)	Industrial and Technical Lectures I	0-1
		15-9

FOURTH TERM

Ch-541(A)	Reaction Motors	2-2
EE-672(A)	Servomechanisms	3-3
Es-456(C)	Introduction to Radar (Airborne)	2-2
Ma-301(B)	Statistics	3-2
Oa-151(B)	Survey of Weapons Evaluation	3-0
Or-242(B)	Guided Missiles II	2-0
IT-102(L)	Industrial and Technical Lectures II	0-1
		15-10

Intersessional period: IE-102(C)—Elements of Management and Industrial Engineering at USNPGS, Monterey.

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
16.472 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

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

ORDNANCE ENGINEERING (Explosives)

(GROUP DESIGNATOR OP)

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 (OP1)

FIRST TERM

Ch-101(C)	General Inorganic Chemistry	3-2
EE-151(C)	DC Circuits and Fields	3-4
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
		14-10

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 Infinite Series	5-0
Or-101(C)	Ordnance I	2-1
		16-7

THIRD TERM

Ch-231(C)	Quantitative Analysis	2-4
Ch-311(C)	Organic Chemistry	3-2
Ch-411(C)	Physical Chemistry	3-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Or-103(C)	Ordnance III	2-2
IT-101(L)	Industrial and Technical Lectures I	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)	Functions of a Complex Variable and Vector Analysis	3-0
Or-104(C)	Ordnance IV	2-1
IT-102(L)	Industrial and Technical Lectures II	0-1
		17-10

Intersessional period: Field trip to representative ordnance installations.

SECOND YEAR (OP2)

FIRST TERM

Cr-271(B)	Crystallography and X-ray Techniques	3-2
Ch-571(A)	Explosives	3-2
Ch-612(C)	Thermodynamics	3-2
EE-751(C)	Electronics	3-4
Ma-301(B)	Statistics	3-2
		15-12

SECOND TERM

Ch-413(A)	Physical Chemistry (Advanced)	2-2
EE-651(C)	Transients and Servos	3-4
Mc-421(A)	Interior Ballistics	2-0
ME-500(C)	Strength of Materials	3-0
Mt-201(C)	Introductory Physical Metallurgy	3-2
Ch-323(A)	The Chemistry of High Polymers	3-0
		16-8

THIRD TERM

Mt-202(C)	Ferrous Physical Metallurgy	3-2
Ch-111(A)	Fuel and Oil Chemistry	2-2
Ch-321(A)	Organic Qualitative Analysis	2-2
Ph-610(B)	Survey of Atomic and Nuclear Physics	3-0
EE-745(A)	Electronic Control and Measurement	3-3
IT-101(L)	Industrial and Technical Lectures I	0-1
		13-10

FOURTH TERM

Ch-322(A)	Organic Chemistry Advanced	3-2
Ch-541(A)	Reaction Motors	2-2
Ch-800(A)	Chemistry Seminar	2-0
ME-601(C)	Materials Testing Laboratory	0-2
Oa-151(B)	Survey of Weapons Evaluation	3-0
Ph-450(B)	Underwater Acoustics	3-2
IT-102(L)	Industrial and Technical Lectures II	0-1
		13-9

Intersessional period: IE-102(C)—Elements of Management and Industrial Engineering at USNPGS, Monterey.

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)

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

ORDNANCE ENGINEERING (Fire Control)

(GROUP DESIGNATOR OF)

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 (OF1)

FIRST TERM

Ch-101(C)	General Inorganic Chemistry	3-2
EE-151(C)	DC Circuits and Fields	3-4
Ma-120(C)	Vector Algebra and Geometry	3-1
Ma-111(C)	Introduction to Engineering Mathematics	3-1
Mc-101(C)	Engineering Mechanics I	2-2
		14-10

SECOND TERM

Ch-711(C)	Chemical Engineering Calculations	3-2
EE-241(C)	AC Circuits	3-2
Ma-112(B)	Differential Equations and Infinite Series	5-0
Mc-102(C)	Engineering Mechanics II	2-2
Or-101(C)	Ordnance I	2-1
		15-7

THIRD TERM

Ch-631(A)	Chemical Engineering Thermodynamics	3-2
EE-461(C)	Transformers and Synchros	3-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
Mc-401(A)	Exterior Ballistics	3-0
Or-103(C)	Ordnance III	2-2
Ph-610(B)	Survey of Atomic and Nuclear Physics	3-0
IT-101(L)	Industrial and Technical Lectures I	0-1
		17-7

FOURTH TERM

Ch-401(A)	Physical Chemistry (Ordnance)	3-2
EE-462(B)	Asynchronous Motors and Special Machines	4-2
Ma-114(A)	Functions of a Complex Variable and Vector Analysis	3-0
Or-104(C)	Ordnance IV	2-1
Ph-450(B)	Underwater Acoustics	3-2
IT-102(L)	Industrial and Technical Lectures II	0-1
		15-8

Intersessional period: Field trip to representative ordnance installations.

SECOND YEAR (OF2)

FIRST TERM

Ch-571(A)	Explosives	3-2
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
		15-10

SECOND TERM

EE-745(A)	Electronic Control and Measurement	3-3
Ma-125(B)	Numerical Methods for Digital Computers	2-2
Mc-402(A)	Mechanics of Gyroscopic Instruments	3-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
Ph-240(C)	Geometrical and Physical Optics	3-3
		14-10

THIRD TERM

EE-665(B)	Lines, Filters, and Transients	4-2
Es-447(C)	Electronic Pulse Techniques	3-0
Ma-351(B)	Industrial Statistics I	3-2
Ma-421(A)	Digital and Analog Computation	3-2
Mt-203(B)	Physical Metallurgy (Special Topics)	2-2
Or-241(C)	Guided Missles I	2-0
IT-101(L)	Industrial and Technical Lectures	0-1
		17-9

FOURTH TERM

Ch-541(A)	Reaction Motors	2-2
EE-672(A)	Servomechanisms	3-3
Ma-401(A)	Analog Computers	2-2
Ma-352(B)	Industrial Statistics II	2-2
Oa-151(B)	Survey of Weapons Evaluation	3-0
Or-242(B)	Guided Missiles II	2-0
IT-102(L)	Industrial and Technical Lectures	0-1
		14-10

Intersessional period: IE-102(C)—Elements of Management and Industrial Engineering at USNPGS, Monterey:

THIRD YEAR (OF3)

At Massachusetts Institute of Technology

FALL SEMESTER

16.33 Instrumentation and Control Laboratory
16.39 Vector Kinematics and Gyroscopic Instrument Theory
16.41 Fire Control Principles
16.472 Rockets, Guided Missles, and Projectiles
6.291 Principles of Radar
Thesis

SPRING SEMESTER

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

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

ORDNANCE ENGINEERING (Industrial)

(GROUP DESIGNATOR OI)

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-579 Advanced Production Control
GE-585 Industrial Relations
GE-587 Wage Administration
Stat-501 Statistical Methods in Engineering
PSY-570 Personnel Psychology

SPRING SEMESTER

GE-583 Plant Layout
GE-590 Projects in Industrial Engineering (Program Planning)
GE-655 Seminar in Industrial Management
Electives:
GE-690 Advanced Production Problems
GE-692 Advanced Industrial Engineering Problems
GE-694 Research in Industrial Relations
PSY-574 Psychology of Industrial Training

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

THIRD YEAR (OI3)

At Rensselaer Polytechnic Institute

SUMMER TERM

G6.30 Law For Engineers
T6.32 Motion and Time Study

FALL SEMESTER

T6.28 Cost Finding and Control
T6.34 Production Planning and Control
G6.40 Advanced Motion and Time Study
G6.60 Organization Planning and Development
T3.26 Personnel Tests and Measurements

SPRING SEMESTER

G6.21 Cost Analysis
T6.27 Statistical Methods
G6.45 Production Management
G6.65 Industrial Relations
G6.80 Seminar in Management

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

ORDNANCE ENGINEERING (Guided Missiles)

(GROUP DESIGNATOR OG)

OBJECTIVE

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

FIRST YEAR (OG1)

FIRST TERM

Ch-101(C)	General Inorganic Chemistry	3-2
EE-151(C)	Direct-Current Circuits and Fields	3-4
Ma-111(C)	Introduction to Engineering Math	3-1
Ma-120(C)	Vector Algebra and Geometry	3-1
Mc-101(C)	Engineering Mechanics I	2-2
		14-10

SECOND TERM

Ae-100(C)	Basic Aerodynamics	3-4
EE-251(C)	Alternating-Current Circuits	3-4
Ma-112(B)	Differential Equations and Infinite Series	5-0
Mc-102(C)	Engineering Mechanics II	2-2
Or-101(C)	Ordnance I	2-1
		15-11

THIRD TERM

Ae-121(C)	Technical Aerodynamics	3-2
Es-261(C)	Electron Tubes and Circuits I	3-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of Complex Variables	3-0
ME-150(C)	Thermodynamics	4-2
ME-500(C)	Strength of Materials	3-0
ME-601(C)	Materials Testing Lab	0-2
		16-8

FOURTH TERM

Ae-136(B)	Aircraft Performance Flight Analysis	3-2
Ch-401(A)	Physical Chemistry (Ordnance)	3-2
Es-262(C)	Electron Tubes and Circuits II	3-2
Ma-114(A)	Functions of Complex Variables and Vector Analysis	3-0
Mc-311(A)	Vibrations	3-2
		15-8

Intersessional Period: Field trip to representative guided missile activities.

SECOND YEAR (OG2)

FIRST TERM

Ae-501(A)	Hydro-Aero Mechanics I	4-0
EE-671(A)	Transients	3-4
Es-267(A)	Electron Tubes and UHF Techniques	3-2
Ma-115(A)	Differential Equations for Automatic Control	3-0
Ma-116(A)	Matrices and Numerical Methods	3-2
		16-8

SECOND TERM

Ae-502(A)	Hydro-Aero Mechanics II	4-0
EE-745(A)	Electronic Control and Measurement	3-3
Es-461(A)	Pulse Techniques	3-3
Ma-421(A)	Digital and Analog Computation	3-2
Mc-201(A)	Methods in Dynamics	2-2
		15-10

THIRD TERM

Ae-146(A)	Aircraft Dynamics	3-2
Ae-508(A)	Compressibility	3-2
EE-463(C)	Transformers, Controls and Spec. Mach.	3-2
EE-473(B)	Synchros	2-2
Es-422(B)	Radar Systems I	3-3
		14-11

FOURTH TERM

EE-672(A)	Servo Mechanisms	3-3
Es-423(B)	Radar Systems II	3-6
Ma-301(B)	Statistics	3-2
Ma-401(A)	Analog Computers	2-2
		11-13

Nuclear Weapons and Reactor Orientation (1 week) between 7th and 8th terms.

Intersessional Period: IE-102(C) Elements of Management and Industrial Engineering at U. S. Naval Postgraduate School (8 weeks).

THIRD YEAR (OG3)

FIRST TERM

Ch-541(A)	Reaction Motors	2-2
Ch-571(A)	Explosives	3-2
EE-673(A)	Non-linear Servos	2-2
Mc-402(A)	Mechanics of Gyro Instruments	3-0
Mt-201(C)	Introduction to Physical Metallurgy	3-2
Or-241(C)	Guided Missiles I	2-0
		15-8

SECOND TERM

Es-341(C)	Radio Telemetry and Simulation	3-3
Me-401(A)	Exterior Ballistics	3-0
Mr-101(C)	Fundamentals of Atmospheric Circulation	2-0
Mt-202(C)	Ferrous Physical Metallurgy	3-2
Oa-151(B)	Survey of Weapons Evaluation	3-0
Or-242(B)	Guided Missiles II	2-0
		16-5

THIRD TERM

This term (11 weeks) is spent in a guided missiles laboratory working under the cognizance of or under contract to the Bureau of Ordnance. The officer student works as a junior engineer on a project related to or forming a part of his thesis.

FOURTH TERM

Es-536(B)	Countermeasures	2-3
ME-310(B)	Heat Transfer	4-2
Mt-301(A)	High Temperature Materials	3-0
	Thesis	2-9
		11-14

This curriculum is expected to afford the opportunity to qualify for the degree of Master of Science.

ORDNANCE ENGINEERING (Special Physics)

(GROUP DESIGNATOR OX)

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 (OX1)

FIRST TERM

Ch-101(C)	General Inorganic Chemistry	3-2
Es-141(C)	Fundamentals of Electric Circuits and Fields	4-4
Ma-100(C)	Vector Algebra and Geometry	2-1
Ma-181(C)	Partial Derivatives and Multiple Integrals	4-1
Mr-100(C)	Fundamentals of Atmospheric Circulation	2-0
		15-8

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
Or-101(C)	Ordnance I	2-1
		18-7

THIRD TERM

EE-451(C)	Transformers and Synchros	2-2
Es-143(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
IT-101(L)	Industrial and Technical Lectures 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
IT-102(L)	Industrial and Technical Lectures II	0-1
		16-7

Intersessional period: Field trip.

SECOND YEAR (OX2A)

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
Ph-750(A)	Physics Seminar	1-0
		14-5

SECOND TERM

Es-461(A)	Pulse Techniques	3-3
Ph-541(B)	Kinetic Theory and Statistical Mechanics	4-0
Ph-642(A)	Nuclear Physics	4-0
Ph-643(A)	Nuclear Physics Laboratory	0-3
Ph-721(A)	Introduction to Quantum Mechanics	4-0
Ph-750(A)	Physics Seminar	1-0
		16-6

THIRD TERM

Es-161(A)	Electronic Instrumentation and Circuits	3-3
Ph-343(A)	Nuclear Instrumentation	4-0
Ph-352(A)	Electromagnetic Waves	3-0
Ph-644(A)	Advanced Nuclear Physics	4-0
Ph-645(A)	Advanced Nuclear Physics Laboratory	0-3
Ph-750(A)	Physics Seminar	1-0
IT-101(L)	Industrial and Technical Lectures I	0-1
		15-7

FOURTH TERM

Es-162(A)	Electronics Instrumentation and Circuits	3-3
Ma-301(B)	Statistics	3-2
Ph-441(A)	Shock Waves in Fluids	3-0
Ph-723(A)	Physics of the Solid State	4-0
IT-102(L)	Industrial and Technical Lectures II	0-1
Ph-750(A)	Physics Seminar	1-0
		14-6

Intersessional period: Field trip.

THIRD YEAR (OX3A)

The third year consists of approximately ten-months work at the Radiation Laboratory of the University of California (Berkeley) under the auspices of the Postgraduate School. A thesis is prepared during this period. This curriculum affords the opportunity to qualify for the degree of Master of Science in Physics.

SECOND YEAR (OX2)

At Massachusetts Institute of Technology

SUMMER SEMESTER

6.20 Electronic Control and Measurements
8.071 Thermodynamics and Statistical Mechanics
6.80 Electrical Measurements Laboratory
8.08 Electronics

FALL SEMESTER

6.633 Electronic Circuit Theory
8.05 Atoms, Molecules and Nuclei I
8.72 Introduction to Theoretical Physics (Electromagnetic Theory)
L17 Scientific German
M39 Methods of Applied Mathematics

Intersessional period: Field trip.

SPRING SEMESTER

6.623 Pulse Circuits, Principles
8.06 Atoms, Molecules and Nuclei II
8.60 Special Problems in Nuclear Physics
8.71 Introduction to Theoretical Physics (Mechanics)

THIRD YEAR (OX3)

At Massachusetts Institute of Technology

FALL SEMESTER

8.361 Quantum Theory of Matter I
8.511 Nuclear Physics I
8.60 Special Problems in Nuclear Physics
N21 Nuclear Reactor Engineering I

SPRING SEMESTER

8.512 Nuclear Physics II
N22 Nuclear Reactor Engineering II
Thesis

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

PETROLEUM ENGINEERING

(GROUP DESIGNATOR NP)

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 (NP1)

FIRST TERM

Ch-121(B)	General and Petroleum Chemistry	4-2
Cr-301(B)	Crystallography and Mineralogy	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
		14-10

SECOND TERM

Ch-221(C)	Qualitative Analysis	3-2
Ge-401(C)	Petrology and Petrography	2-3
Ma-112(B)	Differential Equations and Infinite Series	5-0
ME-500(C)	Strength of Materials	3-0
Mt-201(C)	Introductory Physical Metallurgy	3-2
		16-7

THIRD TERM

Ch-231(C)	Quantitative Analysis	2-4
Ch-311(C)	Organic Chemistry	3-2
Ch-411(C)	Physical Chemistry	3-2
Ge-101(C)	Physical Geology	3-2
Ma-113(B)	Introduction to Partial Differential Equations and Functions of a Complex Variable	3-0
		14-10

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
ME-601(C)	Materials Testing Laboratory	0-2
		11-12

Intersessional period: Field trip.

SECOND YEAR (NP2)

At University of California

SUMMER SESSION

(Second half)

ED102 Dynamics
ME103 Elementary Fluid Mechanics

FALL TERM

Chem. 143 Introduction to Chemical Engineering
Chem. 144 Thermodynamics
Pet. Eng. 101 Oil Field Development
Mech. Eng. 230 Engineering Analysis

SPRING TERM

Math. 130E Statistical Inference for Engineers
Pet. Eng. 102 Oil Reservoir Engineering and Production
Mech. Eng. 152 Industrial Mass Transfer
Mech. Eng. 161 Applied Fluid Mechanics

Intersessional period: Field trip.

THIRD YEAR (NP3)

At University of California

FALL TERM

Chem. 146B Chemical Engineering Unit Operations
Mining 101 Mineral Economics
Pet. Eng. 207A Fundamentals of Reservoir Eng.
Pet. Eng. 298A Group Study
Pet. Eng. 299A Individual study or research

SPRING TERM

Elective
Pet. Eng. 298B Group Study
Pet. Eng. 299B Individual study or research
Comprehensive examination
ME-164 Instrumentation and Automatic Control

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 affords the opportunity to qualify for the degree of Master of Engineering.

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, and other reasons.

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

DESCRIPTIONS

BUSINESS ADMINISTRATION

GROUP DESIGNATORS:

At Harvard University—ZKH
At Univ. of Michigan—ZKM
At Stanford University—ZKS

OBJECTIVE

A curriculum consisting generally of courses in the fields of finance, business organization, marketing, statistics, public relations, administrative practices, and geography. The one-year curriculum at the University of Michigan is for advanced students. The curricula at Harvard and Stanford Universities are of two-years duration. The summer between academic years is spent in individual assignments with industrial companies.

CINEMATOGRAPHY

(GROUP DESIGNATOR ZCP)

At the University of Southern California

OBJECTIVE

A twelve-month curriculum, to prepare officers for assignments to duty in connection with the production of training films and motion picture reports. 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.

CIVIL ENGINEERING (Qualification)

(GROUP DESIGNATOR ZG)

At Rensselaer Polytechnic Institute

OBJECTIVE

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

Refresher Period 8 weeks

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

SUMMER SESSION

5.76 Structural Analysis I
5.78 Reinforced Concrete I
10.11 Engineering Geology

FALL TERM

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

SPRING TERM

5.32 Soil Mechanics (CEC)
5.79 Reinforced Concrete II
T5.82 Indeterminate Structures I
12.42 Heating and Ventilation (CEC)
13.541 Metallurgy and Welding (CEC)
G5.82 Shipbuilding and Ship Repair Facilities (CEC)
T6.28 Cost Finding and Control

SECOND SUMMER SESSION

5.16 Topographical Survey (Field Trip)
5.18 Route Survey (Field Trip)
5.59 Sanitary Engineering
7.69 Power Plants (CEC) Electrical Engineering
12.48 Power Plants (CEC) Mechanical Engineering
5.35 Foundation Engineering (CEC)

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

CIVIL ENGINEERING (Advanced)

SOIL MECHANICS AND FOUNDATIONS

(GROUP DESIGNATOR ZGR)

At Rensselaer Polytechnic Institute

OBJECTIVE

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

SUMMER TERM

1.25 Engineering Mathematics
10.11 Engineering Geology
Soil Mechanics and Foundations Refresher

FALL TERM

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

SPRING TERM

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

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

CIVIL ENGINEERING (Advanced)

STRUCTURES
(GROUP DESIGNATOR ZGI)

At the University of Illinois

OBJECTIVE

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

FIRST SUMMER

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

FALL SEMESTER

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

SPRING SEMESTER

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

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

SECOND SUMMER

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

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

CIVIL ENGINEERING (Advanced)

SANITARY ENGINEERING
(GROUP DESIGNATOR ZGM)

At the University of Michigan

OBJECTIVE

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

SUMMER

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

FALL

BACT109 Bacteriology for Engineers
CE153 Sewerage and Sewage Disposal
CE155 Municipal and Industrial Sanitation
EH225 Sanitary Chemistry
EH241 Principles and Methods of Industrial Health
CE255 Sanitary Engineering Seminar

SPRING

CE157 Industrial Waste Treatment
CE250 Sanitary Engineering Research
CE254 Advanced Sanitary Engineering Design
PHS231 Statistics Applied to Stream Analysis
ME193 Procedures and Design in the Handling of Radioactive Materials,
or
EH228 Radiological Health

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

CIVIL ENGINEERING (Advanced)

WATERFRONT FACILITIES

(GROUP DESIGNATOR ZGP)

At Princeton University

OBJECTIVE

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

SUMMER TERM

Mathematics
Strength of Materials
Reinforced Concrete
Structural Analysis
Statics
Soil Mechanics

FALL TERM

CE501 Soil Stabilization
CE505 Advanced Structures
CE511 Waterfront Structures
CE513 Port and Harbor Engineering
ME531 Applied Elasticity
Thesis

SPRING TERM

CE502 Soil Mechanics
CE504 Municipal Engineering
CE508 Soil Physics
CE512 Waterfront Structures
Thesis

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

COMPTROLLERSHIP

(GROUP DESIGNATOR ZS)

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.

SUMMER SESSION

ACCT 3 General Accounting
BA 271 Readings and Conferences in Comptrollership
BA 275 Human Relations in Business

AUTUMN SEMESTER

ACCT 212 Managerial Accounting
ACCT 247 Governmental Budgeting
BA 263 Business Organization and Management
BA 265 Seminar in Comptrollership
ECON 195 Industrial and Governmental Economics
STAT 119 Statistics with Application to Comptrollership

SPRING SEMESTER

ACCT 204 Cost Accounting
ACCT 248 Governmental Budgeting
ACCT 275 Internal Control and Auditing
BA 264 Business Organization and Management
BA 276 Human Relations in Business
BA 286 Research Seminar in Comptrollership

This curriculum affords the opportunity to qualify for the degree of Master in Business Administration.

HYDROGRAPHIC ENGINEERING

(GROUP DESIGNATOR ZV)

At Ohio State University

OBJECTIVE

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

MANAGEMENT AND INDUSTRIAL ENGINEERING

(GROUP DESIGNATOR ZT)

At Rensselaer Polytechnic Institute

OBJECTIVE

To prepare selected officers for managerial and industrial engineering billets in the Navy's industrial organization. The curriculum majors in industrial engineering and its application to managerial problems.

SUMMER TERM

T6.32 Motion and Time Study
G6.30 Law for Engineers

FALL TERM

T6.27 Statistical Methods
T6.28 Cost Finding and Control
T6.34 Production Planning and Control
G6.60 Organization Planning and Development
T3.26 Personnel Tests and Measurements

SPRING TERM

G6.21 Cost Analysis
G6.40 Advanced Motion and Time Study
G6.45 Production Management
G6.65 Industrial Relations
G6.80 Seminar in Management
or
G6.90 Thesis

This curriculum affords the opportunity to qualify for a graduate degree.

METALLURGICAL ENGINEERING

(GROUP DESIGNATOR ZNM)

At Carnegie Institue of Technology

OBJECTIVE

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

FALL SEMESTER

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

SPRING SEMESTER

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

This curriculum does not lead to a degree.

NAVAL CONSTRUCTION AND ENGINEERING

(GROUP DESIGNATOR ZNB)

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

OBJECTIVE

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

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

FIRST SUMMER

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

FIRST YEAR

FALL

2.081 Strength of Materials
2.402 Heat Engineering
15.11 Introduction to Industrial Management
1.612 Fluid Mechanics
13.17 History of Warships
M351 Adv. Calculus for Engineers

SPRING

1.401 Structures
10.311 Heat Transfer
13.012 Naval Architecture
13.12 Warship General Arrangement
13.21 Warship Form Design
M352 Adv. Calculus for Engineers
Intersessional period: Field trip.

SECOND YEAR

FALL

1;63 Applied Hydromechanics
13.13 Warship Structural Theory I
13.22 Warship General Design
13.75 Warship Propulsion
13.791 Marine Propellers
13.90 Warship Electrical Engineering
3.391 Properties of Metals

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
N10 Introduction to Nuclear Technology
Intersessional period: Field trip.

THIRD YEAR

FALL

2.126 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
1.561 Advanced Structural Mechanics
Thesis

SPRING

13.26 Preliminary Design of Warships
1.562 Advanced Structural Mechanics
13.04 Ship Design, Advanced
3.15 Welding Engineering
Thesis

This curriculum affords the opportunity to qualify for the degree of Naval Engineer.

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

XIII-A-2 Marine Electrical Engineering
XIII-A-3 Electronics Engineering
XIII-A-4 Ship Propulsion Engineering
XIII-A-5 Nuclear Engineering

Hull Design and Construction at Webb Institute of Naval Architecture

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

FIRST SUMMER

Practical Naval Architecture I
Calculus Review
Mechanics Review

FIRST YEAR

Calculus III and IV
Differential Equations
Theoretical Fluid Mechanics I and II
Ship Model Testing
Thermodynamics I
Mechanical Processes
Mechanics of Materials I and II
Laying Off
Practical Naval Architecture II and III
Theoretical Naval Architecture I and II
Naval Architecture Design I and II
Ship Resistance and Propellers I

SECOND YEAR

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

THIRD YEAR

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

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

NAVAL INTELLIGENCE

(GROUP DESIGNATOR ZI)

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

OBJECTIVE

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

NUCLEAR ENGINEERING (Advanced)

(GROUP DESIGNATOR ZNE)

At Massachusetts Institute of Technology

OBJECTIVE

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

FIRST SUMMER

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

FALL

8.531 Nuclear Physics for Engineers I
3.396 Technology of Nuclear Reactor Materials
2.521 Advanced Heat Transfer I
N21 Nuclear Reactor Theory I
N41 Nuclear Engineering Laboratory I

SPRING

8.532 Nuclear Physics for Engineers II
N20 Biological Effects of Radiation
N23 Nuclear Reactor Engineering
Thesis
One elective from:
N22 Nuclear Reactor Theory II
2.522 Advanced Heat Transfer II

2.783 Control Problems in M.E.
3.43 Corrosion
3.44 Behavior of Metals at Elevated Temperatures

SECOND SUMMER

Thesis

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

OCEANOGRAPHY

(GROUP DESIGNATED ZO)

At the University of Washington

OBJECTIVE

A one-year curriculum to prepare officers for assignment to billets requiring specialized knowledge in the field of oceanography.

For students with adequate educational background this curriculum affords the opportunity to qualify for the degree of Master of Science.

PERSONNEL ADMINISTRATION AND TRAINING

(GROUP DESIGNATOR ZP)

At Stanford University

OBJECTIVE

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

PETROLEUM LOGISTICS

(GROUP DESIGNATOR ZL)

At the University of Pittsburgh and in the petroleum industry

OBJECTIVE

A two-year program consisting of one full year of academic work at the University of Pittsburgh followed by a year in the field with a major oil company. It is designed to equip senior officers with a broad understanding of the petroleum industry, its problems and economics, for duties with 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 Laboratory
Pet. Eng. 106 Petroleum Production Laboratory
Pet. Eng. 110 Fundamentals of Reservoir Eng.
Chem. Eng. 17 Petroleum Processes
Geology 2 Historical Geology

SPRING

Pet. Eng. 102 Petroleum Production Practice
Pet. Eng. 107 Gathering, Transportation and Storage
Pet. Eng. 108 Reservoir Eng. Seminar
Pet. Eng. 200 Research and Thesis
Pet. Eng. 111 Principles of Natural Gas Engineering
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 procedure in office and field, in close contact with the management.

This curriculum affords the opportunity to qualify for the degree of Master of Science on completion of the summer term of academic work.

PUBLIC INFORMATION

(GROUP DESIGNATOR ZIB)

At Boston University

OBJECTIVE

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

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

RELIGION

(GROUP DESIGNATOR ZU)

At University chosen by student

OBJECTIVE

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 enrolled at Harvard University, Union Theological Seminary, the Menninger Foundation and Notre Dame.

SPECIAL MATHEMATICS

OBJECTIVE

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

The course has been given at the University of Illinois, and more recently at the Naval Postgraduate School.

TEXTILE ENGINEERING

(GROUP DESIGNATOR ZM)

At Georgia Institute of Technology

OBJECTIVE

A two-year program of study 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.

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

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

Text: Taylor: Elementary Meteorology.

Prerequisite: None.

Mr-110(C) Aerological Aspects of Atomic, Biological, and Chemical Warfare 3-0

Classified information involving the effects of weather on ABC warfare.

Texts: Classified official publications.

Prerequisites: Ph-191(C) or equivalent and Mr-203(C) or Mr-212(C) or Mr-227(B).

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

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

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

Prerequisite: None.

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

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

Text: Taylor: Elementary Meteorology.

Prerequisite: None.

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

Elementary principles of meteorology are outlined by lectures and motion pictures. Methods, instruments, and conventions used in observing and representing graphically 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 is made.

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

Prerequisite: None.

Mr-202(C) Weather-Map Analysis 3-9

Lectures cover representativeness and diurnal variation of meteorological elements; anatomy and synoptic characteristics of fronts, wave cyclones, and occlusions; upper-air charts; differential analysis; advection charts. In the 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 is made by the students to compare observed flight conditions with those indicated on the weather map.

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

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

Mr-203(C) Weather Analysis and Prognosis 2-9

A continuation of Mr-202(C). Lectures cover air-mass formation and structure; analysis of the lower and upper troposphere, including cross-sections; the jet stream; pressure-change mechanisms; and features of prognostic value including long waves, blocks, cut-off lows, vorticity considerations, short waves, zonal winds, weather types, and normals. In the laboratory, advanced methods of current weather-map analysis and elementary methods of prognosis are presented. The relation between upper-level and surface analysis is stressed. Students do differential analysis, isotach analysis, isobaric height extrapolations, relative geostrophic vorticity charts, thermal-advection charts, and both surface and upper-level prognostic charts.

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

Prerequisite: Mr-202(C).

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

A continuation of Mr-203(C). Lectures cover additional methods of forecasting the displacement and intensity of fronts and pressure systems; forecasting cloudiness, ceiling height, visibility, surface and upper-level winds, precipitation, temperature, fog, thunderstorms, and tornadoes. In the laboratory, student teams analyze surface and upper-level charts, prepare prognostic charts, and make forecasts. Daily discussions of the analysis, prognostic charts, and forecasts are held. Flight forecasts are verified periodically by flights along the route.

Texts: Riehl et al: Forecasting in Middle Latitudes; selected NavAer, AROWA, and Air Weather Service publications; departmental notes.

Prerequisite: Mr-203(C).

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

Lectures cover significance and forecasting of clouds, precipitation, temperature, wind, icing, turbulence, and severe weather; flight forecasting; forecasting for ship and amphibious operations. In the laboratory students are assigned watches in aerological office routines, weather central duties, and flight forecasting.

Texts: Departmental notes; selected articles from professional publications.

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

Mr-211(C) Weather Codes, Maps, and Elementary Map 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; representativeness and diurnal variation of meteorological elements; synoptic characteristics of fronts, wave cyclones, and occlusions. An aerology series of motion pictures is shown. In the 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.

Text: Departmental notes.

Prerequisite: None.

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

Continuation of Mr-211(C). Lectures cover weather-producing processes; representativeness and diurnal variation of meteorological elements; synoptic characteristics of fronts, wave cyclones, and occlusions; upper-air analysis, including temperature fields and the jet stream; graphical arithmetic, thickness and height-change charts, and height extrapolations. Laboratory consists of practice in the preparation of sea-level, constant-pressure, and differential charts, with elementary extrapolation techniques of prognosis.

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

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

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

Prognostic techniques discussed include mechanisms of pressure change, long-wave and vorticity methods, thickness and continuity charts, movement and development of surface pressure systems, movement of fronts, weather types, air-mass properties and weather, and a checkoff list for general prognostic procedure. Laboratory work includes analysis and prognosis for North America and the adjacent Pacific, both surface and 500 mb., using supplementary charts of pressure changes, vorticity, and stability indices; and forecasts for various selected stations and areas.

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

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

Mr-215(B) Advanced Weather Analysis and Forecasting 2-12*

Lectures concern forecasting actual operational weather. Topics covered are severe-weather forecasting, tornadoes, maximum wind gusts, hail, icing, turbulence, and operational weather affecting jet aircraft operation. In the laboratory, practice in surface and upper-air analysis and prognosis is continued; practice operational weather forecasts are made and verified daily.

Texts: Departmental notes; articles from Monthly Weather Review, A.M.S. Bulletin, and Compendium of Meteorology; Air Weather Service Severe Weather Center Procedures 105-37 and later modifications; NavAer 00-80T-37: All-Weather Flight Manual.

Prerequisite: Mr-204(C).

*Presented as a 2-9 course for the MM Curriculum.

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

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

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

Prerequisite: Mr-215(B).

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

Constant-pressure, jet-stream, and isotach analyses are presented, supplemented by surface-map analysis in Mr-216(B); time cross-sections, constant absolute vorticity trajectories, space-mean charts, and relative vorticity charts are constructed; computations for pressure-pattern flights are carried out and checked by inflight observations; daily prognostic charts and forecasts for selected stations are prepared.

Text: None.

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

Mr-218(B) Tropical Analysis and Forecasting 0-9

General features of tropical meteorology; time cross-sections, streamline analysis; analysis of waves in the easterlies, the intertropical convergence zone, and tropical cyclones; forecasting the formation, movement, and dissipation of tropical cyclones using the latest techniques available.

Texts: Riehl: Tropical Meteorology; AROWA publications.

Prerequisites: Mr-217(B) and Mr-228(B) (may be taken concurrently).

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

Tropical meteorology, including hurricane forecasting; arctic meteorology; Southern Hemisphere meteorology; the general circulation; other topics as time permits.

Texts: Riehl: Tropical Meteorology; selected NavAer publications on polar expeditions; departmental notes.

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

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

Lectures cover fundamental weather-producing processes; principles of surface-map analysis, constant-pressure and differential analyses and preparation of surface and upper-air prognostic charts, with emphasis on the role of the jet stream. In the laboratory, upper-air observations and analyses are used to determine air-mass characteristics; three-dimensional weather analysis is 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: Saucier: Principles of Meteorological Analysis: Berry, Bollay, and Beers: Handbook of Meteorology; selected NavAer and AROWA publications; departmental notes.

Prerequisites: Mr-411(B), Mr-412(A), and Ma-123(A).

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, blocks, cutoffs, long waves, continuity charts, vorticity advection, CAV trajectories, and methods of extended analysis. 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; and NavAer 50-IP-502: Practical Methods of Weather Analysis and Prognosis.

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

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

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

Text: Riehl: Tropical Meteorology.

Prerequisite: Mr-321(A) 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 Navy and Weather Bureau publications; departmental notes.

Prerequisites: Ma-134(B) or Ma-125(B) and Ma-330(C), and Mr-321(A).

Mr-230(A) Operational Forecasting 0-10

Presentation and application of recent developments in the technique of preparing prognostic charts. Vorticity and space-mean charts, vertical motion and horizontal divergence computations, numerical forecasting.

Text: Departmental notes.

Prerequisites: Mr-227(B), Mr-322(A), and Mr-520(B).

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

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

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

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

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

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

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

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

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

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

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

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

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) and Ma-123(A).

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), and Ma-134(B) or Ma-125(B) and Ma-330(C).

Mr-323(A) Dynamic Meteorology III 3-0

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

Text: Sutton: Micrometeorology.

Prerequisites: Mr-321(A), and Mr-322(A) concurrently, and Ma-134(B) or Ma-125(B) and Ma-330(C).

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

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

Texts: U. S. Navy: Manual of the Aerological Service; departmental notes.

Prerequisite: Ph-191(C) or equivalent.

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

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

Text: Haltiner: Elementary Meteorological Thermodynamics (mimeographed).

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

Mr-403(B) Introduction to Micrometeorology 3-0

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

Texts: Departmental notes.

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

Mr-410(C) Meteorological Instruments 2-2

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

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

Prerequisites: Ma-163(C) or equivalent and 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, and Gustin: Dynamic Meteorology; U. S. Department of Commerce Publication: The Thunderstorm.

Prerequisites: Ma-132(C) or Ma-123(A) concurrently, and Ph-196(C) or Ph-198(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 and visibility.

Texts: Johnson: Physical Meteorology; Neuberger: Introduction to Physical Meteorology.

Prerequisite: Mr-411(B) (may be taken concurrently).

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

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

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

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

Prerequisite: Mr-200(C).

Mr-510(C) Climatology 2-0

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

Text: Haurwitz and Austin: Climatology.

Prerequisite: Mr-200(C).

Mr-520(B) Applied Climatology 2-2

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

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

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

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

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

Texts: H.O. 604: Techniques for Forecasting Wind Waves and Swell; H.O. 234: Breakers and Surf; N.Y.U. Tech. Rep. No. 1: Practical Methods for Observing and Forecasting Ocean Waves.

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

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

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

Text: None.

Prerequisites: Mr-422(A), Mr-520(B), Ma-331(A), and Ma-135(B) or Ma-421(A).

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: Fluid Mechanics; Rouse: Elementary Fluid 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 Performance I 4-2

The aerodynamic characteristics of the airplane; propeller and jet engine characteristics; sea level performance; performance at altitudes; range and endurance; special performance problems; charts. The laboratory periods are devoted to computations and performance analysis.

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

Prerequisite: Ae-121(C).

Ae-132(B) Technical Aerodynamics Performance II 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: USNPGS Notes; Perkins: Aircraft Stability and Controllability; Hamlin: Flight Testing.

Prerequisite: Ae-131(C).

Ae-142(A) Dynamics II 3-4

The Euler equations of motion; the moments of inertia of aircraft; the aerodynamic reactions and derivatives; solution of the symmetrical or longitudinal motion analysis; solution of the asymmetrical or lateral motion analysis; effect of control freedom, of controls and response; spins. The laboratory work consists of wind tunnel experimentation on models to study some of the above problems.

Texts: The same as in Ae-141(A).

Prerequisite: Ae-141(A).

Ae-146(A) Dynamics 3-2

Fundamental definitions, forces and moments of composite aircraft; equations of motion; static stability and trim; effects of CG location; static margins; free control stability; dynamic longitudinal stability; dynamic lateral stability, force and moment; derivatives; stability charts; controllability; maneuverability; three-dimensional motions; spins. Laboratory work consists of experimentation and analysis of static and dynamic stability of some particular aircraft.

Texts: Same as in Ae-141(A).

Prerequisite: Ae-131(C) or Ae-136(B).

Ae-151(B) Flight Testing and Evaluation I 2-0

The technical aerodynamics of airplanes, especially performance and test methods.

Texts: Dommasch, Sherby and Connolly: Airplane Aerodynamics; NATC Patuxent, Flight Test Manual; NavAer publications.

Prerequisite: Ae-132(B).

Ae-152(B) Flight Testing and Evaluation II 2-0

Theoretical longitudinal stability and control of aircraft, related test methods and aircraft evaluation.

Texts: Same as Ae-151(B).

Prerequisites: Ae-141(A) or Ae-146(A).

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

Theoretical lateral-directional control of aircraft, related test methods and aircraft evaluation.

Texts: Same as Ae-151(B).

Prerequisite: Ae-142(A) or Ae-146(A).

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

Flight program accompanying Ae-151(B). Test flying in naval aircraft by aviator students and reduction of resulting data: airspeed calibration; level flight performance and fuel consumption; climb performance.

Ae-162(B) Flight Testing and Evaluation Laboratory II 0-4

Flight program accompanying Ae-152(B). Test flying in naval aircraft by aviator students: stalls; static and dynamic longitudinal stability; static and maneuvering neutral points; control effectiveness; trim changes; Mach effects.

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

Flight program accompanying Ae-153(B). Test flying in naval aircraft by aviator students: rate of roll; adverse yaw; control effectiveness with asymmetric power; static and dynamic lateral-directional stability; over-all qualitative evaluation of aircraft.

Ae-200(C) Rigid Body Statics 3-2

This course parallels Mc-101, extending the coverage of rigid body statics graphically and analytically to meet design requirements of aircraft components. Topics include: plane, compound and complex trusses; centroids, moments of inertia, properties of aircraft sections; moments of inertia of aircraft, balance diagrams; simple, compound and complex space frames; load lines, shear and bending moment diagrams; influence lines.

Texts: Bruhn: Analysis and design of Airplane Structures; Niles and Newell: Airplane Structures, 3rd Ed., Vol. 1; Timoshenko and Young: Statics.

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

Ae-211(C) Strength of Materials 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.

Texts: Bruhn: Analysis and Design of Airplane Structures; Niles and Newell: Airplane Structures, 3rd Ed., Vol. I; Timoshenko: Strength of Materials, Vol. I.

Prerequisite: Ae-200(C).

Ae-212(C) Stress Analysis I 4-2

The general state of plane stress in complicated components of 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 II 4-2

A continuation of Ae-212. Strain energy, curved bars and frames. Topics are: strain energy, applications to impact loading; Castigliano theorem; displacements in trusses, trusses with redundant members; virtual energy applications, Maxwell-Mohr method; law of reciprocal deflection, influence line applications; energy methods applied to buckling; curved bars, stresses and deflections; rotating machine parts.

Texts: The same as in Ae-212(C).

Prerequisite: Ae-212(C).

Ae-214(A) Stress Analysis III 3-0

A continuation of Ae-213. The general three dimensional state of stress, strain and displacement in elastic media. Thin stiff plates under lateral load in bending. Axially symmetrical plates and membranes. Discontinuity effects in shells. Beams on elastic foundation, applications to cylinder and hemisphere or flat plate or hollow ring. Thick walled spheres and 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 design and analysis of a jet airplane. Preliminary layout, three-view drawing, weight and balance; aerodynamic characteristics and basic performance; flight loads from V-n diagram; dynamic balancing; wing shear and moment curves; detail structural design of wing.

Texts: The same as A-213(B); also Corning, Airplane Design; Sechler and Dunn: Airplane Structural Analysis and Design; Bureau of Aeronautics Specifications NAVAER SS-1C.

Prerequisite: Ae-213(B).

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

A continuation of Ae-311(C). Stress analysis of wing including: stringer stresses; shear flows; skin stresses and skin buckling check; semi-tension field analysis of front spar web, spar caps, stiffners. Analysis of riveted, bolted, welded fittings.

Texts: Same as Ae-311(C).

Prerequisite: Ae-311.

Ae-409(C) Thermodynamics I (Aeronautical) 4-2

Fundamentals of thermodynamics edited especially for application to aerothermodynamics and aircraft propulsion. Topics include fundamental laws, energy concepts, terminology and symbolism, properties of gases and vapors, property relationships, theoretical cycles and elementary compressible flow.

Texts: Kiefer, Kinney and Stuart: Engineering Thermodynamics; Keenan and Keys: Thermodynamic properties of Steam; Keenan and Kaye: Gas Tables.

Prerequisite: Ae-100(C).

Ae-410(B) Thermodynamics II (Aeronautical) 3-2

This course extends the study of fundamental thermodynamics in preparation for advanced work in aerothermodynamics and aircraft propulsion. Topics include one-dimensional compressible flow, internal combustion engine and turbine cycles and elements of heat transfer.

Texts: Kiefer, Kinney and Stuart: Engineering Thermodynamics; Stoever: Applied Heat Transmission; Keenan and Kaye: Gas Tables.

Prerequisite: Ae-409(C).

Ae-411(B) Aircraft Engines 4-2

This course extends the study of combustion with particular reference to piston engine and gas turbine applications. Topics are: fuel mixtures; ignition; flame propagation and stability; utilization, conversion and mechanical aspects; survey of current engine design and construction.

Texts: Lichty: Internal Combustion Engines; Taylor and Taylor: Internal Combustion Engines; USNPGS Notes.

Prerequisite: Ae-410(B).

Ae-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; Godsey and Young: Gas Turbines for Aircraft; Sutton: Rocket Propulsion Elements.

Prerequisite: Ae-411(B).

Ae-431(A) Aerothermodynamics of Turbomachines 4-1

Fundamental course of the study of flows of elastic fluids in turbomachines. Topics are: absolute and relative fluid motions; equations of motions and energy equations for actual fluids; momentum theorems for absolute and relative flows; flow in cascades; operating principles of turbomachines; axial-flow compressors; mixed-flow and centrifugal compressors; axial-flow turbines; centripetal turbines. The laboratory periods are devoted to measurements and analysis of flow phenomena in an especially instrumented Compressor Test Rig.

Text: USNPGS Notes.

Prerequisites: Ae-503(A).

Ae-451(A) Gas Turbines I 3-0

Thermodynamic studies of gas turbine cycles; free-piston plants; part load performance; heat transfer and losses in regenerators; control problems; design features; operating experiences.

Text: USNPGS Notes.

Prerequisite: Ae-431(A).

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

Advanced aerothermodynamics; three-dimensional flow phenomena; analysis and design of bladings; analysis and design of turbomachines and gas turbines with emphasis on rational methods and future developments.

Text: USNPGS Notes.

Prerequisite: Ae-451(A).

Ae-453(A) Advanced Problems in Gas Turbines I

Discussion and solution of original problems of theoretical or experimental nature.

Hours to be arranged.

Texts: As required.

Prerequisite: Ae-452(A).

Ae-454(A) Advanced Problems in Gas Turbines II

Hours to be arranged.

Continuation of Ae-453(A).

Ae-501(A) Hydro-Aero Mechanics I 4-0

This is the first of a sequence of four courses which study in detail the rational mechanics of fluid media; Vector calculus and aerodynamical applications; fluid kinematics and flow description; stream and velocity potential functions; dynamic equations for a perfect fluid; solution by scalar and vector methods; properties of elemental and combined flows; two-dimensional problems; use of complex numbers in flow description; conformal transformation; complex integration; Blasius equations; Kutta-Joukowski theorem; lift and pitching moment on an infinite wing.

Texts: Glauert: Airfoil and Airscrew Theory; Streeter: Fluid Dynamics; Kuethe and Schetzer: Foundations of Aerodynamics; Abbott and von Doenhoff: Theory of Wing Sections.

Prerequisite: Ae-131(C).

Ae-502(A) Hydro-Aero Mechanics II 4-0

Helmholtz vortex theory; the three-dimensional airfoil; induced velocity, angle of attack, drag; lift distribution; least induced drag; tapered and twisted 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 Schetzer: Foundations of Aerodynamics; Liepmann and Puckett: Aerodynamics of a Compressible Fluid; Sauer: Theoretical Gas Dynamics; Ferri: Elements of Aerodynamics of Supersonic Flow.

Prerequisites: Ae-410(B) and Ae-502(A).

Ae-504(A) Compressibility II 3-2

Two and three-dimensional compressible flows; two-dimensional linearized theory and application to airfoils in compressible flow; three-dimensional linearized theory; hodograph methods; method of characteristics; exact solutions in two-dimensional flow; transonic flow problems. 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) and Ae-502(A).

BIOLOGY

Bi Courses

Bi-800(C) General Biology 6-0

General botany, zoology, animal physiology, biochemistry, genetics, and ecology.

Text: Villee: Biology.

Prerequisite: Ch-315(C).

Bi-801(B) Animal Physiology 6-0

A general course in animal physiology, emphasizing human functional aspects.

Text: Winton and Bayliss: Human Physiology.

Prerequisite: Bi-800(C).

Bi-802(A) Radiation Biology 6-0

Physiological and genetic effects of radiation and blast. Calculation and measurement of dose; methods of experimental radiobiology.

Text: Bacq and Alexander: Fundamentals of Radiobiology.

Prerequisites: Ph-642(B); Bi-801(B).

Bi-810(C) Biological Effects of Radiation 3-0

Principles of biological dose measurement. Tolerance levels; genetic and physiological effects of ionizing radiations.

Text: Spear: Radiation and Living Cells.

Prerequisite: Ph-640(B).

CHEMISTRY

Ch Courses

General Inorganic Chemistry	Ch-101(C)
General Inorganic Chemistry	Ch-102(C)
Elementary Physical Chemistry	Ch-103(C)
Fuel and Oil Chemistry	Ch-111(A)
General and Petroleum Chemistry	Ch-121(B)
Quantitative Analysis	Ch-213(C)
Qualitative Analysis	Ch-221(C)
Qualitative Analysis	Ch-222(C)
Quantitative Analysis	Ch-231(C)
Organic Chemistry	Ch-301(C)
Organic Chemistry	Ch-311(C)
Organic Chemistry	Ch-312(C)
Organic Chemistry	Ch-315(C)
Organic Qualitative Analysis	Ch-321(A)
Organic Chemistry Advanced	Ch-322(A)
The Chemistry of High Polymers	Ch-323(A)
Physical Chemistry (Ord.)	Ch-401(A)
Physical Chemistry	Ch-411(C)
Physical Chemistry	Ch-412(C)
Physical Chemistry Advanced	Ch-413(A)
Physical Chemistry	Ch-414(C)
Physical Chemistry	Ch-415(C)
Physical Chemistry	Ch-442(C)
Plastics	Ch-521(A)
Physical Chemistry (for Metallurgy Students)	Ch-531(A)
Reaction Motors	Ch-541(A)
Radiochemistry	Ch-551(A)
Radiochemistry	Ch-552(A)
Nuclear Chemical Technology	Ch-553(A)
Chemistry of Nuclear Fuels	Ch-554(A)
Physical Chemistry	Ch-561(A)
Explosives	Ch-571(A)
Chemistry of Special Fuels	Ch-581(A)
Blast and Shock Effects	Ch-591(A)
Thermodynamics	Ch-611(C)
Thermodynamics	Ch-612(C)
Chemical Engineering Thermodynamics	Ch-613(A)
Chemical Engineering Thermodynamics	Ch-631(A)
Chemical Engineering Calculations	Ch-701(C)
Chemical Engineering Calculations	Ch-711(C)
Unit Operations	Ch-721(B)
Unit Operations	Ch-722(A)
Petroleum Refinery Engineering	Ch-731(A)
Petroleum Refinery Engineering	Ch-732(A)
Chemistry Seminar	Ch-800(A)

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.

Prerequisite: None.

Ch-111(A) Fuel and Oil Chemistry (Ch. Eng.) 2-2

The occurrence, classification and refining of petroleum, theory of combustion of fuels, theory of lubrication, physical and chemical properties of fuels and lubricants and their correlation with performance, and the analysis of Orsat data. Laboratory work consists of conducting standard tests on fuels and lubricants, and Orsat analysis of combustion gases.

Text: Gruse and Stevens: Chemical Technology of Petroleum; Pugh and Court: Fuels and Lubricating Oils.

Prerequisite: Ch-101(C).

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; 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-222(C) Qualitative Analysis 2-2

A brief course, in which separation and detection of selected cations on a semimicro scale is used as a basis for the study of acid-base systems, chemical equilibrium, solubility product, complex ions, hydrolysis, and oxidation-reduction reactions.

Text: Curtman: Introduction to Semimicro Qualitative Analysis.

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

Ch-231(C) Quantitative Analysis 2-4

A continuation of Ch-221(C), dealing with the principles and calculation involved in quantitative analysis. The laboratory work consists of typical volumetric and gravimetric determinations.

Text: Pierce and Haenisch: Quantitative Analysis.

Prerequisites: Ch-101(C) or Ch-121(B) and Ch-221(C).

Ch-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.

Prerequisite: Ch-102(C).

Ch-321(A) Organic Qualitative Analysis 2-2

Identification of organic compounds on the basis of physical properties, solubility behavior, classification reactions and the preparation of derivatives.

Text: Shriner and Fuson: Identification of Organic Compounds.

Prerequisite: Ch-301(C) or Ch-312(C) or Ch-315(C).

Ch-322(A) Organic Chemistry, Advanced 3-2

A more detailed consideration of reactions used in organic syntheses, with particular attention to reaction mechanisms and electronic configurations.

Text: Royals: Advanced Organic Chemistry.

Prerequisite: Ch-301(C) or Ch-312(C) or Ch-315(C).

Ch-323(A) The Chemistry of High Polymers 3-0

Mechanism of polymerization; addition and condensation polymers; phenoplastics; aminoplastics; elastomers; natural high polymers and their modification; structure and physical properties of high polymers.

Text: Ritchie: Chemistry of Plastics and High Polymers.

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

Ch-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: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews and Williams: Experimental Physical Chemistry.

Prerequisites: Ch-101(C) or equivalent and Ch-613(A) or equivalent.

Ch-411(C) Physical Chemistry 3-2

Gases, solids, physical properties and molecular structure, thermodynamics, thermochemistry, liquids and solutions. The laboratory work consists of experiments which illustrate principles discussed in the lectures.

Texts: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews, Williams: Experimental Physical Chemistry.

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

Ch-412(C) Physical Chemistry 3-2

Continuation of Ch-411(C). Chemical equilibrium, chemical kinetics, electrical conductance, electromotive force, colloids and atomic and nuclear structure. Related laboratory work is included.

Texts: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews, Williams: Experimental Physical Chemistry.

Prerequisite: Ch-411(C).

Ch-413(A) Physical Chemistry (Advanced) 2-2

A graduate course covering selected topics in physical chemistry, such as electrochemistry, electronic configurations and dipole moments, and the physical chemistry of the solid and liquid states. The laboratory work supplements the material covered in the lectures and introduces the student to problems and techniques encountered in research.

Text: To be assigned.

Prerequisites: Two terms of physical chemistry, one term of thermodynamics.

Ch-414(C) Physical Chemistry 3-2

This is the first course of a two-term sequence in Physical Chemistry designed for students specializing in radiology. Topics covered include the gaseous, liquid, and solid states; chemical thermodynamics; thermochemistry, and the properties of solutions. The laboratory work consists chiefly of quantitative analysis.

Text: Prutton and Maron: Fundamental Principles of Physical Chemistry; Pierce and Haenish: Quantitative Analysis.

Prerequisite: Ch-102(C).

Ch-415(C) Physical Chemistry 3-2

This course is a continuation of the Physical Chemistry sequence designed for students majoring in radiology. Topics covered are chemical equilibria, chemical kinetics, electrical conductance, electromotive force, colloids, atomic and nuclear structure and cryogenics. Laboratory work is related to the subject matter.

Text: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews, Williams and Staff: Experimental Physical Chemistry.

Prerequisite: Ch-414(C).

Ch-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.

Text: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, Mathews, Williams and Staff: Experimental Physical Chemistry.

Prerequisite: Ch-101(C) or equivalent.

Ch-521(A) Plastics (Ch. Eng.) 3-2

A study of the nature of plastics. Emphasis is placed on application, limitations as engineering materials, and correlation between properties and chemical structure. Service applications are cited as examples whenever possible. The laboratory exercises consist of the preparation of typical plastics, molding experiments, a study of their properties, and identification tests.

Text: Department Notes: Kinney.

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.

Prerequisites: Physical chemistry and Mt-202(C).

Ch-541(A) Reaction Motors (Ch. Eng.) 2-2

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

Text: Sutton: Rocket Propulsion Elements.

Prerequisites: Ch-101(C) 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-553(A) Nuclear Chemical Technology (Ch. Eng.) 4-3

Applications of chemistry and chemical engineering to the processing of materials, products and wastes associated with nuclear reactors including the following topics: chemistry of uranium, plutonium and fission products, technology of nuclear fuel production, separation of products of nuclear reactors, radioactive waste disposal.

References: To be assigned.

Prerequisites: Ch-121(B) and Ch-561(A) or equivalent.

Ch-554(A) Chemistry of Nuclear Fuels 2-2

Basic chemistry of the actinide elements, particularly uranium, plutonium, and thorium, related to their isolation and separation in reprocessed fuels. Discussion of oxidation states and chemical behavior including complex formation, solubilities and resin exchange phenomena. Principle products of fission and their separation from fuel elements.

Text: None.

Prerequisite: Physical Chemistry.

Ch-561(A) Physical Chemistry 3-2

A course in physical chemistry for students who are non-chemistry majors. Thermodynamics, thermochemistry, gases, liquids, solutions, chemical equilibrium and chemical kinetics. Numerical problems on gas mixtures, combustion, equilibria in combustion products and flame temperatures are emphasized. Related laboratory experiments are included.

Texts: Prutton and Maron: Fundamental Principles of Physical Chemistry; Daniels, 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 are related to their chemical and physical properties; underlying principles of explosives testing and evaluation; theory of detonation; propagation of flame front in propellants. Trends in new explosives investigation, selection, and development are surveyed. Laboratory work involves related parameters such as brisance, power, sensitivity, nitrogen content, heats of explosion and combustion. Independent exploratory work is encouraged.

Prerequisites: One term each of Thermodynamics and Physical Chemistry.

Ch-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 (Ch. Eng.) 3-0

Nature of explosions, propagation of shock waves, scaling laws for damage from explosions, thermal radiation and incendiary effects; ionizing radiation effects; principles of protection of personnel against damage.

Text: Hirschfelder and Associates: The Effects of Atomic Weapons.

Prerequisites: Physical Chemistry, and Thermodynamics.

Ch-611(C) Thermodynamics (Ch. Eng.) 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, Kinney and Stuart: Principles of Engineering Thermodynamics.

Prerequisite: Ch-101(C).

Ch-612(C) Thermodynamics (Ch. Eng.) 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, Kinney and Stuart: Principles of Engineering Thermodynamics; Smith: Introduction to Chemical Engineering Thermodynamics.

Prerequisite: Ch-611(C).

Ch-613(A) Chemical Engineering Thermodynamics (Ch. Eng.) 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. Special attention is devoted to the thermodynamics of combustion processes.

Texts: Smith: Introduction to Chemical Engineering Thermodynamics; Kiefer, Kinney and Stuart: Principles of Engineering Thermodynamics.

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

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; Kiefer, Kinney and Stuart: Principles of Engineering Thermodynamics; 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 are chosen from engineering practice whenever possible and emphasize such applications as: reacting materials, particularly at high temperatures; gaseous and liquid-vapor equilibria; combustion of fuels; production and utilization of basic chemicals.

Texts: Hougen and Watson: Chemical Process Principles, Part I; Lewis and Radasch: Industrial Stoichiometry; Perry: Chemical Engineers' Handbook.

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

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(B) Unit Operations (Ch. Eng.). 3-2

An introduction to the study of the unit operations of chemical engineering. Selection of and primary emphasis on particular unit operations will be made on the basis of current student specialties; e.g., Petroleum Engineering. Among the unit operations, treatment will be given to flow of fluids, filtration, agitation, mixing, sedimentation, heat transmission, evaporation, and drying. Both theoretical and applied material will be illustrated by quantitative examples.

Texts: Brown and Associates: Unit Operations; Perry: Chemical Engineers' Handbook.

Prerequisites: Ch-701(C) and Ch-411(C).

Ch-722(A) Unit Operations (Ch. Eng.) 3-2

A continuation of Ch-721: Size reduction, sizing, crystallization, gas absorption, liquid-liquid extraction, batch and continuous distillation; fractionation columns.

Texts: Brown and Associates: Unit Operations; Perry: Chemical Engineers' Handbook.

Prerequisite: Ch-721(B).

Ch-731(A) Petroleum Refinery Engineering (Ch. Eng.) 3-0

A study of the engineering, chemical, and economic aspects of modern petroleum refinery practice. This course includes the following topics: evaluation of crude oils, process studies such as catalytic cracking, aviation gasoline manufacture, Fischer-Tropsch synthesis, chemical refining of lubricating oils, theory, design, cost, and operation of refinery process equipment, factors determining method of treatment, plant design, applied reaction kinetics, and catalysis and applied thermodynamics of hydrocarbons.

Texts: Nelson: Petroleum Refinery Engineering; Sachanen: Conversion of Petroleum; Huntington: Natural Gas and Natural Gasoline; Selected readings in current technical journals.

Prerequisite: Ch-722(A).

Ch-732(A) Petroleum Refinery Engineering (Ch. Eng.) 3-0

A continuation of Ch-731.

Texts: Nelson: Petroleum Refinery Engineering; Sachanen: Conversion of Petroleum; Huntington: Natural Gas and Natural Gasoline; Selected readings in current technical journals.

Prerequisite: Ch-731(A).

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) Communication 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) Communications-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-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) Naval Fiscal Management 2-0

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.

Co-162(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.

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.

Texts: Buerger: Elementary Crystallography; Barrett: Structure of Metals.

Prerequisite: Ch-101(C).

Cr-301(B) Crystallography and Mineralogy 3-4

Designed primarily for the student who will continue with courses in mineralogy, geology, and petrology. The student is introduced to the fundamental concepts of crystallography, including: symmetry, point groups, plane lattices, space lattices, space groups, coordinate systems, indices, crystal classes, crystal systems, common form and combinations in the various systems and classes, the stereographic projection, and the theory of x-ray diffraction and the application of x-ray powder methods as applied to identification of minerals. The laboratory work includes a study of crystal models for symmetry forms, and combinations; the practical application and construction of stereographic projections; determination of minerals by x-ray powder diffraction patterns.

Text: Rogers: Introduction to the Study of Minerals.

Prerequisite: Ch-101(C).

Cr-311(B) Crystallography and Mineralogy 3-2

Subject matter similar to Cr-301, but designed for students who will continue with courses in chemistry.

Text: Rogers: Introduction to the Study of Minerals.

Prerequisite: Ch-101(C).

ELECTRICAL ENGINEERING

EE Courses

EE-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 and 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, Kirchoff'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 and Elementary Physics.

EE-171(C) Electrical Circuits and Fields 3-4

As a foundation in electricity and magnetism for a curriculum majoring in electrical science, the basic laws are studied in detail. Units, Kirchhoff's laws, electrostatic fields, magnetic fields, ferromagnetism, direct-current networks, direct-current measurements, calculation of resistance, capacitance and inductance are covered. Basic laboratory experiments deal with measurements, the proper use of metering equipment and magnetic circuits. Supervised problem work is included.

Text: Corcoran: Basic Electrical Engineering.

Prerequisites: Differential and Integral Calculus and Elementary Physics.

EE-231(C) Circuits and Machines 3-2

General principles of DC machines, their control and application. The qualitative characteristics of the various machines are developed from basic principles, then a study of the theory of alternating currents is begun. Experiments are performed to demonstrate the general machine characteristics and the use of control devices.

Text: Dawes: Electrical Engineering, Vols. I and II.

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, 3rd Edition.

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, 3rd Edition.

Prerequisite: EE-271(C).

EE-273(C) Electrical Measurements I 2-3

An introduction to the measurement of the fundamental quantities: current, voltage, capacitance, inductance, and the magnetic properties of materials. Direct-current bridges, the measurement of high resistance, characteristics of direct-current galvanometers, potentiometer principles, commercial potentiometer types, direct-current indicating instruments.

Text: Stout: Basic Electrical Measurements.

Prerequisite: EE-272(C).

EE-274(B) Electrical Measurements II 2-3

A continuation of EE-273(C). Alternating-current bridge circuits, components, and accessories. Measurement of the properties of dielectrics.

Text: Stout: Basic Electrical Measurements.

Prerequisite: EE-273(C).

EE-314(C) Electrical Machinery 3-4

The fundamentals of representative direct-current and alternating-current machines are studied in classroom and supplemented with laboratory experiments. The theory, practical construction, types of windings and the performance of direct-current generators and motors, alternators, transformers, synchronous motors, induction motors, and single-phase motors are briefly covered.

Text: Dawes: Electrical Engineering, Vols. I and II.

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

EE-351(C) Direct-Current Machinery 2-2

Fundamentals of direct-current machinery with emphasis upon operating characteristics and applications. The external characteristics are 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) Direct-Current Machinery 3-2

A thorough presentation of the theory and performance of direct-current machines and control devices. Armature windings, armature reaction and commutation are fully covered. The operating characteristics of generators and motors are developed from basic relations so as to provide a foundation for subsequent work in design. Problems are assigned to illustrate the application of the theory. Laboratory work supplements the work of the classroom.

Text: Langsdorf: Principles of Direct-Current Machines.

Prerequisite: EE-171(C).

EE-451(C) Transformers and Synchros 2-2

The theory, construction and performance of single-phase transformers and polyphase transformer connections are covered in the first part of the course. Approximately the latter half of the term is given to the study of synchros, their theory, construction and performance under normal and abnormal conditions. Laboratory experiments parallel the classroom study.

Texts: Hehre and Harness: Electrical Circuits and Machinery, Vol. II; Ordnance Pamphlet 1303: Synchros.

Prerequisite: EE-251(C).

EE-452(C) Alternating-Current Machinery 3-4

A continuation of EE-451(C). It completes a general presentation of AC machinery for those curricula that do not require an extensive treatment. Alternators, synchronous motors, polyphase and single-phase induction motors are presented. A brief survey of induction generators, induction regulators and the commutator type AC motor is included. Laboratory and problem work illustrate the basic theory.

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

Prerequisite: EE-451(C).

EE-453(C) Alternating-Current Machinery 3-4

The basic principles, constructional features and performance characteristics of single and polyphase transformers. Polyphase transformer connections. Special transformers and the induction regulator. Theory and operational characteristics of single and polyphase induction motors, alternating-current generators and synchronous motors. Basic principles and performance characteristics of synchro generators, motors and control transformers under normal operating conditions. Laboratory and problem work illustrate the basic theory.

Texts: Puchstein, Lloyd and Conrad: Alternating Current Machines, 3rd Edition; Ordnance Pamphlet 1303.

Prerequisite: EE-251(C).

EE-455(C) Asynchronous Motors 2-2

An elementary presentation of the principles and operating characteristics of the induction motor and of single-phase commutator motors. Emphasis is placed upon the unbalanced operation of the two-phase symmetrical induction motor. Laboratory and problem work supplement the theory.

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

Prerequisite: EE-451(C).

EE-461(C) Transformers and Synchros 3-2

For those curricula which do not require an extensive coverage of these topics. Single-phase transformer principles, constructional features and operating characteristics. Special transformers. Synchro and induction motor windings. Single-phase and polyphase synchro constructional features. Mathematical analysis of the torque, current and voltage characteristics of synchros operating under normal and fault conditions. Synchros in control circuits. Laboratory and problem work illustrate the basic principles.

Text: Hehre and Harness: Electrical Circuits and Machinery, Vol. II; Ordnance Pamphlet 1303.

Prerequisite: EE-241(C) or EE-251(C).

EE-462(B) Special Machinery 4-2

Basic principles and operating characteristics of single-phase and polyphase induction motors and single-phase commutator motors. Operation of two-phase induction motors with unbalanced voltages and variable phase angles. Theory and operating characteristics of amplidyne and rototrol generators. Operation of direct-current motors on variable voltage. Calculation of the transfer function for motors and generators. Laboratory and problem work illustrate the basic principles.

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

Prerequisite: EE-461(C).

EE-463(C) Special Machinery 3-2

The theory and performance of single phase, iron core transformers at power and audio frequencies with particular attention to attenuation and phase shift as affected by leakage inductance and distributed capacitance; synchro control transformer, synchro motor and synchro generator principles under normal operating conditions; polyphase and single phase induction motor principles and operating characteristics in control applications are emphasized. A brief treatment of DC machinery and special machinery theory (amplidyne, etc.) is included to illustrate the 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.

Prerequisite: EE-251(C) .

EE-471(C) Alternating-Current Machinery 3-4

For those curricula giving advanced work in electrical engineering. Basic theory and operating characteristics of single-phase and polyphase transformers, special transformers, polyphase and single-phase induction motors, induction generators and commutator type alternating-current motors. Motor and generator armature windings, voltage and mmf waves. Laboratory and problem work illustrate the basic theory.

Text: Puchstein, Lloyd and Conrad: Alternating Current Machines, 3rd Edition.

Prerequisite: EE-272(B).

EE-472(C) Alternating-Current Machinery 3-4

A continuation of EE-471(C). Alternator and synchronous motor theory and operating characteristics based on cylindrical rotor and two-reaction theories. Armature windings. Voltage, current and mmf waves. Load saturation characteristics, regulation and losses. Frequency changers. Parallel operation of synchronous machines. Synchro principles and mathematical analysis of operating characteristics for normal and fault conditions. Laboratory and problem work illustrate the basic principles.

Text: Puchstein, Lloyd and Conrad: Alternating Current Machines, 3rd Edition.

Prerequisite: EE-471(C).

EE-473(B) Synchros 2-2

Basic theory and mathematical analysis of single-phase and polyphase synchros. Voltage, current and torque relations under normal and fault conditions. Equivalent circuits and vector diagrams, control circuits using synchros. Laboratory and problem work supplement the study of basic principles.

Text: None.

Prerequisite: EE-251(C) or EE-271(C).

EE-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.

Prerequisites: EE-451(C) and EE-711(C) or EE-751(C).

EE-655(B) Filters and Transients 3-2

Basic principles of filters and electrical transients. T and Pi section filters and composite filters. DC and AC transients in series, parallel, series-parallel and coupled circuits. The solution of the differential equations by classical methods and Laplace operational methods.

Texts: Kerchner and Corcoran: Alternating Current Circuits; Kurtz and Corcoran: Introduction to Electrical Transients.

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) and EE-751(C) or equivalent.

EE-673(A) Nonlinear Servomechanisms 2-2

An introduction to the effects of incidental nonlinearites (backlash, binding, coulomb friction and saturation) on the performance of closed loop systems. A detailed study of the theory of relay servomechanisms. Methods used in these studies are the differential equation, phase plane analysis and describing function analysis.

Text: None.

Prerequisite: EE-672(A).

EE-711(C) Electronics 3-2

The elementary theory of the control of electron motion by electric and magnetic fields in vacuum, gaseous conduction phenomena and electron tube characteristics are presented as a basis for the study of electronic circuits. The principles of the amplifier, rectifier and oscillator circuits are presented in their essentials. Some consideration is given to the special tubes encountered in electronic devices. Laboratory work serves to integrate the principles presented in the classroom 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 consists 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.

ENGINEERING ELECTRONICS

Es Courses

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) Basic Electric Circuits 4-2

In this introduction to DC and AC circuits the principal topics are: concepts of electric potential and current; basic electric circuits relations; resistance and inductance; AC circuit quantities and concepts; analysis of AC circuits; general network theorems.

Texts: Corcoran: Basic Electrical Engineering; Hessler and Carey: Fundamentals of Electrical Engineering; Tang: AC Circuits, Second Edition.

Prerequisite: Mathematics through calculus.

Es-112(C) Alternating-Current Circuits 3-0

Transformers, coupled circuits, tuned coupled circuits, RC and RL transients, non-sinusoidal currents and voltages, polyphase circuits, ladder networks (constant-k and m-derived filters), impedance transformations.

Texts: Tang: Alternating Current Circuits (Second Edition); Everitt: Communication Engineering.

Prerequisite: Es-111(C).

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

An introduction to the principles and techniques of elementary measurements at audio and radio frequencies. The principal topics are: measurement of AC current and voltage with particular reference to the response to complex wave forms, principles and characteristics of vacuum tube voltmeters, measurement of frequency, measurement of impedance by bridges and Q-meters. An introduction to transmission lines. Definition of terms, line parameters and transmission units.

Text: Terman and Pettit: Electronic Measurements.

Prerequisite: Es-112(C).

Es-114(C) Circuit Analysis and Measurements II 3-0

The infinite line. Properties of open wire and cables; loading. Reflections and the solution of the general line. Derivation and use of circle diagrams. Use of lines and stubs as transformers and matching devices. Use of a line as an impedance measuring device. Qualitative extension of transmission line principles to waveguides and waveguide components.

Text: Everitt: Communication Engineering.

Prerequisite: Es-113(C).

Es-121(B) Advanced Circuit Theory I 4-2

Advanced circuit theory with transient analysis. Principles of differential equations. Basic circuit relations, philosophy of circuit behavior. The Laplace transform treated as a tool and used in circuit analysis and study of circuit properties. Normalized networkers. Harmonic analysis, the Fourier integral and Fourier transform and their use in further study of circuit properties. Development of the Laplace transform from the Fourier transform. Superposition formulae, indicial admittance, impulse functions. Translation, repeated action circuit analysis.

Texts: Giet and Kahal: Advanced Circuit Theory with Transient Analysis; Gardner and Barnes: Transients in Linear Systems.

Prerequisite: Es-114(C).

Es-122(A) Advanced Circuit Theory II 4-2

A continuation of Es-121(B). Two terminal pair networks, matrix algebra applied to the analysis of two terminal pair networks both passive and active, including tube and transistor circuits. Transients analysis of distributed constant circuits, long lines. Introduction to circuit synthesis given a driving point impedance. Foster's Reactance theorem. Synthesis of LC, RL, RC and RLC networks.

Texts: Geit and Kahal: Advanced Circuit Theory with Transient Analysis; Gardner and Barnes; Transients in Linear Systems.

Prerequisite: Es-121(B).

Es-126(C) Radio-Frenquency Measurement and Microwave Techniques 2-6

An advanced and extended treatment of the principles and techniques of measurement over the entire frequency band, using lumped, transmission line and waveguide components. The areas considered are those of the measurement of frequency, power, phase, and impedance, by means of lines, bridges and resonance methods. Emphasis in the laboratory is on the development of the ability of the student to analyze a new problem and to plan and implement a method of attack.

Texts: Terman and Pettit: Electronic Measurements; Hartshorn: Radio Frequency Measurements.

Prerequisites: Es-114(C) and Es-225(B).

Es-127(B) Pulse Techniques 2-0

This course serves as foundation material to later courses involving such topics as radar circuits, computer circuits, pulse modulation techniques and others based upon its contents; clipping, clamping, linear approximation, for non-linear circuits, multivibration, Miller effect delay circuits, R-L-C transients, pulse transformers and delay lines.

Texts: M.I.T. Radar School Staff: Principles of Radar (Third Edition); Moskowitz and Rocher: Pulse Techniques.

Prerequisites: Es-221(A), Es-213(C) and Es-121(B).

Es-128(A) Information Theory 3-0

Statistical methods in communications engineering are studied. These include spectra, signal space, correlation techniques, filtering and prediction, information measure, channel capacity and coding.

Texts: Woodward: Probability and Information Theory; Goldman: Information Theory; Lawson and Uhlenbeck: Threshold Signals; Instructor's Notes.

Prerequisites: Es-122(A) and Ma-321(B).

Es-136(A) Electronic Computation and Control 3-2

A unified communication theory approach to modern information processing networks. Analog, digital, and hybrid systems are treated with considerable emphasis upon applications to problems of automatic control. Laboratory work is devoted to the study of basic computer components and circuits, and to application work using the analog and digital computers.

Texts: Wass: Introduction to Electronic Analogue Computers; Richards: Arithmetic Operations in Digital Computers; Instructor's Notes.

Prerequisites: Es-127(B) and Es-128(A).

Es-141(C) Fundamentals of Electric Circuits and Fields 4-4

Basic principles and concepts underlying the study of circuits and electromagnetic fields. Emphasis in the circuits work is upon the setting up of network equilibrium equations and the various techniques of solution. The work in fields is devoted to developing the fundamental laws of electromagnetism as expressed in Maxwell's equations.

Text: Frank: Introduction to Electricity and Optics.

Prerequisite: Mathematics through the calculus.

Es-142(C) Introduction to Circuit Theory 4-3

A continuation of Es-141(C). Introduction to ideas and methods of circuit theory. Emphasis is upon development of impedance concept from complex frequency viewpoint and upon correlation of frequency and time response.

Text: Guillemin: Introductory Circuit Theory.

Prerequisite: Es-141(C).

Es-143(C) Introduction to Fields and Waves 3-3

A continuation of Es-142(C); an extension of the concepts of lumped-constant circuits to distributed constant systems including classical transmission line and filter theory. Application of Maxwell's equations to problems of transmission and control of electromagnetic energy at high frequencies.

Text: Ryder: Networks, Lines, and Fields.

Prerequisite. Es-142(C).

Es-161(A) Electronic Instrumentation I 3-3

The principal topics are: pulse amplifiers, pulse-amplitude analysis circuits, scaling circuits, electronic counter systems, counting-rate meters, coincidence and anti-coincidence circuits.

Text: Elmore and Sands: Electronics; selected references.

Prerequisite: Es-461(A).

Es-162(A) Electronic Instrumentation II 3-3

The principal topics are: special power-supply system considerations, i.e., voltage multipliers, r-f supplies, vibrator circuits, regulation techniques; modulation techniques; multiplex systems; telemetering techniques, radar fundamentals, basic altimetry principles.

Text: Professor's 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 Tube Circuits I 4-0

The physical principles and characteristics of vacuum and gas tubes is stressed in the first half of this course. This is followed by basic tube circuit theory of amplifier and rectifier circuits.

Texts: Geppert: Basic Electron Tubes; Corcoran and Price: Electronics; Seely: Electron-Tube Circuits.

Prerequisites: Es-111(C) and Es-616(C).

Es-213(C) Electron Tube Circuits II 4-3

The treatment of tube circuits is continued in the field of amplification. The topic headings are audio power amplifiers, tuned voltage and power amplifiers, feedback principles, and wide-band amplifiers.

Texts: Corcoran and Price: Electronics; Seely: Electron-Tube Circuits; Cruft: Electronic Circuits and Tubes.

Prerequisite: Es-212(C).

Es-214(C) Electron Tube Circuits III 4-0

A continuation of Es-213. The principal topics are: Sine-wave oscillators; amplitude modulation and detection; frequency conversion; frequency-modulation techniques.

Texts: Cruft Electronics Staff: Electronic Circuits and Tubes; Seely: Electron-tube Circuits; Terman: Radio Engineering.

Prerequisite: Es-213(C).

Es-221(A) Transistor Electronics 3-3

The principal topics are: transistors—properties of semi-conductors and P-N junctions; transistors as circuit elements; small and large signal transistor circuit characteristics and analysis.

Texts: RCA Staff: Transistor Electronics.

Prerequisites: Es-214(C) and Ph-730(A).

Es-225(B) Electron Tubes 3-3

The tubes treated are those in which operation depends on the motions of electrons under the control of electric and magnetic fields. Some of the tube types studied are picture tubes, beam deflection, storage, and photo tubes. The topic of noise is also included.

Texts: Harman: Fundamentals of Electron Motion; Spangenberg: Vacuum Tubes.

Prerequisite: Es-214.

Es-226(A) Microwave Techniques 3-0

The principal topics presented are: fundamentals of microwave amplifiers and oscillators, triode and tetrode microwave amplifiers and oscillators, two and three cavity klystrons, reflex klystrons, magnetrons, travelling-wave and double-beam tubes, circuit components, coupling methods, energy transfer, and circuit concepts at microwave frequencies.

Texts: Reich, Ordung, Krause, Skalnik: Microwave Theory and Techniques; Spangenburg: Vacuum Tubes; Harman: Fundamentals of Electron Motion.

Prerequisites: Es-225(B) and Es-623(A).

Es-227(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; Massachusetts Institute of Technology Radar School Staff: Principles or Radar (Third Edition).

Prerequisite: Es-214(C).

Es-261(C) Electron Tubes and Circuits I 3-2

The first term of a two-term course in the fundamentals and general applications of electron tubes and circuits, primarily for non-communication students. The principal topics are: emission, characteristics of vacuum and gas tubes, rectifiers and filters, grid-controlled rectifiers, class A amplifiers, transistors.

Texts: Hill: Electronics in Engineering; Corcoran and Price: Electronics.

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

Es-262(C) Electron Tubes and Circuits II 3-2

A continuation of Es-261(C). The principal topics are: feedback amplifiers, class B and C amplifiers, oscillators, modulation, detection.

Texts: Seely: Electron Tube Circuits; Corcoran and Price: Electronics.

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; M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-262(C) or equivalent.

Es-271(C) Electronics I 3-2

This is a series of three courses designed to give the Nuclear Engineering student an appreciation of electronic equipment used in this science. The first course takes the student through the analysis of network circuits and introduces elementary transient concepts.

Text: Guillemin: Introductory Circuit Theory.

Prerequisite: None.

Es-272(C) Electronics II 3-3

This course includes the common vacuum tube circuits, such as rectifiers, voltage amplifiers, and elementary feedback circuits. Special emphasis is placed on these circuits in regard to transient response, bandwidth, stability, and pulse shaping. Also included is semiconductor diode and transistor theory.

Texts: Hill: Electronics in Engineering; Corcoran and Price: Electronics.

Prerequisite: Es-271(C).

Es-273(C) Electronics III 3-2

This course emphasises systems of vacuum tube circuits used by the nuclear engineer, such as the cathode-ray oscilloscope, scalers, pulse height analyzers, Geiger counters, and other nuclear energy detecting devices such as Radiac. Detection and measurement of nuclear energy by making use of telemetering systems is also included.

Texts: Seely: Electron-Tube Circuits; Elmore and Sands: Electronics.

Prerequisite: Es-272(C).

Es-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 I 3-3

A continuation of Es-281(C). This course covers the following applications of vacuum tube circuits: amplifiers; oscillators; power supplies; detectors; and modulators; basic AM receivers and transmitter circuits.

Text: Sheingold: Fundamentals of Radio Communications.

Prerequisite: Es-281(C).

Es-283(C) Vacuum Tube Circuits II 3-3

A continuation of Es-282(C). The course covers further applications of electron tubes. 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 are treated. The principal topics are: Characteristics of non-sinusoidal waves; pulse-shaping techniques; the saw-tooth 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; M.I.T. Radar School Staff: Principles of Radar (Second Edition). Sheingold: Fundamentals of Radio Communications.

Prerequisite: Es-282(C).

Es-321(B) Communication Systems I 2-0

The first of a series of five courses designed to give the student the opportunity to coordinate his previous theoretical background in the philosophy, requirements, and synthesis of increasingly complex electronic systems. Class discussion is supported by laboratory projects which include tests for the determination of system characteristics and relative capabilities and limitations. The first course concerns itself primarily with the design of radio transmitters for the medium and high frequency range, together with considerations which lead to a successful system, such as reliability, consideration in human engineering, etc.

Texts: Terman: Radio Engineering Handbook; Federal Telephone and Telegraph Corporation: Reference Data for Radio Engineers; Black: Modulation Theory; Navy Equipment Manuals.

Prerequisites: Es-225(B) and Ma-104(A).

Es-332(B) Communication Systems II 2-3

A study of the considerations involved in the design of communication receivers for range from VLF to UHF. The use of propagation prediction data, and the natural division of services and frequency allocations is also covered.

Texts: Sturley: Radio Receiver Design; Wallman and Valley: Vacuum Tube Amplifiers; Terman: Radio Engineering Handbook; Black: Modulation Theory.

Prerequisite: Es-321(B).

Es-333(B) Communication Systems III 3-3

A study of radio codes and their effect on information rates and bandwidth. This course applies these radio codes in such systems as frequency-shift-keying, and radio teletype. The ultimate aim of the course is directed toward conservation of bandwidth, power, and equipment through the application of multiplexing and single-sideband transmission.

Texts: Black: Modulation Theory; Navy Instruction Manuals; Instructor's Notes.

Prerequisite: Es-332(B).

Es-334(B) Communication Systems IV 2-3

The aim of this course is toward those communications systems not yet fully developed but which will become the important systems of the future. The principles and design of many of the pulse modulation and image systems such as facsimile and television are included.

Texts: Black: Modulation Theory; Navy Instruction Manuals; Instructor's Notes.

Prerequisite: Es-333(B).

Es-335(B) Electronic System 3-3

Study in this course is directed toward the philosophy, principles, and design of electronic aids to navigation, missile guidance systems and electronic countermeasures. A study of telemetering is included in support of missile guidance systems.

Texts: Navy Instruction Manuals; Instructor's Notes.

Prerequisite: Es-334(B).

Es-341(C) Radio Telemetry and Simulation 3-3

A survey of telemetering and missile guidance methods including consideration of time and frequency division multiplexing, pulse modulation techniques, FM/FM telemetry, transducers, data recording devices, analog and digital computation, simulation of the tactical problem, and classroom and laboratory study of existing telemetering and missile guidance systems.

Text: To be designated.

Prerequisite: Es-423(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: Navy Equipment Instruction Books; printed professor's notes.

Prerequisites: Es-282(C) and 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: M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-114(C).

Es-422(B) Radar Systems I 3-3

A study of the fundamental principles of radar. The principal topics are: the theory of operation of radar timing circuits, indicators, modulators, transmitters, r-f systems and receivers, the radar range equation.

Texts: Ridenour: Radar System Engineering; M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-421(B).

Es-423(B) Radar Systems II 3-6

A continuation of Es-422(B). The course contents include a study of representative search, fire-control and IFF systems, including airborne, with particular attention to design features; a study of current radar developments; related laboratory work on current Navy radar equipment.

Text: Ridenour: Radar System Engineering.

Prerequisite: Es-422(B).

Es-431(B) Radar System Engineering I 3-3

A treatment of the fundamental principles of radar. The principal topics are: the theory of operation and design features of radar timing circuits, indicators, modulators, transmitters, r-f systems and receivers.

Texts: Ridenour: Radar System Engineering; M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-127(B).

Es-432(B) Radar System Engineering II 3-6

A continuation of Es-431(B). The course contents include a study of representative search, fire-control and IFF systems, including airborne, with particular attention to design features; a study of current radar developments; related laboratory work on current Navy radar equipment.

Text: Ridenour: Radar System Engineering.

Prerequisite: Es-431(B).

Es-446(C) Introduction to Radar 2-2

A study of the radar range equation, i.e., effect of pulse duration, pulse repetition frequency, types of targets, etc.; block diagram studies of current fire-control systems, with emphasis on operational limitations, propagation phenomena, types of presentation, and anti-jam techniques; and laboratory work that emphasizes operational techniques of current fire-control systems.

Text: M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-262(C) or equivalent.

Es-447(C) 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; M. I. T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-262(C) or equivalent.

Es-456(C) Introduction to Radar (Airborne) 2-2

A study of the radar range equation, i.e., effect of pulse duration, pulse repetition frequency, types of targets, etc., block diagram studies of current airborne systems with emphasis on operational limitations, propagation phenomena, types of presentation, and anti-jam techniques and laboratory work on current airborne radar equipment.

Text: M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-262(C) or equivalent.

Es-461(A) Pulse Techniques 3-3

The principal topics are: clipping circuits, differentiating and integrating circuits, clamping circuits, pulse-coupling circuits, relaxation oscillators, theory and circuit application of the transistor.

Texts: Spangenberg: Vacuum Tubes; M.I.T. Radar School Staff: Principles of Radar (Third Edition).

Prerequisite: Es-267(A).

Es-466(C) Radar Propagation and Displays 2-2

The principal topics are: the operational characteristics 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; M.I.T. Radar School Staff: Principles of Radar, (Third Edition).

Prerequisite: None

Es-511(C) Basic Electrical Laboratory 0-5

This course supplements Es-111(C) and Es-616(C). It familiarizes the student with electronic components and basic measuring equipment and illustrates the principles studied.

Text: None.

Prerequisite: Concurrent with Es-111(C) and Es-616(C).

Es-512(C) Electronic Circuits Laboratory I 0-5

This course supplements Es-112(C) and Es-212(C). Through the medium of laboratory exercises it illustrates the principles studied.

Text: None.

Prerequisite:_ Concurrent with Es-112(C) and Es-212(C).

Es-513(C) Electronic Circuits Laboratory II 0-5

This course supplements Es-114(C) and Es-214(C). Through the medium of laboratory exercises it illustrates the principles studied.

Text: None.

Prerequisite: Concurrent with Es-114(C) and Es-214(C).

Es-526(B) Radiation and Microwave Laboratory 0-6

This course provides the laboratory phase of Es-736(B) and Es-226(A) and extends into the microwave realm including such operations as scattering matrices, microwave discontinuities, multimode couplers, directional couplers, ferrites, complex ε and μ matrices, and microwave tubes and circuits.

Texts: Instructor's Notes and appropriate literature.

Prerequisite: Concurrent with Es-226(A) and Es-736(B).

Es-527(B) Pulse Techniques and Transmitter Laboratory 0-5

This course provides the laboratory phases of Es-127 (B) and Es-321(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-537(B) Sonar System Engineering Design and Developments 3-3

Classroom and laboratory study of engineering design problems met in operational and developmental sonar systems.

Texts: Classified Technical Reports; Navy Equipment Instruction Books.

Prerequisite: Ph-423(A).

Es-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; ıadar and sonar systems; Loran systems.

Texts: Navy Equipment Instruction Books; Sheingold: Fundamentals of Radio Communications.

Prerequisites: Es-386(C) and Es-786(C).

Es-616(C) Basic Electric and Magnetic Fields 3-0

Electric field concepts (potential, intensity, flux, mapping, energy, capacitance); magnetic field concepts (potential, intensity, flux, energy, inductance); magnetic circuits (B-H curves, calculation of MMF and flux, hysteresis and eddy currents); electromagnetic induction and forces; mutual induction; electromagnetic forces on charged particles.

Text: Corcoran: Basic Electrical Engineering.

Prerequisite: Elementary Physics; Differential and integral Calculus.

Es-621(C) Electromagnetics I 4-0

An introduction to the concepts utilized in electromagnetic theory. The material covered includes vector analysis, field theorems, the electrostatic field, dielectric materials, electric current, the magnetic field, Maxwell's hypothesis, plane waves, radiation, antennas, wave guides.

Text: Skilling: Fundamentals of Electric Waves (Second Edition).

Prerequisite: Elementary Calculus.

Es-622(B) Electromagnetics II 5-0

Phasor notation; generalized coordinates; rectangular, cylinderical, and spherical harmonics; Bessel functions; Maxwell's equations for time varying elds; displacement current density; retarded potentials; circuit concepts from fields; impedance; skin effect; inductance; Poynting's theorem; propagation of plane waves; phase velocity and Snell's law; pseudo-Brewster angle; waves in imperfect media; guided waves.

Text: Ramo and Whinnery: Fields and Waves in Modern Radio (Second Edition).

Prerequisite: Es-621(C) and Ma-104(A).

Es-623(A) Electromagnetics III 4-0

A continuation of Es-622(B). TEM, TE, TM waves; rectangular and cylinderical wave guides; miscellaneous guiding systems; resonant cavities; fields from dipole antenna; gain; image antenna; field from rhombic antenna; antenna arrays; induced EMF method; pseudo-Maxwell's equations; parabolic reflector; slot antenna; electromagnetic horns; biconical antenna; driving point impedance of cylinderical antenna; receiving antenna.

Text: Ramo and Whinnery: Fields and Waves in Modern Radio (Second Edition).

Prerequisite: Es-622(B).

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-332(B) and 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 3-0

The engineering problems associated with the practical design of antennas, antenna systems, and transmission lines.

Text: Kraus: Antennas.

Prerequisite: Es-623(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 characteristics; 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

In this seminar an oral report is made to the class by each student on his individual development work on a project at an industrial laboratory in electronics. A written engineering report is also required of each student covering his term project in industry.

Text: None.

Prerequisite: None.

GEOLOGY

Ge Courses

Ge-101(C) Physical Geology 3-2

The study of the various geological phenomena. Topics discussed are: rock-forming minerals; igneous, sedimentary, and metamorphic rocks; weathering and erosion; stream sculpture; glaciation; surface and sub-surface waters; volcanism, dynamic processes; structural geology; and interpretation of topographic maps. Frequent reference is made to other than the prescribed textbook. The course stresses those topics of particular interest to the petroleum engineer.

Text: Longwell, Flint: Introduction to Physical Geology.

Prerequisite: Ge-401(C).

Ge-201(C) Physical Geology 3-0

Course content similar to Ge-101, but directed towards the specific needs of the Nuclear Engineering Groups.

Text: Longwell, Flint: Introduction to Physical Geology.

Prerequisite: None.

Ge-241(A) Geology of Petroleum 2-4

Seminars and discussion on the origin, accumulation, and structures which aid in the accumulation of petroleum, its general occurrence, and distribution. The following regions are studied: Eastern United States, Mid-Continent, Gulf Coast, Rocky Mountains, Pacific Coast, North America (except U. S.), West Indies, South America, Europe, 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 2-3

A series of lectures on the differentiation of magmas into the various igneous rock series on the basis of physical chemical theories; the characteristics, structures and textures of igneous rocks; the metamorphic rocks, mineral alteration, metamorphism and the resultant rock types. The laboratory work consists of the study of the various rocks in hand specimens, and in thin sections under the petrographic microscope. When practicable, the course is supplemented by trips to nearby localities to study rocks and minerals in the field.

Texts: Pirsson, Knopf: Rocks and Rock Minerals; Grout: Petrography and Petrology.

Prerequisite: Cr-301(B) or Cr-311(B).

INDUSTRIAL ENGINEERING

IE Courses (Summer Session)

Elements of Management and Industrial Engineering ....IE-101(C)

Elements of Management and Industrial Engineering ....IE-102(C)

IE-101(C) Elements of Management and Industrial Engineering 23-0

A period of six weeks is devoted to a series of short courses in such areas as: Accounting, Business Law, Industrial Economics, Industrial Relations, Personnel Administration, Production Management, Principles of Organization, and Quality Control. The basic principles are presented together with their application to the solution of illustrative problems.

Text: To be assigned.

Prerequisite: None.

IE-102(C) Elements of Management and Industrial Engineering 23-0

This is basically the same course as IE-101(C) but is eight weeks in length and provides greater coverage in some areas.

Text: To be assigned.

Prerequisite: None.

A certificate is awarded upon satisfactory completion of each course.

INDUSTRIAL AND TECHNICAL LECTURES

IT Lecture Courses

Industrial and Technical Lectures I ......IT-101(L)

Industrial and Technical Lectures II .....IT-102(L)

IT-101(L) Industrial and Technical Lectures I 0-1

Consists of first nine lectures of an eighteen-lecture series to be delivered by authorities, both civilian and governmental, in various fields such as management, industrial engineering, labor relations and research. New developments in various fields of engineering interest are included.

Text: None.

Prerequisites: None.

IT-102(L) Industrial and Technical Lectures II 0-1

A continuation of course IT-101(L) consisting of the second nine lectures of the eighteen-lecture series described under IT-101(L).

Text: None.

Prerequisites: None.

MATHEMATICS

Ma Courses

Ma-100(C) Vector Algebra and Geometry 2-1

Vectors and their algebra. Analytic geometry of space; points, lines, and planes in scalar and vector notation. Determinants and linear systems. Special surfaces. The laboratory periods are devoted to a review of a selection from essential topics in trigonometry and analytic geometry.

Texts: Smith, Gale and Neelley: New Analytic Geometry; Weatherburn: Elementary Vector Analysis; USNPGS Notes.

Prerequisite: A former course in plane analytic geometry.

Ma-109(A) Topics in Advanced Calculus 3-0

Extension of natural numbers to the real number system; basic theorems on limits; continuity and differentiation properties of functions; the definite integral and improper definite integrals; infinite series.

Texts: Landau: Foundations of Analysis; Courant: Differential and Integral Calculus, Volume I; Osgood: Functions of Real Variables.

Prerequisite: A former course in differential and integral calculus.

Ma-111(C) Introduction to Engineering Mathematics 3-1

Partial differentiation; multiple integrals; hyperbolic functions. The laboratory periods are devoted to a review of selected topics in basic calculus.

Texts: Granville, Smith and Longley: Elements of the Differential and Integral Calculus; Wylie: Advanced Engineering Mathematics.

Prerequisites: A former course in differential and integral calculus and Ma-100(C) or Ma-120(C) to be taken concurrently.

Ma-112(B) Differential Equations and Infinite Series 5-0

A continuation of Ma-111(C). First order ordinary differential equations; ordinary linear differential equations with constant coefficients; power series and power series expansion of functions; power series solution of ordinary differential equations; Fourier series.

Texts: Golomb and Shanks: Ordinary Differential Equations; Granville, Smith and Longley: Elements of the Differential and Integral Calculus; Wylie: Advanced Engineering Mathematics.

Prerequisite: Ma-111(C).

Ma-113(B) Introduction to Partial Differential Equations and Functions of a Complex Variable 3-0

A continuation of Ma-112(B). Solution of partial differential equations by means of series of orthogonal functions; analytic functions of a complex variable; line integrals in the complex plane; infinite series of complex variables; theory of residues.

Text: Wylie: Advanced Engineering Mathematics.

Prerequisite: Ma-112(B).

Ma-114(A) Functions of a Complex Variable and Vector Analysis 3-0

A continuation of Ma-113(B). Conformal mapping and applications; calculus of vectors with geometric applications; differential operators; line, surface and volume integrals involving vector fields; applications to heat flow and potential problems.

Text: Wylie: Advanced Engineering Mathematics.

Prerequisite: Ma-113(B).

Ma-115(A) Differential Equations for Automatic Control 3-0

Phase trajectories for linear and certain non-linear systems; singular points of non-linear equations; graphical solutions; stability investigations. The Laplace Transformation methods as used in ordinary initial value problems and partial differential equations; the inversion integral; calculation of inverse transforms by residues and by the Heaviside rules. Reduction of differential equations to non-dimensional form.

Texts: Minorsky: Introduction to Non-linear Mechanics; Churchill: Modern Operational Mathematics in Engineering; Pipes: Operational Methods in Non-linear Mechanics; Stoker: Non-linear Vibrations.

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: Frazer, Duncan and Collar: Elementary Matrices; Reprints of articles from scientific journals; Salvadori and Baron: Numerical Methods in Engineering.

Prerequisite: Ma-114(A).

Ma-120(C) Vector Algebra and Geometry 3-1

Real number system. Algebra of complex numbers. Vectors and their algebra. Analytic geometry of space; points, lines, and planes in scalar and vector notation. Determinants, matrices and linear systems; linear dependence. Special surfaces. Laboratory periods devoted to review of essential topics in trigonometry and plane analytic geometry.

Texts: Smith, Gale, Neely: New Analytic Geometry; Weatherburn: Elementary Vector Analysis; Churchill: Introduction to Complex Variables; USNPGS Notes.

Prerequisite: Former course in plane analytic geometry.

Ma-121(C) Introduction to Engineering Mathematics 3-1

Concepts of function, limit, continuity. Ordinary derivatives and applications. Rolle's theorem and the theorem of the mean. Taylor's series with a remainder. Partial derivatives. Implicit functions. Jacobians. Definite integral. Infinite series; Power series and Fourier series.

Texts: Burington and Torrance: Higher Mathematics; Franklin: Methods of Advanced Calculus; Granville, Smith, Longley: Elements of the Differential and Integral Calculus.

Prerequisites: A former course in differential and integral calculus and Ma-120(C) to be taken concurrently.

Ma-122(B) Differential Equations and Vector Calculus 5-0

Multiple integrals. Line, surface and volume integrals. Divergence theorem. The theorems of Stokes, Green, and Gauss with applications. Vector calculus; intrinsic definition of the curl and divergence, the operator del, and vector formulation of integral theorems. Elementary differential equations. Hyperbolic functions.

Texts: Weatherburn: Elementary Vector Analysis; Phillips: Vector Analysis; Sokolnikoff and Sokolnikoff: Higher Mathematics.

Prerequisite: Ma-121(C).

Ma-123(A) Orthogonal Functions and Partial Differential Equations 5-0

Special functions; elliptic integrals, Gamma and Beta functions. Series solution of differential equations. Orthogonal functions. Elements of Sturm-Liouville Theory. Bessel functions. Legendre polynomials. Partial differential equations and solution of boundary value problems.

Texts: Churchill: Fourier Series and Boundary Value Problems; Sokolnikoff and Sokolnikoff: Higher Mathematics.

Prerequisite: Ma-122(B).

Ma-124(B) Complex Variable 3-0

Analytic functons. Cauchy's theorem and formula. Taylor and Laurent series. Theory of residues. Contour integration. Conformal mapping. Applications.

Text: Churchill: Introduction to Complex Variable.

Prerequisite: Ma-123(A).

Ma-125(B) Numerical Methods for Digital Computers 2-2

Numerical methods for solution of systems of linear algebraic equations, polynomial equations, and systems of non-linear algebraic equations; finite differences, numerical interpolation, differentiation, integration; numerical methods for solving initial value and boundary value problems involving ordinary and partial differential equations. The laboratory periods cover sample problems solved on hand-operated keyboard calculators; emphasis is given to the methods which are most useful in large scale automatic digital computers.

Text: Salvadori and Baron: Numerical Methods in Engineering.

Prerequisite: Ma-113(B) or Ma-123(A) or Ma-183(B).

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.

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-123(A).

Ma-135(B) Differential Equations and Numerical Methods 4-1

Total differential equations and systems of linear differential equations. Elementary partial differential equations and boundary value problems. Numerical interpolation, differentiation and integration. Logical design of digital computers. Introduction to programming and coding. Applications to meteorology.

Texts: Cohen: Differential Equations; Scarborough: Numerical Mathematical Analysis; Booth and Booth: Automatic Digital Calculators.

Prerequisite: Ma-331(A).

Ma-161(C) Algebra, Trigonometry and Analytic Geometry 5-0

Review of elementary algebraic operations. Exponent laws and logarithms. Variables and functions of variables. Coordinate representation of functions; graphs. The trigonometric functions. The straight line and its slope. Simultaneous linear equations. The quadratic equation. Elementary equations of the conics.

Text: Brink: A First Year of College Mathematics.

Prerequisite: None.

Ma-162(C) Introduction to Calculus 5-0

The limit concept. The derivatives of elementary functions. Elementary applications of derivatives. Differentials, higher order derivatives and curvature. The integral as an antiderivative and as an area. Elementary applications of integration.

Text: Granville, Smith and Longley: Elements of the Differential and Integral Calculus.

Prerequisite: Ma-161(C) or satisfactory evidence of competence in analytic geometry.

Ma-163(C) Calculus and Vector Analysis 4-0

Elementary vector operations. Partial derivatives, total derivatives and total differentials with applications. Partial and multiple integrals. Differentiation of vectors; gradient, divergence and curl. Introduction to line integrals.

Texts: Phillips: Vector Analysis; Granville, Smith and Longley: Elements of the Differential and Integral Calculus.

Prerequisite: Ma-162(C) or a recent course in differential and integral calculus.

Ma-181(C) Partial Derivatives and Multiple Integrals 4-1

Review of elementary calculus. Partial and total derivatives. Gradients and their physical interpretations. Line integrals. Double and triple integrals. Introduction to ordinary differential equations. Physical applications.

Texts: Granville, Smith and Longley: Differential and Integral Calculus; Sokolnikoff and Sokolnikoff: Higher Mathematics.

Prerequisites: A former course in differential and integral calculus, and Ma-100(C) or Ma-120(C) to be taken concurrently.

Ma-182(C) Vector Analysis and Differential Equations 5-0

Vector differentiation. Vector integral relations. Physical applications. Ordinary first order differential equations. Higher order linear differential equations. Systems of differential equations. Physical interpretations. Infinite series.

Texts: Sokolnikoff and Sokolnikoff: Higher Mathematics; Phillips: Vector Analysis.

Prerequisites: Ma-100(C) and Ma-181(C).

Ma-183(B) Fourier Series and Complex Variables 5-0

Expansion of functions. Series solution of differential equations. Fourier series and solution of partial differential equations. Algebra of complex numbers. Analytic functions of a complex variable, and the elementary transcendental functions. Conformal maps. Cauchy's Theorem. Residues.

Texts: Sokolnikoff and Sokolnikoff: Higher Mathematics; Churchill: Fourier Series and Boundary Value Problems; Churchill: Complex Variables.

Prerequisite: Ma-182(C).

Ma-184(A) Matrices and Numerical Methods 3-0

Algebra of matrices. Characteristic values of matrices. Applications of matrices. Notation of finite differences. Numerical differentiation and numerical integration.

Texts: Sokolnikoff and Sokolnikoff: Higher Mathematics; Margenau and Murphy: Mathematics of Physics and Chemistry.

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 to probability theory.

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, 1930, 164 ff); Baude: Simplified Nomogram Construction (Machine Design, May 1952, 155 ff); USNPGS Notes.

Prerequisite: Ma-100(C) or Ma-120(C).

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-123(A) or Ma-113(B). (May be taken concurrently.)

Ma-320(C) Introduction to Statistics and Operations Analysis 4-0

Frequency distributions. Mean value and standard deviation. Basic probability theory for discrete and continuous variables. 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 Integral Calculus.

Prerequisite: A former course in differential and integral calculus.

Ma-321(B) Probability and Statistics 4-2

Tabulation and graphical presentation of frequency distributions from observational data. Elementary rules for calculation of probabilities with applications. Random variables and probability distributions. The binomial, Poisson, and normal distributions. Chi-square, Gosset's t, and variance quotient distributions. Regression and correlation, Estimation and testing of statistical hypotheses. Applications in quality control and acceptance sampling.

Text: Cramer: The Elements of Probability Theory.

Prerequisite: Ma-123(A) or Ma-113(B).

Ma-330(C) Introduction to Statistics 2-0

Preliminary considerations in the analysis of observations. Measures of central tendency and dispersion. Elementary probability. The Poisson, Bernoulli and normal distributions. Some applications to sampling.

Text: Wilks: Elementary Statistical Analysis.

Prerequisite: Ma-121(C) or equivalent.

Ma-331(A) Statistics 4-2

A continuation of Ma-330(C). Definition and laws of probability over an event space. Joint frequency functions. Tests of statistical hypotheses. Large and small sampling theory. Correlation and regression methods in multivariate problems. Introduction to the theory of estimators of population parameters and their distributions. Applications to problems in aerology.

Texts: Hoel: Introduction to Mathematical Statistics (Second Edition); Best and Panofsky: Some Applications of Statistics to Meteorology.

Prerequisite: Ma-134(B) or Ma-330(C).

Ma-351(B) Industrial Statistics I 3-2

Frequency distributions. Elements of the theory of probability. The hypergeometric, binomial, Poisson, and normal probability distributions. Sampling distributions of the mean, variance, and range. Single, double, and sequential acceptance sampling by attributes. Control charts.

Text: Duncan: Quality Control and Industrial Statistics.

Prerequisite: Ma-113(B).

Ma-352(B) Industrial Statistics II 2-2

Acceptance sampling by variables. Statistical tests. Analysis of variance and design of experiments. Regression and correlation. Illustrations from selected ordnance publications.

Text: Duncan: Quality Control and Industrial Statistics.

Prerequisite: Ma-351(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. Applications in the field of the group.

Texts: Wilks: Elementary Statistical Analysis; Best and Panofsky: Applications of Statistics to Meteorology. (Aerology groups only.)

Prerequisite: Ma-163(C) or Ma-181(C).

Ma-382(A) Probability and Statistics 3-0

Mathematical probability. Joint distributions. Functions of stochastic variables. Mathematical expectation. Limit theorems. Probabilities of hypotheses and Bayes' theorem. Probabilities in continuum.

Texts: Munroe: Theory of Probability; Mood: Introduction to the Theory of Statistics; Cramer: The Elements of Probability and Some of Its Applications.

Prerequisite: Ma-381(C) or Ma-301(B).

Ma-383(A) Probability and 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; Tucker: Introduction to Statistical Decision Functions, (USNPGS Thesis).

Prerequisites: Ma-383(A) and Ma-501(A). (The latter may be taken concurrently.)

Ma-401(A) Analog Computers 2-2

Elementary analog devices which may be used to perform addition, multiplication, function generation, integration, etc. Combinations of such devices for solution of differential equations, systems of linear equations, algebraic equations, harmonic analysis, etc. Digital differential analyzers.

Texts: W. W. Soroka: Analog Methods in Computation and Simulation; Murray: Theory of Mathematical Machines; Reprints of articles from scientific periodicals.

Prerequisite: Ma-113(B) or Ma-123(A).

Ma-421(A) Digital and Analog Computation 3-2

Logical design of digital and analog computers. Programming and coding for general-purpose digital, differential analyzer, and analog computers. Laboratory operation of computing machines. Applications to problems in engineering.

Texts: Programming Manuals; Booth and Booth: Automatic Digital Calculators; Korn and Korn: Electronic Analog Computers.

Prerequisite: Ma-116(A) or Ba-125(B).

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 Notes.

Prerequisites: Ma-195(A) and 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; general principles of dynamics; dimensional analysis; kinematics of a particle; relative and absolute time rate of change of a vector; Coriolis acceleration.

Text: Housner and Hudson: Applied Mechanics.

Prerequisite: A previous course in mechanics is desirable. Ma-100(C) or Ma-120(C) to be taken concurrently.

Mc-102(C) Engineering Mechanics II 2-2

Dynamics of a particle; impulse and momentum; work and energy; potential; conservation of energy; vibrating systems, free and forced, with and without damping; impact; dynamics of rigid bodies; moments and products of inertia; principal axes of inertia; the gyroscope.

Text: Housner and Hudson: Applied Mechanics.

Prerequisite: Mc-101(C).

Mc-201(A) Methods in Dynamics 2-2

The principles of linear momentum, angular momentum, work and energy, power and energy, conservation of energy, virtual work, and d'Alembert are developed and discussed in detail. This work is followed by a development and interpretation of Lagrange's equations of motion. Application of these various principles to obtain the differential equations of motion of dynamical systems is given particular attention. Numerous exercises in the writing of differential equations of motion are assigned; some of these are designed to furnish practice in the formulation of the differential equations for systems of variable mass.

Texts: Synge and Griffith: Principles of Mechanics; Timoshenko and Young: Advanced Dynamics.

Prerequisites: Mc-102(C) and Ma-113(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).

Prerequisites: Ma-114(A), Mc-102(C) and either ME-500(C) or Ae-211(C).

Mc-401(A) Exterior Ballistics 3-0

Topics presented include density and temperature structure of the atmosphere; air resistance; elastic waves in air; numerical integration of differential equations of motion under standard conditions by use of the electronic digital computer; differential corrections for abnormal conditions; weighting factors; general aerodynamic force system and equations of angular motion of a spinning axially-symmetric projectile; stability; yaw and pitch of repose; drift; trailing; swerve; windage jump; effects of yaw in gun, eccentric mass, and muzzle blast; rocket motion and launching effects.

Texts: Ritter: A Course in Exterior Ballistics; McShane, Kelley and Reno: Exterior Ballistics.

Prerequisite: Mc-102(C).

Mc-402(A) Mechanics of Gyroscopic Instruments 3-0

Review of the vector kinematics and dynamics involved in the angular motion of rigid bodies; steady free and forced precession and general motion of a gyro; stability of a free gyro; gyroscopic moment of an unsymmetrical gyro; the gyrocompass; gyro angular velocity indicator; the stable platform.

Texts: Synge and Griffith: Principles of Mechanics (Second Edition); Timoshenko and Young: Advanced Dynamics.

Prerequisite: Mc-102(C).

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.

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) and Ch-631(A).

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-112(B).

ME-112(B) Engineering Thermodynamics 4-2

Properties of mixtures of quasi-ideal gases, low-pressure gas-vapor mixtures and related indices, representative processes with these, multi- and mono-pressure hygrometric diagrams. Combustion of fuels, material and energy balances, fuel calorimetry, 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-112(B).

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 Supplement: 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-113(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.

Texts: 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 ME-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. Associated laboratory work.

Texts: Kiefer, Kinney and Stuart: Engineering Thermodynamics; miscellaneous supplementary material.

Prerequisite: ME-221(C).

ME-223(B) Marine Power Plant Analysis 2-4

Preliminary methods of estimating for a hypothetical naval ship the hull, main engine and auxiliary power requirements, inter-relationship of individual equipment items, and computation of various plant and ship performance indices. Preliminary design investigation of main propulsion turbines and other power plant equipment. Heat balance and flow diagrams.

Texts: Seward: Marine Engineering; Labberton: Marine Engineering; Church: Steam Turbines; Bureau of Ships publications and data.

Prerequisites: ME-222(C) and ME-421(C) or ME-411(C).

ME-240(B) Nuclear Power Plants 4-0

A general survey of nuclear power with emphasis on the relation of the reactor to power sources, present and future. Nuclear particles, energies and properties. Nuclear reactions, radioactivity, decay. Scattering and diffusion of neutrons. Nuclear reactor principles, types. Problems of power removal and utilization. Reactor core considerations. Elements of reactor economics, feasibility. Shielding problems. Discussion of world future energy source.

Text: Murray: Introduction to Nuclear Engineering.

Prerequisites: ME-111(C) and Ph-610(B).

ME-241(A) Nuclear Power Plants 3-2

The first of a two-term series, ME-241 and ME-242 covering engineering aspects of nuclear power reactors. Reactor types, properties and criteria for selection. History and organization of atomic energy effort. Advanced heat transfer and thermodynamics of characteristic cycles. Elementary nuclear and thermal core and plant design. Shielding. Economics of nuclear plants.

Texts: Murray: Introduction to Nuclear Engineering; Glasstone and Edlund: Elements of Nuclear Reactor Theory; USGPO: Liquid Metals Handbook.

Prerequisites: ME-310(B) and Ph-642(B).

ME-242(A) Nuclear Power Plants 3-2

Reactor control methods and programs. Plant stability, kinetic behavior, poisoning. Detailed studies of existing naval reactor plants. Material in this course will be partly of a classified nature.

Texts: Murray: Introduction to Nuclear Engineering; Glasstone and Edlund: Elements of Nuclear Reactor Theory; USGPO: Liquid Metals Handbook.

Prerequisite: ME-241(A).

ME-246(B) Nuclear Power Plants 3-0

A general survey of nuclear reactor principles, intended for other than mechanical engineering students. Essential elements of thermodynamics, heat transfer, and neutron physics. Reactor principles, reactor power plant descriptions, shielding, materials, corrosion, and associated problems.

Text: Murray: Introduction to Nuclear Engineering.

Prerequisites: Ph-631(B) or Ph-730(A). (May be taken concurrently.)

ME-310(B) Heat Transfer 4-2

General manners of energy transition by temperature potential, characteristic thermal circuits, concepts and correlation of individual and overall heat transfer coefficients. Fourier's general law of conduction, applications to representative steady-state situations and unsteady-state condition, Schmidt and relaxation methods of approximation. Convection phases of thermal circuits, free and forced, and ones involving vaporization and condensation. Heat radiation. Associated problems and laboratory work.

Texts: Jakob and Hawkins: Elements of Heat Transfer and Insulation; McAdams: Heat Transmission.

Prerequisites: Ma-114(A) and ME-112(B).

ME-350(B) Heat Transfer 2-2

General survey of the manners of energy transition by temperature potential, with major emphasis on its transfer by radiation and conduction under steady and unsteady-state conditions.

Texts: McAdams: Heat Transmission; Jakob: Heat Transfer, Vol. I; Jakob and Hawkins: Elements of Heat Transfer and Insulation.

Prerequisite. Ma-182(C).

ME-410(B) Hydromechanics 3-2

Brief coverage of hydrostatics, energy aspects of flow, momentum principle, and applications of dimensional analysis. Resistance to flow through and about bodies. Two dimensional potential flow theory and examples. Two dimensional viscous, incompressible fluid flow, with application to hydrodynamic lubrication. Associated laboratory exercises and problem work.

Texts: Departmental notes: Engineering Fluid Mechanics; Streeter: Fluid Dynamics.

Prerequisite: Ma-113(B).

ME-411(C) Hydromechanics 3-2

The mechanical properties of liquids, hydrostatic pressures and forces, buoyancy and ship stability. Energy aspects of fluid flow, fluid flow in pipes, flow metering and control. Dynamic forces associated with flow, impulse-momentum principles, analysis of hydro machinery. The principle of dynamic similarity and the techniques of dimensional analysis are developed and extensively used in analyses of lift and drag, performance of propellers, pumps, turbines, hydraulic couplings, etc. Elementary vortex flows; rotation and circulation introduced. Associated laboratory experiments and problem work. The course is the first of a sequence ME-411 and ME-412.

Text: Departmental notes: Engineering Fluid Mechanics.

Prerequisite: Ma-113(B).

ME-412(A) Hydromechanics 4-2

Continuation of ME-411. Basic concepts of kinematics of ideal, incompressible fluids. Stream and velocity potential functions, elementary flow patterns and the synthesis of combined flows, graphically and mathematically. Basic concepts in vector notation, use of the complex variable leading to the theory and application of conformal transformations. Kutta-Joukowski and Blasius theorems. Theory of hydrodynamic lubrication.

Texts: Departmental notes: Engineering Fluid Mechanics; Streeter: Fluid Dynamics.

Prerequisites: ME-411(C) and Ma-114(A).

ME-421(C) Hydromechanics 3-2

The course is the first of a sequence of ME-421 and ME-422. The content parallels that of ME-411, but proceeds at a slower rate.

Text: Departmental notes: Engineering Fluid Mechanics.

Prerequisite: Ma-111(C).

ME-422(B) Hydromechanics 2-2

Dynamic forces in fluid flow, centrifugal pumps, couplings and torque converters, jet propulsion. Introduction to the kinematics of ideal-fluid flow, primary flow patterns and their synthesis by graphical technics. Elements of hydrodynamic lubrication.

Text: Departmental notes: Engineering Fluid Mechanics.

Prerequisites: Ma-113(B) and ME-421(C).

ME-441(B) Hydromechanics 4-2

A one-term coverage of ME-411 plus selected portions of ME-412 as follows: Introduction to the stream function, velocity potential, source, sink and potential vortex and their synthesis to form simple irrotational flow patterns. Brief survey of the utilization of vector calculus and the complex variable in analysis of more complex patterns.

Text: Departmental notes: Engineering Fluid Mechanics.

Prerequisite. Ma-114(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 Supplement: 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-111(C) and Mc-101(C).

ME-511(C) Strength of Materials 5-0

Topics in elastic-body mechanics, including tensile and compressive stress, shearing stress, Hooke's law, thin-walled cylinders, combined stresses, torsion of circular-sectioned members, elementary beam theory, statically indeterminate problems in bending, combined loading, columns, and beams on elastic foundations.

Text: Timoshenko and MacCullough: Elements of Strength of Materials.

Prerequisites: Ma-111(C) and Mc-101(C).

ME-512(A) Strength of Materials 5-0

Beam columns, strain energy, shear center, thin plates, buckling of bars and plates, problems having radial symmetry, behavior beyond the elastic limit.

Text: Timoshenko: Strength of Materials, Vols. I and II.

Prerequisite: ME-511(C).

ME-513(A) Theory of Elasticity 3-0

Plane-stress considerations, differential equations of equilibrium and compatibility, the Airy stress function, curvilinear coordinates, problems in plane stress and plane strain, three-dimensional stress systems, St.-Venant theory of torsion, energy methods.

Text: Timoshenko and Goodier: Theory of Elasticity.

Prerequisite: ME-512(A).

ME-522(B) Strength of Materials 4-0

Beam columns, strain energy, shear center, thick cylinders, rotating disks, torsion of non-circular sections.

Text: Seeley and Smith: Advanced Mechanics of Materials.

Prerequisite: ME-511(C).

ME-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-111(C) and Mc-101(C).

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 and plastic analysis of structural elements. Structural types and nomenclature. Elastic and plastic analysis of statically determinate and indeterminate structures. Behavior of materials under suddenly applied loads. Engineering idealizations of loads imposed by blasts. Exact solutions for dynamic response of simple elements to suddenly applied loads. Introduction to the general problem of dynamic analysis of structures, through elastic and plastic phases. Numerical analysis of simple cases.

Texts: Timoshenko and MacCullough: Elements of Strength of Materials; Atomic Energy Commission: The Effects of Atomic Weapons; current reports.

Prerequisites: Mc-311(A) and ME-500(C).

ME-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) Mechanical Properties of Engineering Materials 2-2

Study of the theories of failure, the evaluation of experimental error and experiments in the determination of the mechanical properties of engineering materials. These tests include: tension, compression, torsion, shear, transverse bending, impact, hardness, fatigue and column action.

Texts: Seely and Smith: Advanced Mechanics of Materials; Davis, et al: Testing and Inspection of Engineering Materials.

Prerequisite: ME-511(C).

ME-612(A) Experimental Stress Analysis 3-2

The course includes: dimensional analysis, strain gage techniques, photoelasticity, brittle lacquer method, membrane analogy, miscellaneous methods in experimental stress analysis. Diversified 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

Theory and application of the wire resistance strain gage for finding static and dynamic stresses in machines and structures. Brief survey of other techniques including brittle lacquer, photo-elasticity, and analog methods. Laboratory experiments cover both static and dynamic stress studies with the resistance gage and a variety of auxiliary instrumentation.

Text: Perry and Lissner: Strain Gage Primer.

Prequisites: ME-522(B) and ME-611(C).

ME-700(C) Kinematics of Machinery 3-2

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 4-2

Emphasis is placed on velocities and accelerations of machine parts. An analysis is made of static and inertia forces on machine members. Practical dynamic analysis of cams is included. The kinematics of gears are studied including spur, bevel, helical and worm gears. This course is the first of a coordinated sequence of ME-711 and ME-712.

Text: Ham and Crane: Mechanics of Machinery.

Prerequisite: Mc-102(C).

ME-712(A) Dynamics of Machinery 3-2

Studies are made of the following topics: Balancing of solid rotors and reciprocating machines, free and forced vibrations without and with damping for one, two or many degrees of freedom, vibration isolation, vibration absorbers, torsional vibration including the Holzer method, vibration of beams including Rayleigh's method for transverse vibrations, nonlinear systems. Laboratory work includes the following experiments: balancing a solid rotor on a mechanical as well as an electrical balancing machine, rate of decay in the tranverse vibration of beams, calibration of velocity and acceleration pickups.

Texts: Den Hartog: Mechanical Vibrations; Thomson: Mechanical Vibrations.

Prerequisites: Ma-114(B), ME-711(B) and ME-511(C).

ME-713(A) Advanced Dynamics of Machinery 3-0

Several topics are studied from a theoretical as well as a practical point of view. These include: Shock and vibration mounts, torsional vibrations of crank shafts with emphasis on the design of tuned vibration absorbers, special bearings, gear tooth lubrication, sleeve bearings with pulsating loads, oil film whirl, turbine blade vibration, non-linear vibration problems, design and calibration of a velocity and an acceleration pick-up as carried out in the dynamics laboratory.

Texts: Den Hartog: Mechanical Vibrations; Thomson: Mechanical Vibrations; Karman and Biot: Mathematical Methods in Engineering.

Prerequisites: ME-712(A) and ME-812(B).

ME-730(A) Vibrations 3-2

Studies are made of the following topics: Balancing of solid rotors and reciprocating machines, free and forced vibrations without and with damping for one, two or many degrees of freedom, vibration isolation, vibration absorbers, torsional vibration including the Holzer method, vibration of beams including Rayleigh's method for transverse vibrations, non-linear systems. Laboratory work includes the following experiments: balancing a solid rotor on a mechanical as well as an electrical balancing machine, rate of decay in the transverse vibration of beams, calibration of velocity and acceleration pick-ups.

Texts: Den Hartog: Mechanical Vibrations; Thomson: Mechanical Vibrations.

Prerequisites: Ma-114(B), Mc-102(C), and ME-500(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; Departmental notes.

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) 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: Departmental Notes.

Prerequisite: ME-811(C).

ME-820(C) Machine Design 2-4

Short review of strength of materials. Stress-concentration, factors of safety. Fits and tolerances. Several short design projects which illustrate the application of the principles of stress, strain, deflection, fits and tolerances, vibrations, etc. General design information on bearings, springs, shafting, screw fastenings, gears, clutches, brakes, cams and thick and thin cylinders.

Text: Departmental notes.

Reference: Vallance and Doughtie: Design of Machine Members.

Prerequisite: ME-700(C).

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.

Prerequisites: ME-700(C) and Ae-202(C).

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 fundamental processes of extractive metallurgy; refractories, fuels, fluxes, slags and equipment; a brief summary of steel-making and the production of copper and zinc.

Text: Stoughton, Butt: Engineering Metallurgy (1938).

Prerequisite: Ch-101(C) or Ch-121(B), or concurrently with either.

Mt-102(C) Production of Steel 3-0

The subject matter includes such topics as the occurrence and composition of various iron ores, blast furnace products. The various methods of steel production and the production of grey, white and malleable cast iron.

Text: Bray: Ferrous Production Metallurgy.

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

Mt-103(C) Production of Non-Ferrous Metals 3-0

A discussion of the sources, the strategic importance of, and the methods of production of the following metals: copper, zinc, lead, tin, aluminum, magnesium, and other metals of technical interest.

Text: Bray: Non-Ferrous Production Metallurgy.

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

Mt-104(C) Production Metallurgy 4-0

An introduction to the study of production metallurgy. Subjects treated include the occurrence of metal bearing raw materials, the fundamental processes of extractive metallurgy, refractories, fuels, fluxes. Production of steel, cast iron, copper, zinc, lead, tin, nickel, aluminum and magnesium.

Text: Bray: Ferrous Production Metallurgy;
Bray: Non-Ferrous Production Metallurgy.

Prerequisite: Ch-101(C) or equivalent.

Mt-201(C) Introductory Physical Metallurgy 3-2

An introduction to physical metallurgy. Subjects treated include: (a) the nature, characteristics and properties of metals; (b) the application of the phase rule to binary and ternary alloy systems and characteristic phase diagrams; (c) the correlation of microstructure, mechanical properties and corrosion resistance of alloys, with phase diagrams; (d) mechanical deformation and heat treatment of alloys; (e) descriptions of representative non-ferrous alloys of commercial importance. The subject matter is illustrated by reference to technically important alloy systems in which the phenomena are commonly observed.

The laboratory experiments are designed to introduce to the student the methods available to the metallurgist for the study of metals and alloys. These include the construction of equilibrium diagrams and metallographic studies of fundamental structures, brass, bronze, bearings, etc.

Texts: Coonan: Principles of Physical Metallurgy; Brick and Phillips: Structure and Properties of Alloys.

Prerequisite: None.

Mt-202(C) Ferrous Physical Metallurgy 3-2

Continues the presentation of subject matter introduced in Metals, Mt-201, with emphasis on the alloys of iron. Subjects treated include (a) the iron-carbon alloys, (b) effects of various heat treatments and cooling rates on the structure and properties of steel, (c) isothermal reaction rates and the hardenability of steel, (d) surface hardening methods, (e) characteristics and properties of plain carbon and alloy cast irons, (f) the effect of other alloying elements on steel, (g) tool steels.

The laboratory work includes experiments in the heat treatment of steel, mechanical testing and metallographic examination of common ferrous alloys.

Texts: Coonan: Principles of Physical Metallurgy; Clark and Varney: Physical Metallurgy for Engineers.

Prerequisite: Mt-201(C).

Mt-203(B) Physical Metallurgy (Special Topics) 2-2

A continuation of material presented in Mt-201 and Mt-202. The subject matter includes a discussion of the theories of corrosion, factors in corrosion, corrosion prevention, corrosion resistant metals and alloys, powder metallurgy, metallurgical aspects of welding and casting, fatigue and fatigue failures, creep of metals, properties of metals at low temperatures, and surveys of the alloys of aluminum and magnesium and of certain alloys having characteristics suitable for special applications.

Texts: Coonan: Principles of Physical Metallurgy; Heyer: Engineering Physical Metallurgy; Woldman: Metal Process Engineering; Clark and Varney: Physical Metallurgy for Engineers.

Prerequisite: Mt-202(C).

Mt-204(A) Non-Ferrous Metallography 3-3

An expansion of material introduced in Mt-201, Mt-202 and Mt-203 with greater emphasis on the intrinsic properties of specific nonferrous metals and alloys. Metals and alloys of importance in engineering and technical applications are discussed in considerable detail with respect to their physical and mechanical properties, microstructures, response to mechanical deformation and heat treatment, advantages and disadvantages for technical applications and unique characteristics leading to specific applications.

Text: None

Prerequisites: Mt-201(C) and Mt-202(C).

Mt-205(A) Advanced Physical Metallurgy 3-4

The subject matter includes a discussion of equilibrium in alloy systems, structure of metals and alloys, phase transformations and diffusion.

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(B) Physics of Solids 3-0

A course for engineers intended as an introduction to the physics of solids. Topics discussed include introductory statistical mechanics, atomic structure and spectra, introductory quantum mechanics, binding and energy bands, crystal structure, and imperfections in crystals.

Text: Sproull: Modern Physics.

Prerequisite: Mt-202(C).

Mt-208(C) Physical and Production Metallurgy 4-2

This course covers the same material as Mt-202 and includes in addition the production of iron and steel. One period each week is devoted to this latter topic.

Texts: Coonan: Principles of Physical Metallurgy; Clark and Varney: Physical Metallurgy for Engineers.

Prerequisite: Mt-201(C).

Mt-301(A) High Temperature Materials 3-0

A study of the effect of high temperature on the properties of metals. Methods of evaluating behavior of materials at elevated temperatures. Factors in the selection of materials for elevated temperatures. Development of alloys for high temperature service. Refractory metals, super alloys, alloys of titanium and molybdenum. Creep and allied phenomena. Metals used in gas turbines, reaction motors, etc. Use of ceramics, development of cermets.

Text: Coonan: High Temperature Materials.

Prerequisite: Mt-202(C).

Mt-302(A) Alloy Steels 3-3

The subject matter covered includes a thorough study of the effects of the alloying elements, including carbon, commonly used in steel making on the characteristics of steels in the annealed, the hardened and the hardened and tempered conditions. The principles elucidated are subsequently applied to studies of the classes of steels used for structural purposes, machinery (S.A.E. and A.I.S.I. grades), electrical purposes, tools, and corrosion resisting purposes.

Text: E. C. Bain: The Alloying Elements in Steel; references and reading assignments in other books and current literature.

Prerequisite: Mt-202(C).

Mt-303(A) Metallurgy Seminar

Hours to be arranged

Papers from current technical journals will be reported on and discussed by students.

Text: None.

Prerequisite: Mt-203(B) or 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.

Texts: Cottrell: Theoretical Structure Metallurgy; Kittell: Solid State Physics; selected references.

Prerequisites: Mt-205(A) and either Ph-610(B) or Ph-640(B).

Mt-402(B) Nuclear Reactor Materials—Effects of Radiation 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.

Texts: The Reactor Handbook—General Properties Materials; selected references.

Prerequisite: Mt-202(C), Mt-207(B), or equivalent.

Mt-501(A) Welding Metallurgy 3-3

This course is designed to study in considerable detail the various materials, equipment, and processes employed for joining metals by both the plastic and the fusion welding methods, and to correlate the mechanical, electrical, and metallurgical factors essential to successful welding. Topics covered include heat sources, welding machines, manual and automatic processes, fluxes and slags, evaluation of materials, examination and testing of welded structures, metallurgy of weld deposits and heat-affected parent metals, weldability, underwater welding and cutting, corrosion of welds and welded structures, and the origin and control of defects in welding.

The laboratory exercises are designed to familiarize the student with the more common welding processes and to permit verification of certain aspects of the subject matter.

Texts: None. References from handbooks, periodicals and manufacturers' literature.

Prerequisite: Mt-203(B).

OCEANOGRAPHY

Oc Courses

Oc-100(C) Survey of Oceanography 3-0

A descriptive course, complete in itself, suitable for all curricula. Similar to Oc-110(C), but emphasizing physical, chemical, biological, geological, and meteorological problems that the marine environment presents to naval operations.

Texts: Sverdrup: Oceanography for Meteorologists; Shepard: Submarine Geology; NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare.

Prerequisite: None.

Oc-110(C) Introduction to Oceanography 3-0

A descriptive course which provides background for later courses in oceanography; it may be taken by students in all curricula. Topics include the physical and chemical properties of sea water, marine biology, and submarine geology; the heat budget of the oceans; water masses and the general circulation; currents, waves, and tides.

Texts: Sverdrup: Oceanography for Meteorologists; Shepard: Submarine Geology; NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare.

Prerequisite: Ph-196(C) or equivalent.

Oc-120(B) General Oceanography 4-0

Similar to Oc-110(C) but with emphasis on the meteorological aspects of oceanography, including the exchange of heat, moisture, and momentum between the sea and atmosphere, the relation of these exchanges to the changes in the vertical thermal structure of the sea, and the characteristics of ocean waves.

Texts: Sverdrup, Johnson, and Fleming: The Oceans; Shepard: Submarine Geology; NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare.

Prerequisite: Ph-196(C) or equivalent.

Oc-210(B) Physical Oceanography 2-1

Processes which tend to modify the distribution of the physical properties in the oceans; vertical thermal structure in the surface layers; equations of motion; advection and diffusion; mass-distribution and wind-driven currents; characteristics of surface and internal waves; tidal phenomena.

Texts: Sverdrup: Oceanography for Meteorologists; NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare; departmental notes.

Prerequisites: Oc-110(C) or equivalent, Ma-163(C) or equivalent, and Ph-198(C).

Oc-212(B) Tides and Tidal Currents 3-0

Theories of the astronomical tides; the tide-producing forces; tidal oscillations in ocean basins; geographical variation of the tides; analysis and prediction of tides; tidal datum planes. Meteorological tides. Seiches. Tidal currents.

Texts: Marmer: The Tide; Marmer: Tidal Datum Planes.

Prerequisites: Ma-111(C) and Ph-142(B) or their equivalents.

Oc-213(B) Shallow-Water Oceanography 3-0

Types and characteristics of continental shelves, coasts, and beaches; surf, breaking waves, littoral currents, and other shallow-water phenomena, and their influence upon amphibious operations; estuarine and harbor circulation.

Text: Departmental notes.

Prerequisites: Oc-110(C) or equivalent, and Mr-610(B).

Oc-220(B) Ocean Currents and Diffusion 2-0

Physical processes in the oceans, with emphasis on the advection and diffusion of radioactive wastes in the sea, and the natural flushing of contaminants from harbors and estuaries. Especially suitable for the Nuclear Engineering Curriculum.

Texts: Sverdrup, Johnson, and Fleming: The Oceans; Shepard: Submarine Geology; NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare.

Prerequisites: Ma-381(C) or equivalent, and Oc-110(C).

Oc-310(B) Submarine Geology 3-0

General physiography of the ocean basins; topographic features of the sea floor, especially seamounts, the continental slope and shelf, submarine canyons, and coral reefs; marine processes that have shaped the ocean basins and coasts; character of marine sediments; geographical and vertical distribution of sediment types; rates of deposition; origin of the ocean basins. Summary of the influence of of the sea floor on naval problems.

Text: Shepard: Submarine Geology.

Prerequisite: Oc-110(C). Ge-101(C) is desirable but not necessary.

Oc-410(B) Marine Biology 3-1

Plant and animal groups in the oceans; marine biological environments; character of the plankton, nekton, and benthos; ecology of marine organisms; oceanographic factors influencing populations and the effect of organisms on the physical-chemical properties of sea water; bioluminescence. Summary of the influence of marine biology on naval problems, including a study of those organisms responsible for boring, fouling, sound and light production, and sound scattering.

Text: Sverdrup, Johnson, and Fleming: The Oceans.

Prerequisite: Oc-110(C).

Oc-510(B) Chemical Oceanography 3-2

Chemical composition of sea water; total salinity and density; dissolved gases with emphasis on the carbon-dioxide system; plant nutrients; organic and inorganic agencies affecting the composition; the observed distribution of salts, dissolved gases, and nutrients; sea ice; geochemistry of the oceans. Summary of the Navy's problems in chemical oceanography, including corrosion and the production of fresh water from sea water. The laboratory includes chemical determination of the salinity and oxygen content of sea-water samples, and sea-water density computations.

Texts: Harvey: Recent Advances in the Biological Chemistry and Physics of Sea Water; Sverdrup, Johnson, and Fleming: The Oceans.

Prerequisites: Ch-101(C) or equivalent, and Oc-110(C).

Oc-610(B) Naval Applications of Oceanography 3-0

The applications of oceanography to navigation, submarine warfare, mine warfare, amphibious, carrier, and sea-plane operations, survival and rescue at sea, etc.

Texts: NavAer 50-1R-242: Application of Oceanography to Subsurface Warfare; selected publications.

Prerequisite: Oc-110(C) or equivalent.

Oc-620(B) Oceanographic Factors in Underwater Sound 3-0

The oceanographic factors involved in sound ranging, including thermal gradients, sound absorption properties of sea water, sound scattering and reflection characteristics of the sea surface and sea floor, scattering properties of marine organisms, and ambient noise arising in the sea. Forecasts are made of the vertical thermal structure in the surface layers.

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

Prerequisite: Oc-120(C) or Oc-210(B).

Oc-631(B) Oceanography of Mine Warfare I 3-0

Relation of mines to the sea floor, bathymetry, marine sediments and their physical properties, sediment scour and deposition. Wave and current forces on moored and ground mines. Visual observation of mines, transparency of sea water, water color, scattering of light from the surface and bottom. Sonic detection of mines, the absorption and scattering of sound in sea water, the sea floor as a sonic background.

Text: Departmental notes.

Prerequisites: Oc-110(C) and Ma-113(B).

Oc-632(B) Oceanography of Mine Warfare II 3-0

A continuation of Oc-631(B). Topics include biological fouling of mines; types and distribution of fouling organisms; rates of fouling. Classification of harbors; a case history of the oceanographic factors pertinent to mining and countermining in a major harbor. Oceanographic observations and equipment. Data sources.

Texts: Departmental notes and selected publications.

Prerequisite: Oc-631(B).

Oc-640(A) Engineering Aspects of Oceanography 3-0

Engineering application of oceanographic information, including the motion of ships in a seaway; the effect of harbor surging on moored ships; wave forces on breakwaters, pilings, mines, etc; permanent and mobile breakwaters; the influence of piers, breakwaters, and seawalls on coastline erosion; shoreline protection from marine erosion; harbor design and maintenance; and hydraulic models.

Texts: Departmental notes and selected publications.

Prerequisites: Oc-210(B) and Mr-610(B).

OPERATIONS ANALYSIS

Oa Courses

Oa-121(B) Survey of Operations Analysis 3-0

The nature, origin, and contemporary status of operations analysis; fundamental concepts with special emphasis on applications in the field of evaluating radar and sonar; introduction to game theory, linear programming, and other advanced techniques.

Texts: Operations Evaluation Group: Report No. 54, Methods of Operations Research; classified official publications; notes from MIT Summer Course on Operations Research, 1953.

Prerequisite: Ma-321(B).

Oa-151(B) Survey of Weapons Evaluation 3-0

Review of probability theory with military interpretations. Sources of firing errors and their relative contributions to the over-all errors. Damage probabilities. Selection of optimal weapon systems. Introduction to game theory.

Texts: Operations Evaluation Group: Report No. 54, Methods of Operations Research; classified official publications.

Prerequisites: Ma-113(B) and Ma-301(B).

Oa-152(C) Measures of Effectiveness of Mines 3-0

Review of probability theory with military interpretations. Introduction to operations analysis. Errors in mine laying. Probability of damage. Theory of mine field operation.

Texts: Classified official publications.

Prerequisite: Ma-381(C).

Oa-153(B) Game Theory and Its Applications to Mine Fields 3-0

A continuation of Oa-152(C). Introduction to game theory. Operation of a mine field according to game theory. Analysis of countermeasures.

Texts: Classified official publications.

Prerequisite: Oa-152(C).

Oa-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) and 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) and 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. Queuing theory, with applications.

Texts: Classified official publications.

Prerequisites: Ma-182(C) and Ma-382(A).

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) and Oa-193(B).

Oa-195(A) Optimal Weapon Systems II 3-0

Evaluation of fleet air defense. Applications of operations analysis to the problem of continental air defense. Special weapons. The effects of system complexity on system reliability.

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. Dynamic programming. Laboratory work on computation of optimal solutions of linear programs.

Texts: Koopmans: Activity Analysis of Production and Allocation; Project RAND Paper P-189, Optimal Inventory Policy; Project RAND Report R-245, An Introduction to the Theory of Dynamic Programming.

Prerequisites: Ma-501(A) and Ma-195(A).

Oa-202(A) Econometrics 3-0

A continuation of Oa-201(A). Inter-industry analysis; mathematical economic theory; review of current theoretical investigations of relationships between military programs and the national economy.

Texts: Koopmans: Activity Analysis of Production and Allocation; Project RAND Report R-245, An Introduction to the Theory of Dynamic Programming; Morgenstern: Economic Activity Analysis.

Prerequisites: Oa-201(A) and Ma-195(A).

Oa-401(A) Theory of Information Communication 3-0

Markov chains; surprisal of events and uncertainty of distributions; characterization of uncertainty; noise and rate of information transmission; limit distributions connected with sequences from an ergodic Markov chain; Shannon-Fano coding: detection.

Texts: Shannon and Weaver: The Mathematical Theory of Communication; S. Goldman: Information Theory; P. M. Woodward: Probability and Information Theory with Applications to Radar; R. M. Fano; The Transmission of Information, MIT Technical Reports 65 and 149.

Prerequisites: Ma-195(A) and Ma-383(A).

Oa-891(A) Seminar in Operations Analysis 2-4

Opportunity is given to students to prepare original material, or to choose current publications for study, and to present reports of this work as a phase of Operations Analysis.

Text: None.

Prerequisite: A background of advanced work in Operations Analysis.

ORDNANCE

Or Courses

Or-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); gyros; 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)

PHYSICS

Ph Courses

Ph-113(B) Dynamics 3-0

Fundamental dynamical concepts, oscillator theory, motion of a particle in two and three dimensions, motion in central fields with emphasis on atomic structure, motion of a system of particles, center of mass coordinates, wave motion, Lagrange's and Hamilton's methods.

Texts: Symon: Mechanics; Page: Introduction to Theoretical Physics.

Prerequisite: None.

Ph-141(B) Analytical Mechanics 4-0

Fundamental dynamical concepts, oscillator theory, curvilinear motion in a plane, energy concepts, statics and dynamics of a rigid body. Both analytical and vector methods are used.

Texts: Symon: 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: Symon: Mechanics; Page: Introduction to Theoretical Physics.

Prerequisites: Ma-183(B) (may be taken concurrently) and Ph-141(B).

Ph-144(A) Analytical Mechanics 4-0

The linear oscillator, central force motion, Lagrange's and Hamilton's equations. Kinematics of rigid bodies. Canonical transformations. Coupled systems and normal coordinates.

Text: Goldstein: Classical Mechanics; lecture notes.

Prerequisite: Ph-142(B) or equivalent.

Ph-190(C) Survey of Physics I 3-0

Elementary concepts and laws of statics and dynamics. Introduction to the statics and dynamics of fluids. Temperature, heat, radiation, kinetic theory and the gas laws. Fundamentals of vector representation and notation.

Text: Sears and Zemansky: College Physics.

Prerequisite: None.

Ph-191(C) Survey of Physics II 3-0

A continuation of Ph-190(C). A survey of wave propagation, sound, electricity and magnetism, atomic structure, the properties of light, and other electromagnetic wave phenomena.

Text: Sears and Zemansky: College Physics.

Prerequisite: Ph-190(C) or equivalent.

Ph-196(C) Review of General Physics 5-0

A review of statics and dynamics. A survey of temperature, heat, kinetic theory, electricity and magnetism, wave motion and sound, and selected topics in light as time permits.

Text: Sears and Zemansky: University Physics.

Prerequisite: Ph-191(C) or equivalent.

Ph-197(C) Review of Physics I 3-0

Statics and dynamics of particles, solids and fluids. Temperature, heat, radiation, kinetic theory and gas laws. Basic differential and integral calculus is used.

Text: Sears and Zemansky: University Physics.

Prerequisites: A previous course in college physics, Ma-100(C) and Ma-101(C). (To be taken concurrently.)

Ph-198(C) Review of Physics II 3-0

A continuation of Ph-197(C). Wave motion, sound, electricity, magnetism and such selected topics in light as time permits.

Text: Sears and Zemansky: University Physics.

Prerequisite: Ph-197(C).

Ph-240(C) Optics and Radiation from Atomic Systems 3-3

Reflection and refraction of light, optical systems, dispersion, interference, diffraction, polarization. Basic atomic structure, photoelectric effect, radiation from atoms, molecules and solids.

Texts: Sears: Optics; Jenkins and White: Fundamentals of Optics.

Prerequisite: None.

Ph-241(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.

Texts: Slater and Frank: Electromagnetism; Whitmer: Electromagnetics.

Prerequisites: Ma-103(B); Es-112(C).

Ph-312(A) Applied Electromagnetics 3-0

A continuation of Ph-311 with particular emphasis on magnetic fields of significance to mine warfare. Propagation of induction and radiation fields of electromagnetic waves.

Texts: Slater and Frank: Electromagnetism; Whitmer: Electromagnetics.

Prerequisite: Ph-311(A).

Ph-341(C) Electricity and Magnetism 4-2

DC and AC circuits, elementary electrostatics, vacuum tubes, coupled circuits, filters, lines, vacuum tube circuits. The treatment emphasizes the physical aspects of these phenomena.

Texts: Winch: Electricity and Magnetism; lecture notes.

Prerequisite: Ma-182(C). (May be taken concurrently.)

Ph-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) and Es-272(C).

Ph-352(A) Electromagnetic Waves 3-0

A continuation of Ph-351(A). Cylindrical 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) and EE-272(B), 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-421(B) 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, and membranes. 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. Acoustic filters and absorption of sound in fluids.

Text: Kinsler, Frey: Fundamentals of Acoustics.

Prerequisite: Ma-104(A) or Ma-193(B).

Ph-425(A) Underwater Acoustics 3-2

A continuation of Ph-421(B). An analytic treatment of the propagation of underwater acoustic waves as influenced by boundary conditions, refraction, reverberation, and attenuation. Physical characteristics of sonar transducers. Psychoacoustics, shock waves, sonar systems and developments, experimental measurements in underwater acoustics. Laboratory includes experiments in underwater acoustic measurements, sonar beam pattern, and operational characteristics of sonar equipment.

Texts: Kinsler, Frey: Fundamentals of Acoustics; NDRC Technical Summary: Principles of Underwater Sound; NDRC Technical Summary: Physics of Sound in the Sea.

Prerequisite: Ph-421(B) or 431(B).

Ph-426(B) Acoustics Laboratory 0-3

A laboratory course to accompany Ph-421(B). An experimental study of vibrating systems and acoustic radiations.

Text: None.

Prerequisite: Ph-421(B) or 431(B).

Ph-431(B) Fundamental Acoustics 4-0

An analytical study of the dynamics of free, forced, and damped simple harmonic oscillators, strings, bars and membranes. Development of, and solutions to, the acoustic wave equation. Propagation of plane waves through pipes and between different media. Acoustic filters. Beam patterns and directivity of acoustic radiation from a piston. Radiation reaction. Loudspeaker and cabinet design. Classical and molecular absorption of sound in free space and in tubes.

Text: Kinsler and Frey: Fundamentals of Acoustics.

Prerequisite: Ma-104(A).

Ph-432(A) Underwater Acoustics and Sonar Systems 4-3

A continuation of Ph-431(B). Microphone and sonar transducer theory and design. Transmission of sound in sea water, including problems of refraction, attenuation, and reverberation. Physical principles, electronic circuits, detection systems used in design and operation of current sonar equipment. New developments in sonar. Experiments in acoustical measurements, transducer measurements, sound beam and sonar equipment measurements, and noise analysis.

Texts: Kinsler and Frey: Fundamentals of Acoustics; NDRC Technical Summary: Principles of Underwater Sound.

Prerequisite: Ph-431(B).

Ph-433(A) Propagation of Waves in Fluids 2-0

A theoretical treatment of the propagation of acoustic waves in fluids including both ray and wave propagation characteristics as well as second order effects.

Text: Instructor's notes.

Prerequisite: Ph-421(B) or Ph-431(B).

Ph-441(A) Shock Waves in Fluids 4-0

Simple Oscillator. Hydrodynamics. Longitudinal wave equation. Propagation of acoustic waves in fluids. Propagation of explosive shock waves in fluids. Shock waves propagated from atomic explosions.

Texts: Kinsler, Frey: Fundamentals of Acoustics; Cole: Underwater Explosions; AFSWP-Hirschfeller: The Effects of Atomic Weapons.

Prerequisites: Ma-183(B) and Ph-142(B).

Ph-442(A) Shock Waves in Fluids 3-0

Finite amplitude waves. Theory of propagation of explosive shock waves in fluids, Rankine-Hugoniot equation of shock front, scaling laws, experimental measurements of shock waves in water. Shock waves propagated from atomic explosions.

Text: Cole: Underwater Explosions.

Prerequisite: Ph-421(A).

Ph-450(B) Underwater Acoustics 3-2

An analytic treatment of the fundamentals of acoustics, with particular emphasis on sound radiation and transmission problems encountered in underwater acoustics.

Texts: Kinsler, Frey: Fundamentals of Acoustics; NDRC Technical Summary: Principles of Underwater Sound; NDRC Technical Summary; Physics of Sound in the Sea.

Prerequisite: Ma-102(C).

Ph-461(A) Transducer Theory and Design 3-3

A theoretical treatment of the fundamental phenomena inherent to the design of crystal, magnetostrictive, and ceramic sonar transducers. Characteristics and parameters of various sonar transducer systems are studied in the laboratory.

Texts: Hueter, Bolt: Sonics; NDRC Technical Summary: Crystal Transducers; instructor's notes.

Ph-471(A) Acoustics Research 0-3

Advanced laboratory work in acoustics.

Text: None.

Prerequisite: Ph-432(A) or equivalent.

Ph-530(B) Thermodynamics 3-0

Fundamental theory of thermodynamics and application to physical problems. First and second laws of thermodynamics, entropy, free energy, the phase rule, gaseous reactions, thermodynamics of dilute solutions, specific heats of gases, the Nernst heat theorem.

Text: Sears: Thermodynamics.

Prerequisites: Ph-113(B) or Ph-142(B), and Ma-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), and 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) and Ph-142(B).

Ph-542(B) Survey of 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: Sears: Thermodynamics.

Prerequisites: Ph-113(B) or Ph-142(B), and Ma-103(B) or Ma-183(B).

Ph-610(B) Survey of Atomic and Nuclear Physics 3-0

An introductory course in atomic and nuclear physics. Elementary charged particles, photoelectricity, x-rays, radioactivity, atomic structure, nuclear reactions, nuclear fission.

Text: Semat: Atomic Physics.

Prerequisite: None.

Ph-620(B) Atomic Physics 3-0

The atom and kinetic theory, electrons as particles and waves, elementary quantum mechanics, atomic structure and spectra, molecular structure, introduction to fundamental nuclear particles and structure of nuclei, behavior of atoms in solids.

Text: Sproull: Modern Physics.

Prerequisites: Ph-240(C), Ph-113(B).

Ph-631(B) Atomic Physics 4-0

Dynamics of elementary charged particles, Rutherford's model of the atom and the scattering of alpha particles, special theory of relativity, Bohr model of the atom, Schroedinger wave equation, dipole radiation, optical spectra, Zeeman effect, magnetic moments, Pauli's principle, x-rays, photoelectric effect, natural radioactivity, the nucleus, artificial radioactivity.

Text: Richtmeyer and Kennard: Introduction to Modern Physics.

Prerequisite: Ph-361(A) or equivalent.

Ph-640(B) Atomic Physics 3-0

Elementary charged particles, photoelectricity, Bohr model of the hydrogen atom, optical and x-ray spectra, Zeeman effect, Compton effect, electron diffraction, special theory of relativity, Schroedinger's wave equation.

Texts: Finkelnburg: Atomic Physics; Semat: Atomic Physics.

Prerequisites: Ph-142(B) and Ph-240(C).

Ph-641(B) Atomic Physics Laboratory 0-3

An experimental study of the phenomena, observational methods, and instruments used in atomic physics.

Text: Laboratory notes.

Prerequisite: Ph-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-640(B); Ph-720(A). (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).

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-650(A) Nuclear Instrumentation 4-0

Particle accelerators, nuclear reactors, nuclear spectrometers, cloud chambers, scintillation detectors, Cerenkov detectors, and associated equipment.

Text: None.

Prerequisite: Ph-642(B).

Ph-651(A) Reactor Theory 3-0

Nuclear fission, the diffusion and slowing down of neutrons, homogeneous and heterogeneous 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) and Ph-640(B) or equivalent.

Ph-723(A) Physics of the Solid State 4-0

Crystal classes, interference phenomena. Quantum theory of crystal lattices, binding energies. Statistics of electrons in solids, band theory of solids, Brillouin zones, Hume-Rothery rule, electron negative mass and the "hole" concept. Conductivity, insulators and semiconductors, electron trapping, fluorescence, junction rectification, transistor action. Superconductivity, properties of liquid helium II. Magnetic properties of solids. Dislocations, strength and plastic flow.

Texts: Kittel: Introduction to Solid State Physics; Seitz: Modern Theory of Solids; Read: Dislocations in Crystals.

Prerequisite: Ph-631(B) or Ph-640(B).

Ph-730(A) Physics of the Solid State 3-3

Statistics of electrons in solids, band theory of solids, Brillouin zones, thermionic, photoelectric, and field emission, "hole" concept, conductivity, insulators and semi-conductors, photoconductivity, fluorescence, phosphorescence, junction rectification, transistor action. Magnetic and electric properties of solids, superconductivity.

Text: Kittel: Introduction to Solid State Physics.

Prerequisite: Ph-620(B).

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 1-0

Discussion of special topics of current interest in the field of physics and student thesis reports.

Text: None.

Prerequisite: Consent of instructor.

SECTION III

THE GENERAL LINE SCHOOL

Director

Everett Milton BLOCK, Captain, U. S. Navy
B.S., USNA, 1930; Armed Forces Staff College; Strategy and Tactics, Advanced Course, U. S. Naval War College.

Assistant Director

Albert Peyton COFFIN, Captain, U. S. Navy
B.S., USNA, 1934; Air War College, Maxwell Field, Ala.

Assistant Director (Waves)

Elizabeth Spencer HARRISON, Lieutenant Commander, U. S. Navy

Administrative Officer

Edgar Smith PALMER, Lieutenant Commander, U. S. Navy

Electronics and Training Aids Officer

Reginald Obie BROWN, Commander, U. S. Navy

Scheduling Officer

James Hoyt DOZIER, Lieutenant, U. S .Navy
B.S., Wake Forest College, 1943

NAVAL STAFF

ADMINISTRATION DEPARTMENT

Robert Edward PAIGE
Commander, U. S. Navy
Head of Department
B.S., USNA, 1939.

Harold Naylor HEISEL
Commander, U. S. Navy
Instructor in Administration and Leadership
B.A., Texas Western, 1936.

James Paul LYNCH
Commander, U. S. Navy
Instructor in Leadership
B.S., USNA, 1941.

John Winton GROSS
Commander, U. S. Navy
Instructor in Logistics and Administration
B.S., University of Alabama, 1937.

James Stuart NEILL
Commander, U. S. Navy
Instructor in International Relations
B.S., Trinity College, 1940.

Joseph Alois KRIZ
Commander, SC, U. S. Navy
Instructor in Logistics and General Administration
B.S., USNA, 1943; M.B.A., Columbia Univ., 1952.

Charles Leo NAGEL, Jr.
Lieutenant Commander, U. S. Navy
Instructor in General Administration
B.S., Louisiana State University, 1942.

Herbert Joseph A. HILLSON
Lieutenant Commander, U. S. Navy
Instructor in Psychological Warfare and Logistics

John Clarke ROBERTS, Jr.
Commander, U. S. Navy
Senior Instructor in Naval Justice and International Law
B.A., Univ. of Texas, 1939; LL.B., 1942.

Samuel Harris DINSMORE
Commander, U. S. Navy
Instructor in Naval Justice
B.A., St. Martin College, 1946.

Daniel Donald McLEOD
Lieutenant Commander, U. S. Navy
Instructor in Naval Justice, Public Speaking
LL.B., Univ. of Arkansas, 1936.

Burton M. L. SMITH
Associate Professor of Speech (1955)
A.B., University of Wisconsin, 1936; M. A., 1937.

OPERATIONS DEPARTMENT

Oliver Walton BAGBY
Commander, U. S. Navy
Head of Department
B.S., USNA, 1938; U. S. Naval War College, 1950.

CIC-ASW DIVISION

Alexander William BELIKOW
Commander, U. S. Navy
Senior Instructor

Clayton Francis STAFFEL
Commander, U. S. Navy
Instructor in CIC-ASW
B.B.A., St. Johns Univ., 1942.

Thomas Chapman YOUNG
Lieutenant Commander, U. S. Navy
Instructor in CIC-ASW

Robert Delphin PROVOST, Jr.
Lieutenant, U. S. Navy
Instructor in CIC-ASW
B.E.E., Univ. of Virginia, 1949.

NAVIGATION-SEAMANSHIP DIVISION

Harold Carl STIRLING
Commander, U. S. Navy
Senior Instructor

John Stephen MALAYTER
Lieutenant Commander, U. S. Navy
Instructor in Seamanship

Tyrus Carroll CHAPMAN
Lieutenant Commander, U. S. Navy
Instructor in Navigation
B.A., Univ. of Utah, 1950.

Louis Wilfred NOCKOLD
Lieutenant, U. S. Navy
Instructor in Seamanship

TACTICS DIVISION

Ronald Paul GIFT
Commander, U. S. Navy
Senior Instructor

Joseph Brennan DRACHNIK
Commander, U. S. Navy
Instructor in Amphibious Operations and Operational Planning
B.S., USNA, 1943.

Charles Eugene STASTNY
Commander, U. S. Navy
Instructor in Tactics
B.S., USNA, 1943.

Jack Stephens HALL
Commander, U. S. Navy
Instructor in Tactics and Operational Planning

Dan Albert DANCY
Lieutenant Commander, U. S. Navy
Instructor in Tactics and Amphibious Operations
B.S., California Nautical School, 1939.

Robert Calder ALEXANDER, III
Lieutenant Commander, U. S. Navy
Instructor in Tactics

Jack BROWN, Jr.
Lieutenant, U. S. Navy
Instructor in Tactics

COMMUNICATIONS DIVISION

William Scott PEASE
Lieutenant Commander, U. S. Navy
Senior Instructor

John Herbert WRIGHT
Lieutenant, U. S. Navy
Instructor in Communications and Intelligence
B.S.E.E., Illinois Institute of Technology, 1945
B.S.E.E., Massachusetts Institute of Technology, 1948.

Albert Francis SHIMMEL
Lieutenant, U. S. Navy
Instructor in Communications
B.S., USNA, 1948.

ORDNANCE AND GUNNERY DEPARTMENT

Jack Jones HINMAN, III
Commander, U. S. Navy
Head of Department
B.S., USNA, 1940; M.S., Massachusetts Institute of Technology, 1946.

Delbert Massey MINNER
Commander, U. S. Navy
Senior Instructor in Ordnance and Gunnery
B.A., University of Delaware, 1935; M.A., George Washington University, 1950.

Lee George MILLS
Commander, U. S. Navy
Instructor in New Ordnance Developments

Robert Joseph NELSON
Commander, U. S. Navy
Instructor in Restricted Weapons

Richard Fenner YARBOROUGH, Jr.
Lieutenant Commander, U. S. Navy
Instructor in Restricted Weapons
B.S., USNA, 1942.

Burton Brooks WITHAM, Jr.
Lieutenant, U. S. Navy
Instructor in Mine Warfare

Frederick LEIST, Jr.
Lieutenant, U. S. Navy
Instructor in Guided Missiles

Richard William ANDERSON
Lieutenant, U. S. Navy
Instructor in Guided Missiles
B.S., USNA, 1946.

Fremont Easton REICHWEIN
Lieutenant, U. S. Navy
Instructor in Basic Ordnance and Fire Control
B.S., California Institute of Technology, 1946.

ENGINEERING DEPARTMENT

Millard John SMITH
Commander, U. S. Navy
Head of Department
B.S., USNA, 1936.

Henry Brooke SOMERVILLE
Commander, U. S. Navy
Senior Instructor in Naval Engineering
B.S.E., Univ. of Virginia, 1938.

Kenneth Frederick SHIFFER
Commander, U. S. Navy
Senior Instructor in Damage Control
B.S., M.S., USNPGS, 1954.

Roy Earl HUETTEL
Commander, U. S. Navy
Instructor in Naval Engineering

George Stephen SCHLEMMER
Lieutenant Commander, U. S. Navy
Instructor in Naval Engineering

Edmund Eugene LE BER
Lieutenant Commander, U. S. Navy
Instructor in Naval Engineering and Damage Control
B.S., Webb Institute, 1930.

Charles Lindley SCHOOLER
Lieutenant Commander, U. S. Navy
Instructor in Damage Control

Reginald Lee BARRINGTON
Lieutenant Commander, U. S. Navy
Instructor in Damage Control

Theodore "E" WOLFE
Commander, U. S. Navy
Instructor in Theory of Flight

Luke Oscar CONERLY, Jr.
Lieutenant Commander, U. S. Navy
Instructor in Aerology
B.S., USNPGS, 1954.

ACADEMIC 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 1948.
B.S., Univ. of London, 1923; M.S., California Institute of Technology, 1938.

John Dewitt RIGGIN
Professor of Electrical Engineering (1946).
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 Engineering (1947)
B.S., Kansas State College, 1937; M.S., Brown Univ., 1953.

John Miller BOULDRY
Associate Professor of Electrical Engineering (1946)
B.S., Northeastern Univ., 1941.

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 broaden the mental outlook and to increase the professional knowledge of line officers in such a manner as to enable them to meet the duties, responsibilities and complexities of higher rank, thereby improving the efficiency and combat readiness of the Navy.

CURRENT AND FUTURE PROGRAMS

The present program, referred to as the Nine and One-Half Month Program, is similar to that which existed prior to World War II, complies with the general objectives of that previous curriculum, and is designed for all career line officers who have completed five to seven years of commissioned service.

The Nine and One-Half Month Program is designed to broaden the individual officer's knowledge, mental outlook, individual growth, initiative, and problem-solving ability.

In February, 1956, women line officers of the Regular Navy with five to seven years of commissioned service were enrolled for a twenty-week curriculum to be conducted concurrently with the Nine and One-Half Month Program. It is planned to have three inputs per year of approximately twenty women officers each. The Program exempts women officers from courses designed primarily for seagoing officers but has the same general objectives of broadening the mental outlook and increasing the professional knowledge of women line officers.

ADMINISTRATION

Responsibility for administration of the General Line School under the Superintendent, U. S. Naval Postgraduate School, rests in the director. Under the director is the staff.

The staff consists of five department heads, four naval officers and one civilian, and such additional officers and civilians as may be assigned to those departments as instructors.

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 General Line School occupies the East Wing of the Administration Building. In this wing, in addition to classrooms, are contained the offices of the director, heads of departments, and instructors. Other buildings contain laboratories and facilities for practical exercises.

One of these buildings contains training aid models and actual engineering plant equipment such as would be installed in a modern destroyer. The boiler, turbines, reduction gear and pumps which comprise the actual engineering equipment have been sectionalized and are demonstrated as cut-away models for better display and instructional purposes.

Classes in Combat Information Center operations and in anti-submarine warfare are conducted in a specially designed building which houses two classrooms, two CIC mock-ups, two Sonar ASW attack-direction system mock-ups and associated problem generators, an electronics workshop, and an office for the instructors. The mock-ups simulate the installations found on the latest-type radar picket destroyers and are constructed to permit the two "ships" to simulate the procedures and maneuvers used in making coordinated attacks against a submarine. Officer students man and control the bridge, sonar, and CIC stations, which are used during simulated task force problems and anti-submarine attacks. These problems and attacks are made to demonstrate to the students the principles which they study during the classroom sessions.

In another building, Powers Hall, are located facilities for practical exercises in navigation, during which the students utilize the equipment, charts, and publications normally available to a navigator on board a ship.

The Academic Department laboratories of the General Line School are designed to illustrate the principles of electrical engineering, electronics and a certain amount of physics and nucleonics from a practical point of view.

The following ordnance and associated equipment is available for laboratory purposes in the Gun Mount Building: 40 millimeter bofors heavy machine gun, 5"/38 caliber dual-purpose gun mount, 3"/50 caliber rapid fire gun mount, auxiliary gun director, mines, rocket launcher and torpedoes.

CURRICULUM AND INSTRUCTION

The curriculum of the Nine and One-Half Month Program is designed to accomplish its mission and tasks by being divided into three well-integrated areas of subject content, each area supplementing the other two. These areas are:

1. **Exemptive Subjects**, the objective being primarily that of equalizing the basic education of all officer students. Through controlled scheduling and individual counseling the curriculum will reinforce

prior education and experience and will fill the gaps of professional knowledge which may exist through differences in the education and experience of the officer student.

2. **Required Subjects**, the objective being to integrate the education and experience of the officer. Also, this area will afford an opportunity to perfect the officer's understanding of the professional responsibilities of command rank and will provide an opportunity for the officer to elevate his own professional growth.

3. **Elective Subjects**, the objective being to allow officer students to pursue professional fields which will provide an opportunity for them to develop independent judgement in professional areas of high personal and naval interest and will result in a professional growth beneficial to the Navy and the individual officer.

Electives will be offered in accordance with the needs and desires of the officer students with proper consideration for those limitations imposed by the availability of staff personnel, facilities, and time.

CURRICULUM (Nine and One-Half Month Program)

Academic Department	**Hours**
Exemptive Courses	
Mathematics Refresher	36
Physics Refresher	27
D.C. Circuits and D.C. Machinery	36
A.C. Circuits and A.C. Machinery	45
Electronics	54
Required Courses	
Nucleonics	18
Elective Courses	
Mathematics—Calculus	54
Physics	54
Nucleonics for the Navy	54

Administration Department	
Exemptive Courses	
Naval Justice I and II	54
Required Courses	
Logistics	18
Leadership	27
General Administration	27
National and International Relations	18
Elective Courses	
Psychological Warfare	27
International Law I	27
International Law II	27
Recent Naval History	36
Personnel Administration	27
Public Speaking I and II	36
Organization for National Security	18
Art of Presentation	27
Group Procedures	27

Ordnance and Gunnery Department	**Hours**
Exemptive Courses	
Basic Ordnance and Fire Control	27
Required Courses	
New Ordnance Concepts and Equipment	27
Guided Missiles	27
Restricted Weapons	27
Mine Warfare	36
Elective Courses	
Harbor Defense	27

Operations Department	
Exemptive Courses	
Navigation	36
Tactics I	36
Communications I	27
Required Courses	
Tactics II	27
Operational Planning	36
Amphibious Operations	36
Combat Information Center Operations	36
Anti-Submarine Warfare	36
Communications II	27
Submarine Indoctrination	
Elective Courses	
Seamanship	27
Intelligence	18

Engineering Department	
Exemptive Courses	
Marine Engineering	36
Damage Control	27
Atomic, Biological, and Chemical Warfare Defense	27
Theory of Flight	18
Aerology	27
Required Courses	
Engineering Trends and Developments	18
Aircraft Propulsion Systems	18
Elective Courses	
Fluid Mechanics	54
Engineering Materials	27

CURRICULUM (Twenty-Week Program for Women Line Officers)

Academic Department	
Elective Courses	
Nucleonics	18

Administrative Department	
Exemptive Courses	
Naval Justice I and II	54
Required Courses	
Leadership	27
Logistics	18
General Administration	27

	Hours
National and International Relations	18
Organization for National Security	18
Personnel Administration	27
Elective Courses	
International Law I and II	54
Psychological Warfare	27
Art of Presentation	27
Public Speaking I and II	36
Group Procedures	27
Operations Department	
Exemptive Courses	
Communications I and II	36
Intelligence	18
Elective Courses	
Operational Planning	36
Engineering Department	
Elective Courses	
ABC Warfare Defense	27
Aerology	27

ADMINISTRATION DEPARTMENT

Naval Justice I and II **Exemptive (54)**

OBJECTIVE

A course to provide an understanding of UCMJ and its application to military duties in order that the administration of justice may function effectively.

COURSE DESCRIPTION

The course covers: jurisdiction; charges and specifications; punitive articles; evidence; non-judicial punishment; investigations; summary, special, and general courts-martial; punishments; fact-finding bodies.

Logistics **Required (18)**

OBJECTIVE

This course has the objective of bringing to the student an appreciation of logistic problems at the fleet level.

COURSE DESCRIPTION

The major topics include : Meaning and concept of logistic support; logistic organizations and commands; man power, petroleum; transportation and resupply at the fleet level.

Leadership **Required (27)**

OBJECTIVE

A course to reiterate the fundamentals of leadership and to present the fundamentals of applied psychology.

COURSE DESCRIPTION

The topics will include: elementary psychology; military philosophy; case histories in leadership.

General Administration **Required (27)**

OBJECTIVE

A course in basic management techniques designed to illustrate the cycle of administration and its importance in the solution of various naval organizational problems.

COURSE DESCRIPTION

Planning is discussed with emphasis on types of plans, limitations, and on the analytical approach to method. Attention is then turned to organization and grouping of functions, line, staff, and functional structure, and span of control. Execution and direction are analyzed with final attention on control within an organization. Lecture method is utilized but major accomplishment of objectives is achieved through case discussion.

National and International Relations **Required (18)**

OBJECTIVE

A course, limited in scope, to present the role of the U. S. in world affairs and the inter-relationship of various governmental agencies in the execution of national policy.

COURSE DESCRIPTION

Included in the topics are: the State Department and Consular service; treaty organizations; military and economic aid programs; the Department of Defense and Attachés.

Psychological Warfare **Required (27)**

OBJECTIVE

To present a course on warfare, psychologically waged, in which propaganda is the weapon utilized to accomplish or to facilitate the accomplishment of our national objectives.

COURSE DESCRIPTION

Scope of course: evolution of psychological warfare; national and service organizations for psychological warfare; social group and propaganda analysis; basic objectives and effects; appeal and timing of themes; psychological warfare planning; techniques, media, and devices for delivery of propaganda; and research projects into the use and value of psychological warfare by foreign nations. Tape recordings of enemy propaganda messages will be utilized to present actual cases wherein psychological warfare is utilized.

International Law I **Elective (27)**

OBJECTIVE

A course to present the fundamentals of international law with special reference to the practical problems of the naval officer.

COURSE DESCRIPTION

The course covers: historical background, scope and sources; international persons with special reference to the United Nations; territory; marginal seas; air space; straits and special bodies of water; war crimes trials; rules of war; rules relative to prisoners-of-war; relations of belligerents and neutrals; military government.

International Law II **Elective (27)**

OBJECTIVE

A course to present advanced problems in international law and methods for their solution with special reference to the practical problems of the naval officer.

COURSE DESCRIPTION

The course covers application and interpretation of the fundamentals of international law learned in International Law I; solution of theoretical problems; problem discussions.

Recent Naval History **Elective (36)**

OBJECTIVE

A course to present through historical study an over-all view of modern naval operations.

COURSE DESCRIPTION

Included in the course will be: the Battle of the Atlantic; the Guadalcanal Operation; the Saipan Operation; the Normandy invasion; the Philippine invasion; the Okinawan invasion; the Inchon invasion; a survey of Korean naval operations.

Personnel Administration **Elective (27)**

OBJECTIVE

This course presents the principles and procedures of U. S. Navy personnel administration that relate to effective and economical personnel utilization. The primary concern is with the individual, to the end that his acquired skills, knowledge, and abilities may be most effectively utilized and his aptitudes most effectively developed. Also included is officer career planning and individual financial fitness.

COURSE DESCRIPTION

The major parts of the course include: definitions, objectives and responsibilities in personnel administration; analysis, classification, and evaluation of personnel; Navy personnel distribution and accounting methods; personnel training; welfare and morale factors; effective manpower utilization; officer career planning and appraisal; individual financial management.

Public Speaking I and II **Elective (36)**

OBJECTIVE

A course, practical in nature, designed to increase the ability of the student to organize and express thoughts orally before groups, military and civil.

COURSE DESCRIPTION

This course will include a speech clinic, study of effective speaking techniques, and presentation of speeches of varying lengths and topics before the group.

Organization for National Security **Elective (18)**

OBJECTIVE

A course to outline the broad legal basis of our National Security and the administrative organizations and methods utilized to accomplish the assigned responsibilities.

COURSE DESCRIPTION

This course includes: the role of the President; Constitutional basis; the National Security Act; the Department of Defense; the State Department; the Departments of the Army, Navy, and Air Force; the relationship of the other Cabinet-level Departments in the over-all scheme of National Security.

Art of Presentation **Elective (27)**

OBJECTIVE

A course to develop an understanding and appreciation of the principles of verbal presentation.

COURSE DESCRIPTION

The topics included are: preparation of effective presentations; delivery of presentations in specific speaker-audience situations.

Group Procedures **Elective (27)**

OBJECTIVE

The objective of this course is to present selected theory from the field of group procedures and to provide an opportunity to apply the theory in practical situations while learning.

COURSE DESCRIPTION

This course is designed to provide a knowledge of the basic skills which will allow officers to function more effectively in working with others. The course presents a brief background of the development of group work and presents in detail the "forces" that determine the behavior of individuals in groups. Practical application of the theory is provided by actually working in groups on assigned problems.

OPERATIONS DEPARTMENT

Tactics I — Exemptive (36)

OBJECTIVE

To familiarize the student with fundamental tactical doctrines, arrangements, and techniques.

COURSE DESCRIPTION

The main topics included are: task organization and command, formations, dispositions, applications of maneuvering board principles, screening, scouting, search and rescue, and general cruising instructions.

Tactics II — Required (27)

OBJECTIVE

To familiarize the student with advanced tactical concepts and their application to various types of operations.

COURSE DESCRIPTION

The broad topics covered are: the Attack Carrier Striking Force, the Surface Action Striking Force, tactical deception, convoy and escort instructions, replenishment, tactical employment of special weapons, and the analytical study of selected operations of World War II and the Korean action.

Operational Planning — Required (36)

OBJECTIVE

To acquaint the student with the problems and principles inherent in naval planning in order that he may understand planning procedures and carry out military directives in a discerning and farsighted manner.

COURSE DESCRIPTION

Topics covered include: principles of planning; the planning process; analysis of the military directive; the format and content of annexes, appendices, and tabs; the determination of requirements incident to a mission.

Amphibious Operations — Required (36)

OBJECTIVE

To give the student an over-all view of amphibious warfare with emphasis in planning requirements.

COURSE DESCRIPTION

Major items of study will be: organization; command; equipment; naval gunfire support; ship-to-shore movement; protective measures; communications; logistics of an amphibious operation.

Anti-Submarine Warfare — Required (36)

OBJECTIVE

To present the problems of detection, attack and destruction of hostile undersea craft, with particular emphasis on the capabilities and limitations of the various weapons and weapons carriers as they fit into a weapon family, and upon the capabilities of the over-all ASW weapons system as represented by a hunter-killer group.

COURSE DESCRIPTION

The first phase of the curriculum is devoted to a study of the design and operational characteristics, capabilities, and limitations of the various submarine designs. The anti-submarine phase emphasizes air, surface and sub-surface anti-submarine searches and anti-submarine detection, tracking and attack equipment and techniques. In the final phase, the student is taught the employment of the various weapons families in coordinated action to bring about the fulfillment of the task for which the ASW weapons system is designed: the destruction of hostile undersea craft through the efforts of a hunter-killer group.

Submarine Indoctrination — Required (No Credit)

OBJECTIVE

To give each student the opportunity to make a short trip in a modern fleet submarine from which he can gain a first-hand appreciation of the capabilities and limitations of an undersea craft.

COURSE DESCRIPTION

Small groups of students make short trips within the confines of Monterey Bay on fleet submarines assigned from the U. S. Pacific Fleet. One submarine comes to Monterey one day each month for this purpose. Prior to making an indoctrination trip, each group of students is given a short lecture concerning the particular submarine on which the group will be embarked. Any special equipment to be found on board the submarine is explained, as well as the normal equipment and operating procedures found on and used by all submarines.

Combat Information Center — Required (36)

OBJECTIVE

To present the capabilities and limitations of the fleet air defense weapons system. Emphasis is placed on the relationships between fleet operations and the several shipboard and airborne combat information centers (and their control and assist functions) and the naval functions peculiar to the support of the missions assigned to the U. S. Navy in the air defense of the continental United States (CONAD).

COURSE DESCRIPTION

A series of lectures during the first portion of the course provides an overview of the theory and applications of electromagnetic radiations as applied to search and detection. The employment of combat air patrols, anti-aircraft fire, and guided missiles within the various phases of fleet air defense receives emphasis. Other CIC control and assist functions such as the assistance to the command in maneuvering evolutions, electronic countermeasures, surface control, shore bombardment, ASW, and radar navigation are presented. CIC orientation sessions are scheduled for the purpose of accentuating the intra- and inter-ship problems of coordination existing within the operational fleet. In view of the national importance of the air defense of the Continental United States, lectures have been included to stress the nature and the degree of the participation of the U. S. Navy in the Continental Air Defense Command. An air defense planning problem for an attack carrier group is assigned to each student as a vehicle for the application of the principles expounded during the lecture portion of the course.

Navigation Exemptive (36)

OBJECTIVE

To provide the student with a knowledge of advanced theoretical and practical marine navigation, with emphasis on navigation in difficult areas.

COURSE DESCRIPTION

Items covered include: advanced piloting; advanced celestial navigation; advanced electronic navigation; polar navigation; the capabilities, limitations, and techniques of new methods of navigation.

Seamanship Elective (27)

OBJECTIVE

Te review the fundamental phases of seamanship, with emphasis on the duties and responsibilities of a naval line officer as a conning officer and as an officer of the deck underway and in port.

COURSE DESCRIPTION

Topics include: the duties of an officer of the deck both underway and in port; maintenance of the deck log; conning a ship alongside and away from a pier, in narrow channels, and in "man overboard" procedures; use of anchors and methods of anchoring; mooring (ordinary, flying, to a buoy, Mediterranean); replenishment at sea; cargo-handling and stowage; Rules of the Nautical Road, both international and inland.

Communications I Exemptive (27)

OBJECTIVE

To acquaint the student with the doctrine, policies, and principles governing fleet operational communications, with emphasis on capabilities, limitations, procedures, and responsibilities.

COURSE DESCRIPTION

Topics included are: The communication organization; functions of the Naval Communications System; instructions and procedures for radio and visual communications; command responsibilities; control of electromagnetic radiations (CONELRAD); the Allied Naval Signal Book.

Communications II Required (27)

OBJECTIVE

To familiarize the student with those phases of a communication officer's duties beyond the basic princples and procedures covered in Communications I.

COURSE DESCRIPTION

The major topics presented are: naval postal affairs; security; the registered publications system; communication planning (as typified by attack carrier task force and amphibious task force communication and frequency plans).

Intelligence Elective (18)

OBJECTIVE

To present the sources, uses and importance of intelligence.

COURSE DESCRIPTION

The topics covered include: a general background of intelligence, communism and geopolitics; the naval intelligence organization; the intelligence cycle; counter-intelligence; intelligence in support of an operational command; the function of the line officer in the collection of intelligence.

ORDNANCE AND GUNNERY DEPARTMENT

Basic Ordnance and Fire Control Exemptive (27)

OBJECTIVE

To broaden the professional knowledge of students with limited ordnance background, and to equip them for fuller understanding of more advanced courses in ordnance and related fields.

COURSE DESCRIPTION

The course includes presentation of the basic principles and nomenclature associated with ordnance and fire control, followed by the application of these principles in currently installed equipment. Special considerations are presented relative to shipboard and aircraft gunnery, torpedoes, ASW weapons, rockets, bombs and bombing, shipboard fire control, and naval gunfire support.

New Ordnance Concepts and Equipment Required (27)

OBJECTIVE

To inform students of new developments and trends in ordnance and fire control equipments, their capabilities, limitations and concepts of their application. To stimulate the thinking and broaden the mental outlook of officers in these fields.

COURSE DESCRIPTION

The course includes new and planned developments in the fields of anti-aircraft gunnery systems, explosives, lethal devices, fuzes, underwater ordnance and fire control equipment, and aircraft armament systems. Special considerations are presented relative to military requirements, capabilities, limitations, and cost effectiveness.

Guided Missiles Required (27)

OBJECTIVE

To develop in students an understanding of the capabilities and limitations of guided missiles and some considerations in their employment.

COURSE DESCRIPTION

The course includes a survey of guidance systems, discussion of specific missiles being developed for naval use, and the special considerations arising in the tactical employment of these weapons in naval warfare.

Restricted Weapons Required (27)

OBJECTIVE

To acquaint students with the family of special weapons available and those proposed with their capabilities and limitations.

COURSE DESCRIPTION

The course includes a presentation of the naval problems incident to the procurement, stowage, test, assembly, and offensive use of each of the special weapons. In addition the offensive phase of bacteriological and chemical warfare is presented in general terms for indoctrinational purposes.

Mine Warfare Required (36)

OBJECTIVE

To apprise students of the importance of mine warfare and to provide the knowledge necessary for its conduct, offensively and defensively.

COURSE DESCRIPTION

The course includes minefield characteristics and planning principles, capabilities and limitations of mine countermeasures equipment and craft; mine countermeasures planning; and new developments in mine warfare.

Harbor Defense Elective (18)

OBJECTIVE

To acquaint students with the principles and methods of defending a harbor.

COURSE DESCRIPTION

The course includes the development, mission, organization, equipments, tactical subdivision, and planning of harbor defense; Harbor Defense Command Center and port control operations; and harbor defense systems evaluation.

ENGINEERING DEPARTMENT

Marine Engineering Exemptive (36)

OBJECTIVE

The objective of this course is to review naval shipboard engineering, stressing operation, care and maintenance of a steam main propulsion machinery installation and associated auxiliaries.

COURSE DESCRIPTION

The course includes the following topics: boilers and boiler auxiliaries, turbine and turbine auxiliaries, piping systems, auxiliaries outside the main machinery spaces, organization and administration of a shipboard Engineering Department, and shipboard electrical installations.

Damage Control Exemptive (27)

OBJECTIVE

The objective of this course is to review the basic principles of Damage and Casualty Control.

COURSE DESCRIPTION

Major topics in this course include organization, systems, repair of damage, and the fundamentals of stability.

Atomic, Biological, and Chemical Warfare Defense Exemptive (27)

OBJECTIVE

The objective of this course is to give the officer students an appreciation of the effects of atomic, biological and chemical weapons upon personnel and material; to present the latest developments in protection against these effects and the procedures for re-establishment of normal operations after having suffered an attack which employed these weapons.

COURSE DESCRIPTION

The course includes the following major topics: an introduction to the characteristics and effects of the atomic, biological, and chemical weapons insofar as they affect defense; detection and evaluation of the effects of these weapons; suppressive and corrective action required to counter the effects of these weapons in order to permit the earliest resumption of normal operations.

Theory of Flight **Exemptive (18)**

OBJECTIVE

The objective of this course is to present the phenomena of flight leading to a better understanding of the performance of aircraft, guided missiles and other airborne weapons; also, the media in which they travel.

COURSE DESCRIPTION

Major topics of this course include air flow, sustentation, control, stability and new developments.

Aerology **Exemptive (27)**

OBJECTIVE

The objective of this course is to present the principles of aerology and weather phenomena and their effects on naval operations.

COURSE DESCRIPTION

Topics to be discussed include: the structure of the atmosphere; the weather elements; the station model; pressure and winds; theory of air masses and fronts; tropical storms; sources of weather information; sea and surf conditions; climatology and the principles of weather map analysis and weather forecasting.

Engineering Trends and Developments **Required (18)**

OBJECTIVE

The objective of this course is to acquaint the student with new developments and trends in naval ship propulsion.

COURSE DESCRIPTION

The fields of steam, diesel and nuclear propulsion, as well as that of gas turbines, will be covered. Topics will include forced circulation boilers, high temperature and high pressure steam, high speed light weight diesel engines, pancake diesel engines, nuclear propulsion plants of USS Nautilus and USS Seawolf, gas turbine installations for ship and boat propulsion and problems pertaining thereto, and the limitations of naval ship propulsion plants.

Aircraft Propulsion Systems **Required (18)**

OBJECTIVE

The objective of this course is to present the theory and operation of propulsion units in the manned and unmanned flight vehicles.

COURSE DESCRIPTION

Topics to be discussed include piston engines, jet engines, turbo prop units, pulse jet units, ram jet units, and rocket units.

Fluid Mechanics **Elective (54)**

OBJECTIVE

The objective of this course is to acquaint the student with the general rules of fluid phenomena involved in the performance of ships, aircraft, machinery, propelled weapons and wherever the properties of a fluid media affect the capabilities of modern propulsion techniques.

COURSE DESCRIPTION

Topics will include fluid statics, steady flow processes, viscosity, incompressible and compressible fluids, dynamic lift and propulsion, dynamics of compressible flow, lubrication, fluid couplings, fluid power and control systems.

Marine Engineering **Elective (27)**

OBJECTIVE

The objective of this course is to present briefly the trends and developments in the use of engineering materials in meeting the requirements of modern aspects of naval science. The general areas of interest are metals, plastics, and petroleum products.

COURSE DESCRIPTION

The following topics will be discussed: in metals, the new metals and alloys, such as titanium and the new super alloys, to meet high temperature and corrosion problems; in plastics, the new types of synthetic fibers and elastic materials; in the petroleum industry, the advance in lubricants, diesel fuels and the high-octane gasolines.

ACADEMIC DEPARTMENT

Mathematics Refresher **Exemptive (36)**

OBJECTIVE

The objective of this course is to present with adequate brevity a review of Algebra and Trigonometry.

COURSE DESCRIPTION

The course includes the following topics: exponents, logarithms, factoring, equations, complex numbers, vectors, proportions, angles, trigonometric functions and table graphs, radian measures, trigonometric equations, and oblique triangles.

Physics Refresher **Exemptive (27)**

OBJECTIVE

The objective of this course is a review of the Mechanics and Sound division of Physics with emphasis on Mechanics .

COURSE DESCRIPTION

Mechanics topics include: basic units, velocity and acceleration, laws of motion, force, power, energy, and circular motion. Sound topics include: wave motion, sound production and transmission, and naval applications.

Direct-Current Circuits and Direct-Current Machinery — Exemptive (36)

OBJECTIVE

The objective of this course is to acquaint the officer student with the fields of direct-current circuits and machinery with emphasis on naval aspects.

COURSE DESCRIPTION

Topics include following: resistance, voltage, current, magnetism, and fundamental characteristics of shunt and compound generators as well as shunt, series, and compound motors. The course includes laboratory exercises and demonstrations.

Alternating-Current Circuits and Alternating-Current Machinery — Exemptive (45)

OBJECTIVE

The objective of this course is to cover the fundamentals and important applications of alternating-current circuits and alternating-current machinery, especially the naval aspects.

COURSE DESCRIPTION

Included are the following topics: inductance, capacitance, resonance, three-phase systems, power problems, instruments, transformers, alternators, synchronous motors, and induction motors. Laboratory exercises and demonstrations will be utilized.

Electronics — Exemptive (54)

OBJECTIVE

The objective of this course is to cover the salient naval applications as well as the fundamentals of electronics.

COURSE DESCRIPTION

The following topics are included: vacuum tubes, gas tubes, control circuits, rectifiers, amplifiers, oscillators, modulation, oscilloscopes, transistors, radio communication, radar principles, synchros and servomechanisms. Appropriate laboratory exercises will be included.

Nucleonics — Required (18)

OBJECTIVE

The objective of this course is a presentation of the basic theory of the nuclear field.

COURSE DESCRIPTION

Emphasis is centered on the following topics: atomic structure, nuclear structure, radioactivity, equivalence of mass and energy, nuclear transformations, fission, fusion, production of fissionable materials, and instrumentation.

Calculus — Elective (54)

OBJECTIVE

The objective of this course is the presentation on a college level of Differential and Integral Calculus covering both principles and applications.

COURSE DESCRIPTION

The course includes the following topics: variables, functions, and limits; differentiation of algebraic functions; differentiation of inverse and implicit functions with applications; sucessive differentiation and 2nd derivative applications; parametric equations; theorem of mean value; integration, definite integrals and applications; formal integration; centroids, fluid pressure, and other applications.

Physics — Elective (54)

OBJECTIVE

The objective of this course is the presentation of a General Physics college course including all major subdivisions with the exception of Electricity and Nucleonics.

COURSE DESCRIPTION

Mechanics topics include: basic units; velocity and acceleration; laws of motion; force, power, and energy; circular motion. Sound topics include: wave motion; sound production and transmission; naval applications. Light topics include: reflection and refraction; dispersion; lens systems; optical instruments. Heat topics include: thermal expansion; gas laws; heat transfer; laws of thermodynamics.

Nucleonics for the Navy — Elective (54)

OBJECTIVE

The objective of this course is a presentation of the fundamentals of nucleonics followed by production of fissionable materials and instrumentation. (It is one of the most important naval correspondence courses.)

COURSE DESCRIPTION

The following topics are emphasized: structure of matter; structure of the atom; nuclear structure; nuclear transformations covering radioactivity and equivalence of mass and energy; transformation equations; high energy particles; fission and fusion; slow neutron reactions; military uses and tests of atomic bombs; peacetime applications; ionization instruments; instrument accuracy and applications; navy radiation instruments; photographic dosimetry.

A General Line School class discussing and planning a mock operation, giving the students an insight into the organization of a task force and the procedure by which an operation order is developed.

Orientation class in combat information center mock-up.

INDEX

INDEX

INDEX

INDEX

Index to Buildings at U. S. Naval Postgraduate School

1. Lecture Hall—(Building 237)
2. Main Engineering School Building—Electronics, Physics, Metallurgy and Chemistry, Electrical Engineering—(Building 232)
3. Electrical Engineering Laboratory—(Building 233)
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. BOQ—(Building 222)
8. General Line School—(Building 221)
9. Powers Hall—Classrooms—(Building 300)
10. Fleming Hall—Classrooms—(Building 301)
11. Dressing Rooms and Solarium—(Buildings 209, 210)
12. Superintendent's Quarters, Quarters A
13. Married Officers' Quarters, Quarters M, L, and K
14. Married Officers' Quarters, Quarters B through J, and N
15. Engineering School and Public Works Shops and General Line School Laboratories—(Buildings 223 through 229)
16. Power Plants
17. Enlisted Men's Barracks
18. Criscuolo Hall—Enlisted Men's Recreation Hall—(Building 211)
19. Supply Department—(Building 206)
20. Navy Exchange Service Station—(Building 261)
21. CIC/ASW, Ordnance & Gunnery Classrooms, General Line School—(Buildings 238, 239)
22. Fire Station—(Building 258)


DEL MONTE AVENUE
SLOAT AVENUE
FREMONT STREET
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22