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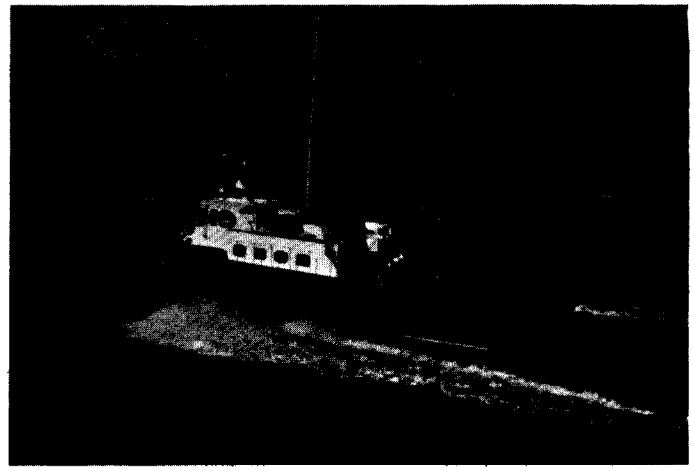

A TWO-YEAR CURRICULUM IN MARINE SCIENCE-ELECTRONIC TECHNOLOGY

PREPARED BY

DEL MAR COLLEGE

AND

SOUTHWEST RESEARCH INSTITUTE

UNDER

GRANT GH-57 FOR

NATIONAL SEA GRANT PROGRAM

NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION

SEPTEMBER 30, 1971

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Corpus Christi, Texas

for

NATIONAL SEA GRANT PROGRAMS

National Oceanic and Atmospheric Administration

U. S. Department of Commerce

Rockville, Maryland 20852

PRINCIPAL INVESTIGATOR - Ted Boaz, Dean

Technical-Vocational Education - Del Mar College

CO-INVESTIGATOR - Dr. Philip Oetking, Director

Southwest Research Institute

September 30, 1971

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The materials contained in this report represent the combined efforts of the administration and faculty of Del Mar College and Technical Institute and the staff of the Ocean Science and Engineering Laboratory of Southwest Research Institute. College personnel who made major contributions to the project are as follows:

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Southwest Research Institute personnel who developed and taught the ocean related courses are:

DR. PHILIP OETKING, Director of Ocean Science and Engineering Laboratory
MR. ROY W. THOMPSON, Manager Electronic Systems

Dr. Jerry O'Donnell has served as director of this project and assumed the responsibility of preparing the final report. His personal interest contributed greatly to the success of the total project.

TED BOAZ, Principal Investigator
September, 1971

PREFACE

The development of this curriculum in "Marine Science-Electronic Technology" is the results of the combined efforts of the staff-faculty of Del Mar College and personnel of the Ocean Science and Engineering Laboratory of Southwest Research Institute. This is the final report of a two-year project funded under Grant No. GH-57 from the National Sea Grant Program Office, U . S. Department of Commerce, Rockville, Maryland.

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Basic objectives of the project are (1) To define the marine science-electronic technician, (2) Develop a curriculum in Marine Science-Electronic Technology, (3) Develop or design teaching aids and instructional materials, (4) Field test the curriculum by processing a class of students through each course, and (5) Conduct a job placement program for graduates.

TABLE OF CONTENTS

INTRODUCTION

The Marine Science-Electronics Technology program resulted from a cooperative effort by Del Mar College, the Ocean Science and Engineering Laboratory of Southwest Research Institute, and other industries and research organizations in the Corpus Christi area. Del Mar College has a very successful Electronics Engineering Technology program, and this, together with the college's location near the sea and its desire as a community college to provide educational programs needed by the area, made the extension of the electronics program into the field of marine science a natural step. The program was developed during 1968 and submitted to the National Science Foundation in 1969. Following approval of the grant, the college began classes in September, 1969.

In "The California Report on the Training of Marine Technicians" (1968), Chan[1] projects a national demand for 38,304 Associate degree technicians. Oceanology International, in their survey of June, 1971 lists 29 colleges offering the Associate degree in ocean-related programs. A total of some 3,000 students are enrolled in these programs. If these figures are correct, it will be 10 years before saturation of employment markets occur. As exploration of the ocean continues, and as concern over pollution of estuaries and bays increases, the demand for marine technicians will naturally increase also. Activities in the marine industries appear to be changing from their historical course of exploration and becoming more oriented toward exploitation of the oceans. Recovery of the nation's economy will result in companies expanding their efforts to exploit the vast economic potential of the sea. Marine technicians will be needed to aid the scientists and engineers who will direct these activities.

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1 Gordon L. Chan, "The California Report in the Training of Marine Technicians," State Department of Education, College of Marin Press, 1968.

MARINE SCIENCE AND OCEANOGRAPHY

The study of the oceans began when man first devised ships to carry him across the waters that were the natural boundaries of his domain. The ancient Greeks contributed much of the early knowledge of the size, shape, and extent of the oceans. These early attempts to describe the oceans were based first on military needs, but as international sea trade developed, man began to realize his dependence on the oceans and the necessity of systematic and accurate navigational charts, and oceanography became a science rather than an avocation practiced by seagoing adventurers.

The great names in the history of sea exploration--Magellan, Captain Cook, Drake, Columbus, de Gama--are also great names in the history of cartography and oceanography. Partly from necessity and partly from their own curiosity, they devised means of measuring tides, waves, water depths, currents, and other aspects of physical oceanography that could be measured with the techniques available to them. The first extensive and systematic expedition to chart the depths was the Challenger voyage of 1872-76.

As the sciences of chemistry, physics, and biology progressed, their findings became incorporated into the body of oceanography, and the focus of attention changed from charting the oceans to the study of the nature of sea water and its influence on the animals and plants which live in it. Physicists devised acoustic instruments to make deep-water soundings with a speed and accuracy not attainable with mechanical devices. Geophysicists discovered that the refraction of sound waves from the ocean floor could be used to discern the structure of the earth beneath the seas. Chemists discovered that magnesium and other valuable chemicals could be extracted from sea water. With these discoveries, man's relation to the sea underwent a fundamental change. No longer was the sea merely a large body of water to be explored and charted; it was a vast source of economic wealth.

The discovery and successful recovery of oil from the sea floor introduced a new era. Oceanography became marine science; the classic study of the physical features of the oceans became secondary to the scientific, political, and legal aspects of exploitation of this great natural resource. Marine science today includes all who derive their livelihood from the oceans, from the marine geologist prospecting for manganese to the marine biologist engaged in mariculture to the lawyer attempting to solve the complex problems of proprietorship of the oceans. Marine science in the future will see more and more efforts toward exploitation of the oceans and attempts to halt man's pollution of this invaluable resource. Through the science of instrumentation, man has made it feasible to gather more data in a week than the Challenger was able to gather in the 200 weeks of its historic expedition only 100 years ago.

Manned underwater habitats, recovery of valuable minerals from the depths of the sea, oil from beneath thousands of feet of water -- these are things that we will certainly see in our lifetime. The future of marine science is as boundless as man's imagination, energy, and needs.

DESCRIPTION OF THE MARINE SCIENCE-ELECTRONIC TECHNICIAN

The science of oceanography is the science of instrumentation. Many properties of the oceans and of the land beneath the oceans are not observable by the human eye and must therefore be studied by instruments. As the effort expended in oceanography increases, the number and degree of sophistication of instruments also increases. The purpose of instruments is, however, not only to increase the number of properties to be measured, but also to increase the reliability of the measurement and to decrease the cost. In order to achieve these complex goals, marine instruments must be correctly installed, operated, and maintained. The Marine Science-Electronics Technician Program is designed to produce people capable of operating and maintaining the many instruments in use today.

The Marine Science-Electronics Technician is not a scientist, but rather a specialist who is able to increase a scientist's productivity. It is the function of the professional men -- engineers and scientists who supervise the technician -- to design the research program and interpret the data. It is the technician's function to see that data obtained is valid and properly recorded and that instruments function properly, thus freeing professional men from routine tasks. Marine technicians will serve as paraprofessional assistants to chemists, biologists, geologists, engineers, ecologists, oceanographers, and meteorologists.

The marine science-electronics technician must have knowledge of, and training in the use of the following: Water quality instruments, sea-floor samplers, biological samplers, acoustic profiling equipment, corers, tide and current gauges, meteorological equipment, radar, radio, electronic navigation equipment, on-board machinery, and laboratory analytical apparatus. He must have experience in boat operations, navigation, piloting, and heavy equipment operation and maintenance. He must be able to calibrate electronic gear, read instrument schematics, and make on-the-spot repairs if necessary. He must be part deck hand, part scientist, part engineer, and part boat captain.

CURRICULUM

MARINE-SCIENCE ELECTRONIC TECHNOLOGY

MARINE SCIENCE ELECTRONIC TECHNOLOGY

		Lec.	Lab.	Sem. Hrs.
First Semester (First Year)				
M.S.T. 301	Marine Science Environment	2	3	3
E.E.T. 804a	Direct Current Theory and Laboratory	3	3	4
E.E.T. 403	Electronics Theory and Laboratory	3	3	4
Math 606a	Technical Mathematics - one	3	0	3
Eng. 303	Communication Skills	3	0	3
		14	9	17
Second Semester (First Year)				
M.S.T. 302	Physical-Chemical Oceanography	2	3	3
E.E.T. 804b	Alternating Current Theory and Laboratory	2	3	4
E.E.T. 404	Transistors and Basic Circuits	3	3	4
Math 606b	Technical Mathematics - two	3	0	3
Eng. 304	Technical Writing	3	0	3
		14	9	17
Summer Session (First Six Weeks)				
M.S.T. 403a	Marine Laboratory - one	0	15	2
M.S.T. 405	Biological-Geological Oceanography	7	7	4
		7	22	6
Summer Session (Second Six Weeks)				
M.S.T. 403b	Marine Laboratory - two	0	15	2
E.E.T. 412	Electrical Machinery	7	7	4
		7	22	6
First Semester (Second Year)				
Math 311	Analytic Geometry and Calculus	3	0	3
E.E.T. 418	Electrical-Electronic Logic	3	3	4
M.S.T. 310	Underwater Acoustics	3	0	3
M.S.T. 211	Marine Laboratory-three	0	6	2
E.E.T. 415	Industrial Control Circuits	3	3	4
		12	12	16
Second Semester (Second Year)				
E.E.T. 419	Pulse Techniques	3	3	4
E.E.T. 413	Electrical Analysis and Measurements	3	3	4
E.E.T. 316	Electronic Communications	3	0	3
M.S.T. 216	Marine Science Seminar	2	0	2
M.S.T. 414	Marine Science Instrumentation	3	3	4
		14	9	17
Summer Session (First Six Weeks)				
M.S.T. 412	Marine Research Tecniques	7	7	4
Gov't. 610a	U.S. Government	7	0	3
		14	7	7
Summer Session (Second Six Weeks)				
M.S.T. 415	Marine Science Problems and Design	7	7	4
M.S.T. 113xy	Intermediate Scuba Diving	0	7	2
		7	14	6

Development of the Marine Science-Electronics Technology curriculum was characterized by a joint effort between educators and researchers in the field. An advisory committee was set up consisting of Del Mar College faculty and administration, and local members of marine-related industrial and research firms. From the varied inputs of these men, a definition of the marine electronics technician was arrived at and a curriculum emerged which would produce a graduate meeting the committee's specifications. Necessary modifications in course content were made as the courses progressed. A Marine Science Curriculum Committee, consisting of Del Mar College faculty and administration, and personnel from Southwest Research Institute, was set up. Scheduled monthly meetings were held to report on progress, review course contents, and indicate future courses of action. The status of the program was monitored continuously, and any needed alterations came from suggestions originating with the Curriculum Committee.

The Marine Science-Electronics Technology curriculum contains eleven new courses. Five of these courses -- MST 301, 302, 405, 113xy, and 310 - - were developed by Del Mar College. The remaining six were developed and taught by personnel of Southwest Research Institute. In addition, S.W.R.I. provided the boat, most of the oceanographic instrumentation, and the professional expertise necessary to design and carry out the program. Before registration for the first term began, students were given an orientation tour on the research vessel and actually recorded scientific data so that they could better judge whether the curriculum would coincide with their interests. Students received a great deal of information not specifically related to any course through contact with the boat captain and the scientific and technical staff of S.W.R.I. The contribution of the Institute was vital to the program and underlined the cooperative nature of the effort.

CURRICULUM OBJECTIVES

The objectives of the curriculum are separable into two classes: The first-year objectives were to introduce the student to marine science and give him a broad background in theoretical aspects of the field. The second-year objectives were to give the student actual experience in marine research activities and to permit him to see the application of the principles learned in the first year. The first-year courses contain elementary physical, chemical, biological, and geological oceanography and physical geography, and laboratory periods are designed to teach elementary instrumentation, sample collection, and laboratory techniques. The laboratory courses of the second year emphasize data handling, record-keeping, and research planning.

COURSE SEQUENCE

In order to fulfill the objectives of the curriculum, the sequence of courses was chosen carefully to provide insofar as possible a smooth and logical development of the student's knowledge. MST 301 serves as an introduction to the field of marine science; the second semester courses (MST 302 and 405) introduce the specific areas of oceanography in which marine research is conducted. The laboratory courses (MST 403 and 211) instruct the student in the vital areas of data collection and compilation, as well as the operation of shipboard and laboratory equipment. Second-year MST courses (414, 310) are designed to teach the basic physics and instrumentation of the techniques used in data collection. The laboratory courses of the second year emphasize planning and systematic procedure in marine research.

The supporting courses are designed to advance the student's technical abilities so as to keep pace with the increasing knowledge required by advanced courses. Basic electronics are completed by the time the student encounters MST 414; the student is concurrently enrolled in MST 310 and elementary calculus. MST 412 and 415 make extensive use of the report-writing skills acquired in technical writing.

MARINE SCIENCE COURSE OUTLINES

MST 301: THE MARINE ENVIRONMENT

Hours Required

Class, 2; Laboratory, 3.

Course Description

The course will consist of two lecture and three laboratory hours per week. The lecture will serve to introduce the student to the subject of oceanography and give him sufficient background in its aspects to allow him to prepare for the more detailed courses which he will encounter later. The topics to be discussed are: history of the earth, formation of the continents and ocean basins, life in the sea, the ocean floor, properties of sea water, tides and currents, climate and weather, and elementary oceanographic instrumentation. The student will be required to write a 1500-word term paper on some aspect of oceanographic research or industry and present a brief summary of it in class.

The laboratory periods will be used to teach the student the fundamentals of scuba diving, with particular emphasis on its utility to the marine sciences. Special attention will also be given to the hazards of operating under the surface and the organization of underwater activities so as to maximize productivity and minimize hazards.

Major Divisions

		Hours
I.	History and Scope of Oceanography	2
II.	Origin of the Continents..	2
III.	Islands and Seas..	2
IV.	Coastlines, Shores, and Waves.. ..	2
V.	Geological Aspects of the Ocean Floor	2
VI.	Physical and Chemical Properties of Sea Water	4
VII.	Life in the Ocean	2
VIII.	Corals and Coral Reefs	2
IX.	Deposits on the Ocean Floor	2
X.	Elementary Climatology and Meteorology	2
XI.	Tides	2
XII.	Causes and Effects of Ocean Currents.. . . . . , ...	2
XIII.	Planetary Oceanic Circulation.	2
XIV.	Oceanographic Instrumentation.	4
XV.	Presenfation and Discussion of Term Papers..	4

Division 1. History and Scope of Oceanography

A. Units of Instruction

1. Early oceanographic expeditions
2. More recent expeditions
3. Present-day oceanographic research
4. Overview of the earth's physiognomy

B. Laboratory Projects

Demonstrate adequate swimming proficiency to begin SCUBA instruction

Division II. Origin of the Continents

A. Units of Instruction

1. Igneous and sedimentary rocks
2. Types of igneous rocks
3. Earth waves
4. Gravity anomalies
5. Theory of continental drift
6. Magnetic anomalies and continental drift

B. Laboratory Projects

Basic physics of gases (lecture)

Division III. Islands and Seas

A. Units of Instruction

1. Classification of islands
2. Volcanic activity and islands
3. Terminology of marine geography

B. Laboratory Projects

Physiology and physics of diving (lecture)

Division IV. Coastline, Shores, and Waves

A. Units of Instruction

1. Terminology
2. Origin, properties and geographical effects of waves
3. Types of coastlines

B. Laboratory Projects

Basic watermanship

Division V. Geological Aspects of the Ocean Floor

A. Units of Instuction
   1. Terminology
   2. Continental shelf
   3. Continental scope
   4. Submarine canyons
   5. Abyssal plains and plateaus
B. Laboratory Projects
   Basic SCUBA gear and hand signals

Division VI. Physical and Chemical Properties of Sea Water
A. Units of Instruction
   1. Elementary solution theory
   2. Analysis of sea water
   3. Terminology of physical and chemical oceanography
   4. Properties of sea water
   5. Oceanographic instruments
B. Laboratory Projects
   Shallow-water diving; the “Buddy” system

Division VII. Life in the Ocean
A. Units of Instruction
   1. Terminology
   2. Classification: plankton, benthos, nekton
   3. Zoning according to life types
   4. Fisheries and whaling
B. Laboratory Projects
   Shallow-water diving; acquiring skill and confidence with SCUBA gear

Division VIII. Corals and Coral Reefs
A. Units of Instruction
   1. Biology of coral organisms
   2. Formation of coral reefs
   3. Conditions for coral growth
   4. Types of coral reefs
   5. Theories of reef formation
B. Laboratory Projects
   “Ditch-and-don” procedure

Division IX. Deposits on the Ocean Floor
A. Units of Instruction
   1. Systems of classification: size, water depth, origin
   2. Types of terrigenous deposits (Murray’s classification)
   3. Types of pelagic deposits
   4. Areas where each type of deposit is found
   5. Manganese nodules
B. Laboratory Projects
   Physiology and decompression tables (lecture)

Division X. Elementary Climatology and Meteorology
A. Units of Instruction
   1 Cloud types
   2. Meteorological instruments
   3. Format of a synoptic weather report
   4. Solar radiation
   5. Wind and pressure systems
   6. Cause and occurrence of precipitation
   7. Fronts
B. Laboratory Projects
   Simulated deep-water dive; use of tables

Division XI. Tides
A. Units of Instruction
   1. Causes of tides
   2. Theories of tides: Newton, Laplace
   3. Relation to phases of the moon
   4. Tidal currents
   5. Tides in rivers
B. Laboratory Projects
   Physiological effects: bends, narcosis, embolism, etc. (lecture)

Division XII. Causes and Effects of Ocean Currents
A. Units of Instruction
   1. Primary and secondary forces as causes
   2. Types of currents
   3. Properties of currents
   4. Non-oceanic origins
B. Laboratory Projects
   Use of hand tools underwater

Division XIII. Planetary Oceanic Circulation
A. Units of Instruction
   1. North Atlantic circulation
   2. Movement of Arctic ice
   3. The Pacific circulation
   4. Indian Ocean circulation
B. Laboratory Projects
   Final SCUBA proficiency checkout

Division XIV. Oceanographic Instrumentation

A. Units of Instruction

1. Depth-measuring devices
2. Water samplers
3. Bottom samplers
4. Temperature-measuring devices
5. Current meters
6. Instruments for chemical oceanography

B. Laboratory Projects

Planning and organizing a scientific dive

Division XV. Presentation and Discussion of Term Papers

A. Units of Instruction

None

B . Laboratory Projects

Shallow-water dive; sample collection

<u>Texts and References</u>

C. H. Cotter, "The Physical Geography of the Oceans, " American Elsevier, New York.

W. S. Von Arx, "Introduction to Physical Oceanography," Addison-Wesley, Reading, Mass.

John A. Day, "The Science of Weather," Addison-Wesley, Reading Mass.

H. W. Harvey, "Biological Chemistry and Physics of Sea Water," Macmillan Co., New York.

Mary Sears, ed., "Oceanography, " American Association for the Advancement of Science, Washington, D. C.

C. A. M. King, "An Introduction to Oceanography, " McGraw-Hill, New York.

Peter K. Weyl, "Oceanography, " John Wiley and Sons, New York.

M. Grant Grass,"Oceanography,"Charles E. Merrill, Columbus, Ohio.

H. U. Sverdrup, M. W. Johnson, R. H. Fleming, "The Oceans, " Prentice-Hall, Englewood Cliffs, N. J.

H. Pettersson, "The Ocean Floor," Yale University Press, New Haven, Conn.

Robert L. Wiegel, "Oceanographical Engineering," Prentice-Hall, Englewood Cliffs, N.J.

Sea Grant Publication, "University Guide for Diving Safety, " #TAMU-SG-70-602, Washington, D. C.

MST 302: PHYSICAL-CHEMICAL OCEANOGRAPHY

Hours Required

Class, 2; Laboratory 3.

Course Description

The course will consist of two lecture hours and three laboratory hours per week. The student will be presumed to have college algebra and MST 301 or its equivalent. No previous association with chemistry is assumed. Briefly, the course will deal with the following topics:

(1) Structure of matter-atoms and molecules
(2) Elements, compounds, and chemical reactions
(3) The quantitative laws of reactions
(4) The analytical chemistry of sea water
(5) Geological and astronomical aspects of oceanography
(6) Tides, waves, and fluid mechanics
(7) Physical and chemical properties of sea water
(8) Advective and convective processes
(9) Current measurement

Major Divisions

		Class Hours	Laboratory Hours
I.	Structure and Properties of Matter	2	0
II.	Chemical Reactions and Weight Relations	2	0
III.	Normality and Molarity	2	3
IV.	Equivalency and Volumetric Analysis	4	6
V.	Analytical Chemistry of Sea Water	2	6
VI.	Determination of Salinity	2	6
VII.	Determination of Trace Elements	2	6
VIII.	Determination of Oxygen	2	6
IX.	Introductory Physical Oceanography	2	3
X.	Waves and Tides	2	0
XI.	Physical Properties of Sea Water	2	6
XII.	Advective Heat Processes	2	0
XII.	Convective Heat Processes	2	0
XIV.	Current Measurement	2	3

Division I. Structure and Properties of Matter
- A. Units of Instruction
  1. Atoms and electrons
  2. Valence
  3. Chemical and physical change
  4. Ions and molecules
- B. Laboratory Projects
  1. Use of the analytical balance
  2. Preparation of standard solutions

Division II. Chemical Reactions and Weight Relations
- A. Units of Instruction
  1. Law of combining weights
  2. Law of combining volumes
  3. Chemical stoichiometry
- B. Laboratory Projects.
  1. Standardization of silver nitrate solution
  2. Determination of chloride by Mohr method

Division III. Normality and Molarity
- A. Units of Instruction
  1. Definition of terms
  2. Gram-formula weights and gram-equivalent weights
  3. Molar solutions and normal solutions
- B. Laboratory Projects

  Determination of chlorinity of sea water by Mohr method

Division IV. Equivalency and Volumetric Analysis
- A. Units of Instruction
  1; Definition of equivalency
  2. Usefulness of the normality concept
  3. Standard solutions
  4. Volumetric determinations in sea water analysis
- B. Laboratory Projects

  Analysis of fresh water for chloride, pH, hardness, calcium and magnesium

Division V. Analytical Chemistry of Sea Water

A. Units of instruction
1. Importance of analysis in oceanography
2. Sampling and sample storage
3. Precision, accuracy, and standard deviation
4. Nomenclature, terminology, and conventions

B. Laboratory Projects
Analysis of sea water for chlorinity, pH, calcium and magnesium

Division VI. Determination of Salinity

A. Units of Instruction
1. Chemical determination
2. Instrumental determination
3. Types of commercial salinometers

B. Laboratory Projects
1. Calibration of an induction salinometer
2. Determination of salinity

Division VII. Determination of Trace Elements

A. Units of Instruction
1. Definition of trace element
2. Importance of trace elements
3. Chemical means of determination
4. Instrumental means of determination

B. Laboratory Projects
1. Introduction to spectrophotometric analysis
2. Determination of iron
3. Determination of mercury

Division VIII. Determination of Oxygen

A. Units of Instruction
1. Importance of oxygen
2. Chemical determination
3. Instrumental determination

B. Laboratory Projects
1. Chemical determination by Winkler method
2. Instrumental determination with D.O. analyzer

Division IX. Introductory Physical Oceanography

A. Units of Instruction
1. Age of the oceans
2. Origins of sea water
3. Physical geography of the earth
4. Geometry of the oceans

B. Laboratory Projects
Field trip along shore to observe effects of currents on shoreline geography

Division X. Waves and Tides

Units of Instruction
1. Lunar forces
2. Particle motion in waves
3. Measurement of tides
4. Diffraction of waves

Division XI. Physical Properties of Sea Water

A. Units of Instruction
1. Density and "sigma-tee"
2. Salinity
3. Temperature-salinity effects
4. Adiabatic effects
5. Stratification
6. Light penetration

B. Laboratory Projects
1. Use of the bathythermograph; temperature and pressure as a function of depth; "sigma-tee"
2. Light transmission; use of the transmissometer and Secchi disk

Division XII. Advective Heat Processes

Units of Instruction
1. Terminology and nomenclature
2. Insolation
3. "Greenhouse" effect
4. Heat distribution over the earth

Division XIII. Convective Heat Processes

Units of Instruction
1. Ocean climates
2. Heat balance in the oceans
3. Latitudinal distribution of rainfall

Division XIV. Current Measurement

A. Units of Instruction
1. Units of current measurement
2. Lagrangian methods
3. Eulerian methods

B. Laboratory Projects
1. Measure several different currents by a Lagrangian method such as a drift bottle
2. Repeat measurements with a Eulerian method such as a Savonius rotor. Account for any differences observed in the two methods

Texts and References

Dean F. Martin, "Marine Chemistry, Vol. I.," Marcel Dekker.

W. S. von Arx "Introduction to Physical Oceanography," Addison-Wesley.

H. J. McLellan "Elements of Physical Oceanography," Pergamon Press.

J. P. Riley and G. Skirrow, "Chemical Oceanography," (2 vols.), Academic Press.

Paul R. Frey, "Chemistry Problems and How to Solve Them," Barnes and Noble.

MST 113x, y: INTERMEDIATE SCUBA DIVING

Hours Required

Class, 0; Laboratory, 2 (each semester).

Course Description

The purpose of this course is to acquaint the student with the techniques and necessary safety precautions of prolonged submergence. The diving sessions will be carried out in the open water, and the student will be required to make at least one dive to a depth of 100 feet.

Major Divisions

		Hours
I.	Introduction to Open-Water Diving..	12
II.	Prolonged Submergence	6
III.	Repetitive Diving..	6
IV.	Diving and Decompression at 100 Feet.	6

Division I. Introduction to Open-Water Diving

Laboratory Projects

1. In an area where water depth is 12 feet or so, stake out a 100x100-ft. grid using flexible poles and string.
2. In an area where water depth is 20-30 feet (but less than 33 feet), collect biological specimens from the sea floor. Illustrate use of underwater floodlights and, if water clarity permits, take photographs.

Division II. Prolonged Submergence

Laboratory Projects

Discuss the use of the decompression tables and their importance. Dive to 30-60 feet and remain submerged until necessary to use air reserve. Decompress and surface.

Division III. Repetitive Diving

Laboratory Projects

Discuss the use and importance of the repetitive dive tables. Dive to 60 feet, return to decompression depth, and return to 60 feet. Decompress and surface.

Division IV. Diving and Decompression at 100 Feet

Laboratory Projects

Discuss Boyles Law, emphasizing the fact that one volume at 100 feet equals 3 volumes at surface. Discuss the use and importance of the diving tables. Dive to 100 feet and remain as long as air allows. Decompress and surface. Rediscuss use of diving tables.

Texts and References

Council for National Cooperation in Aquatics, “The New Science of Skin and SCUBA Diving, ” Association Press.

W. W. Schroeder and W. P. Fife, “University Guide for Diving Safety,” Sea Grant Publication No. TAMU-SG-70-602.

L. J. Greenbaum and E. C. Hoff, “Bibliographical Sourcebook of Compressed Air, Diving, and Submarine Medicine,” Office of Naval Research.

MST 405: BIOLOGICAL-GEOLOGICAL OCEANOGRAPHY

Hours Required

Class 3; Laboratory 3.

Course Description

The purpose of this course is to acquaint the student with the geology and biology of the ocean, the origin of the sediments on the ocean floor, the effect of the physical features of the ocean on living organisms, and the interaction of the sea with neighboring land masses. The student will learn sampling techniques, identification of the most common plants, animals, and minerals found in the ocean, and the use of specialized instruments necessary for the study of biological and geological specimens.

Major Divisions

		Hours Lec.	Hours Lab.
I.	Introduction to Biological Oceanography	2	6
II.	Physical Properties of the Sea and Their Effect on Living Systems	4	0
III.	The Ocean Floor	2	0
IV.	Circulation in the Sea	2	0
V.	The Sea and the Sun	4	0
VI.	Life in the Sea	9	18
VII.	Introduction to Geological Oceanography	2	0
VIII.	Most Common Rock-Forming Minerals and Ores	4	6
IX.	Igneous Rocks	3	6
X.	Sediments	4	6
XI.	Lithification	2	0
XII.	Sedimentary Rocks	2	3
XIII.	Metamorphic Rocks	2	3
XIV.	Geologic Time	3	0

Division I. Introduction to Biological Oceanography

A. Units of Instruction

1. Relative areas of land and ocean
2. General characteristics of the ocean
3. Depth and topography of the ocean floor
4. Zones of ocean life
5. Physical features of the ocean that affect life

B. Laboratory Projects

Use and care of the compound and the dissecting microscope

Division II. Physical Properties of the Ocean and Their Effect on Living Systems

A. Units of Instruction

1. Heat
2. Temperature variations
3. Low temperatures
4. Temperature and light and their effects
5. Viscosity
6. Density
7. Pressure

B. Laboratory Projects

Examination of various types of phytoplankton and zooplankton with the miscroscope

Division III. The Ocean Floor

Units of Instruction

1. Deposits
2. Animals that give rise to deposits

Division IV. Circulation in the Sea

Units of Instruction

1. Ocean Currents
2. Circulation in the Atlantic
3. Circulation in the Pacific
4. Circulation in the Indian Ocean
5. Circulation in the Anarctic
6. Circulation in the Arctic
7. Upwellings
8. Tides

Division V. The Sea and the Sun

Units of Instruction

1. Sources of Energy
2. Wave lengths of absorbed and emitted radiation
3. Characteristics of water related to heat absorption and radiation
4. Specific heat
5. Steam fog and condensation fog
6. Biological heat cycles
7. Transfer of heat in the ocean

8. Penetration of the sea by radiation

Division VI. Life in the Sea

A. Units of Instruction
1. The marine environment: general ecological considerations
2. The marine plants
3. The marine animals
4. Marine animals of terrestrial origin
5. Reducing organisms
6. Zoogeography of the seas
7. Time and marine life
8. The impact of man

B . Laboratory Projects
1. Marine plants: classification into vascular and non-vascular types; examination several kinds with the microscope; identification and examination of various algae
2. Marine animals: classification as to protozoa or metazoa; characteristics of animals; identification of common species
3. Biological field trip: Don SCUBA gear and survey the water in a biologically fertile area (e.g., an oil well platform.) Collect and identify several species of animals. Write a report summarizing the number and types of marine animals observed .

Division VII. Introduction to Geological Oceanography

Units of Instruction
1. Purpose of study by oceanographers
2. The rock cycle

Division VIII. Most Common Rock-Forming Minerals and Ores

A. Units of Instruction
1 . Silicates
2. Carbonates
3. Sulfates
4. Ores

B . Laboratory Projects
1. Identification of common minerals by physical and chemical properties
2. Identification of common ores -- streak tests, reaction to acids, etc.

Division IX. Igneous Rocks

A. Units of Instruction
1 . Composition
2. Texture
3. Occurrence

B . Laboratory Projects
1. Classification of common igneous rocks by composition (sialic, intermediate, sialic)
2. Physical properties of common igneous rocks

Division X. Sediments

A. Units of Instruction
1. Sources
2. Weathering
3. Transportation
4. Characteristics
5. Transitional depositional environments
6. Marine depositional environments
7. Sedimentary facies

B . Laboratory Projects
1. Examination and classification of beach sands according to particle size, organic content, origin
2. Examination and classification of marine sediments

Division XI. Lithification

Units of Instruction
1. Compaction
2. Cementation
3. Recrystallization

Division XII. Sedimentary Rocks

A . Units of Instruction
1. Texture
2. Composition
3. Occurrence

B . Laboratory Projects

Examination and classification of common sedimentary materials

Division XIII. Metamorphic Rocks

A. Units of Instruction
1. Texture
2. Composition
3. Occurrence

B. Laboratory Projects
   Examination and classification of common metamorphic rocks

Division XIV. Geologic Time
   Units of Instruction
   1. Absolute dating methods -- uranium, potassium, carbon - 14
   2. Relative dating methods -- uniformity, superposition, intrusion

Texts and References

Abbott, R. T., "American Seashells, " 1958, D. Van Nostrand.
Barnes, R. D., "Invertebrate Zoology, " Second Edition, 1958, W. D. Saunders, Philadelphia.
Eddy, Samuel and Hodson, A.C., "Taxonomic Keys of the Common Animals of the North Central States," Burgess Pub. Co. Minneapolis, Minnesota.
Hickman, C. P., "Biology of the Invertebrates, " 1967, C. V. Mosby, Co., St. Louis.
Hyman, L. H. "The invertebrates, " VI-6.
Idyll, C. P., "Abyss," 1964, Thomas Y. Crowell, New York.
Kudo, R. S., "Protozoology, " C. T. Thomas, 1947, Springfield, Ill.
Light, F. S., "Intertidal Invertebrates of the Central California Coast," 1957, University of California Press.
Leary, Sandra, "Crabs of Texas," 1964, Texas Parks and Wildlife Department.
Meglitsch, Paul A., "Invertebrate Zoology, " 1967, Oxford University Press, London.
Miner, Roy W., "Field Book of Seashore Life," 1950, Putnam, New York.
Perlmutter, A., "Guide to Marine Fishes," 1961, Bramball House, New York.
Richardson, Harriet, "Monograph of Isopods of North America, " Bulletin 54.
Stiles, K. A., "R. W. Hegner and R. S. Boolootian, College Zoology, " 1969, The Macmillan Co.
McConnaugher, B. A., "Introduction to Marine Biology, " Mosby Co.
Turekian, "Oceans, " Prentice-Hall

MST 403ab: MARINE LABORATORY I, II

Hours Required

Class, 0; Laboratory, 6 (each semester)

Course Description

This laboratory course is designed to introduce the student, as an apprentice technician, to the operations of a research vessel and the support activities of a shore based laboratory. The research vessel phase will provide practical experience in the operation of bottom and sub-bottom profilers, grab and core samplers, electronic navigation equipment and navigation aids, water quality monitoring instrumentation, communication equipment and deck gear. The shore laboratory part of the course will expose the student to the technique of processing scientific and engineering data and to emphasize, through laboratory experience, the value of accurate and comprehensive data collecting. The students will analyze water and sediment samples, calculate and preplot navigation data, index and store the developed data and participate in the initial steps of data analysis and interpretation.

Major Divisions

I. Care and Use of Instruments and Equipment at Sea
II. Care and Use of Laboratory Instruments and Equipment
III. Care and Use of Shore-based Support Equipment
IV. Procedures for Efficient and Accurate Operation at Sea
V. Procedures for Efficient and Accurate Operation in the Laboratory
VI. Water Quality Sampling
VII. Continental Shelf Survey
VIII. Bathymetric and Seismic Survey of Corpus Christi Bay
IX. Sea Floor Sampling
X. Plankton Sampling
XI. Beach Sampling

Division I. Care and Use of Instruments and Equipment at Sea

Units of Instruction

1. Radar
2. Radio-telephone
3. Citizens band radio
4. Hi-Fix positioning system
5. In-situ salinometer
6. Dissolved oxygen analyzer
7. Transmissometer
8. Current meter
9. Seismic profiler
10. Precision depth recorder
11. Fathometer
12. Loran navigation receiver
13. Anemometer
14. Water samplers
15. Sediment samplers
16. Compasses
17. Safety equipment
18. Power generators
19. Winches, capstans, etc.

Division II. Care and Use of Laboratory Instruments and Equipment

Units of Instruction

1. Centrifuge
2. Drying oven
3. Magnetic separator
4. Laboratory balance
5. Desk calculator
6. Programmed computer
7. Laboratory salinometer
8. pH meter
9. Microscope
10. Cameras
11. Plotting and drafting tools
12. Sieves and sieve shaker
13. Sediment sample splitters
14. Charts and maps

Division III. Care and Use of Shore-Based Support Equipment

Units of Instruction

1. Surveying equipment
2. Core drilling machine
3. Sextant
4. Navigation slave stations
5. Wave and tide gauges

Division IV. Procedures for Efficient and Accurate Operation at Sea

Units of Instruction

1. Vessel etiquette
2. Safety
3. Deck skills
4. Weather observation
5. Scientific data recording
6. Sample collecting, handling, and labelling
7. Sesmic profile record-keeping
8. Navigation
9. Small-boat handling

Division V. Procedures for Efficient and Accurate Operation in the Laboratory

Units of Instruction

1, Sample handling
2. Bottom and sub-bottom profile handling
3. Water quality profile handling
4. Data mapping and illustration
5. Position-fixing

Division VI. Water Quality Sampling

Laboratory Projects

1. Learn the purpose and use of each instrument to be used
2. Establish points to be sampled on the chart and convert the latitude-longitude coordinates of these points into electronic navigation system readings
3. Establish a systematic procedure for sampling each site
4. Obtain data and samples at each site as outlined
5. Record original data obtained at site on card including the position coordinates of the site.
6. Label samples for return to laboratory
7. Enter sample numbers on master chart to indicate point of sampling

Division VII. Continental Shelf Survey

Laboratory Projects

1. Pre-plot course to be followed, converting latitude and longitude into navigation system coordinates
2. Prepare track plotter charts for electronic navigation system
3. Learn the use and operation of the seismic profiling equipment
4. Learn the proper procedure for marking the seismic record as it is being obtained
5. Label the seismic record at the conclusion of the run
6. Plot course on master chart to indicate area surveyed

Division VIII. Bathymetric and Seismic Survey of Corpus Christi Bay

Laboratory Projects

1. Learn the correct operation of the precision depth recorder and other acoustic equipment
2. Pre-plot course on track plotter chart for navigation
3. Continue as in VII above

Division IX. Sea Floor Sampling

Laboratory Projects

1. Locate points to be sampled on the master chart and convert to navigation system coordinates
2. Learn the use and correct handling of grab-sampling and coring equipment
3. Sample the ocean floor as indicated by the schedule
4. Label and store the samples for transference to the laboratory
5. Wash and oven-dry the samples. With the aid of screens and a microscope, determine the particle sizes of the various fractions and the percentage of organic material in each
6. Locate each sample on a replica of the master chart so as to indicate the type of sediment at each location

Division X. Plankton Sampling

Laboratory Projects

1. Learn. the use and handling of the plankton net and associated equipment
2. Locate points to be sampled on the master chart and convert the latitude and longitude to electronic navigation system coordinates
3. Prepare a number of sample storage jars and add 200 ml. of 5% formalin to each

4. Aftereach sample is obtained, label it and add the navigation system co-ordinates of the point
5. Record all other pertinent data at sampling site

Division XI. Beach Sampling

Laboratory Projects

1. Locate the proposed sampling sites on a suitable chart
2. Obtain an adequate number of sample containers
3. Take samples as indicated, noting the macro features of the beach (size of surf, presence of dunes, width of beach, man-make objects. At each site. Label samples
4. Wash the samples in the laboratory with water and oven-dry
5. Sieve each sample and determine the percentage of each size fraction
6. Construct a chart of sample size vs location and attempt to correlate with physical features (currents, jetties, inlets, man-made artifacts, etc .)

Texts and References

U. S. Navy, "Instruction Manual for Obtaining Oceanographic Data," Third Edition, U. S. Naval Oceanographic Office Publication No. 607.

Knight, "Modern Seamanship, " Eleventh Edition, O. van Nostrand.

Bowditch, "American Practical Navigator," U. S. Naval Hydrographic Office.

Twenhofel and Tyler, "Methods of Study of Sediments," McGraw-Hill.

Dobrin, "Geophysical Prospecting, " Second Edition, McGraw-Hill

MST 211: MARINE LABORATORY III

Hours Required

Class, 0; Laboratory, 6.

Course Description

The objective of this course is to give the student experience in planning, scheduling and executing an assignment in data retrieval, utilizing the experience derived from MST Marine Laboratories I and II.

The students as teams of two or three will be assigned specific areas within the Corpus Christi Bay area for a comprehensive date sampling and processing project. Emphasis will be placed on student initiative in gaining responsibility for accomplishing the tasks previously guided by continuous instruction. A prime objective of the collecting and preliminary processing of the data is to develop a sufficient backlog of information for retrieval and analysis for subsequent MST Course 412.

Major Divisions

	Hrs.
I. Detailed Examination of Bottom, Sub-Bottom, and Sediment Features of an Assigned Area . .	42
II. Spot Examination of the Bottom, Sub-Bottom, and Sediment Features of a Large Area . . .	42

Division I. Detailed Examination of Bottom, Sub-Bottom, and Sediment Features of an Assigned Area

Laboratory Projects

1. Prepare track plotter charts for the Hi-Fix navigator so as to make high-resolution profiles within the assigned area on three-hundred-foot spacings
2. Locate sediment sampling points on l/4-mile grid spacing and convert the latitudes and longitudes into Hi-Fix coordinates
3. Devise and implement an efficient schedule of data collection
4. Classify the sediments as to particle size, organic and shell content, and other features
5. Record all data and label it clearly for future reference
6. Draw up a large-scale detail map of the area and indicate by color or other scheme the general bottom and sub-bottom characteristics

Division II. Examination of Bottom, Sub-Bottom, and Sediment Features of a Regional Area

Laboratory Projects

1. Determine the latitudes and longitudes of the data sites of the regional area (a much larger area than in Division I). Convert these to Hi-Fix coordinates
2. Prepare track plotter charts
3. Record data as obtained and label clearly
4. Adjust sampling and profiling locations as data indicates to obtain best information
5. Draw a bathymetric map of your area, indicating depth readings as often as necessary to show detail
6. Devise such maps, report forms, etc., necessary to report data in most readable fashion

Texts and References

U. S. Naval Oceanographic Office, "Instruction Manual for Obtaining Oceanographic Data, " Third Edition.

Myers, "Handbook of Ocean and Underwater Engineering," McGraw-Hill.

Twenhofel and Myer, "Methods of Study of Sediments, " McGraw-Hill

Dobrin, "Geophysical Prospecting," Second Edition, McGraw-Hill .

MST 414: MARINE INSTRUMENTATION

Hours Required

Class, 3; Laboratory, 3.

Course Description

The course is a study of the tools and techniques used in oceanographic research activities. These include:

a. Data sampling techniques
b. Water quality instrumentation
c. Meterological instrumentation
d. Sediment sampling tools
e. Bottom profiling equipment
f. Sub-bottom profiling equipment
g. Mapping
h. Navigation

In each case, the tools and techniques used will be reviewed in the lectures along with the advantages, disadvantages and applications of each one. The theory of operation and factors influencing the accuracy of the more important examples will be discussed.

The laboratory section is intended to give the students practical experience and a feel for the usefulness, accuracy and applicability of the different instruments and techniques.

Major Divisions

		Hrs. Lec.	Lab.
I.	Significant Figures, Specified Tolerances, and Error Accumulation.	3	0
II.	Thermometry	3	3
III.	Light Transmission Measurement	3	3
IV.	Current and Water-Level Meters	3	3
V.	Anemometers, Salinometers, and Chemical Sensors ..	3	3
VI.	Types of Navigation and Geodesy	3	0
VII.	Chart Projections	3	0
VIII.	Conic and Lambert Projection	3	6
IX.	Longitude and Latitude Calculation	6	6
X.	Celestial and Electronic Navigation	6	6

Division I. Significant Figures, Specified Tolerances, and Error Accumulation

Units of Instruction

1. Specified tolerances
2. Significant figures
3. Error accumulation
4. Nyquist sampling rate

Division II. Thermometry

A. Units of Instruction
   1. Liquid-in-glass thermometers
   2. Bi-Metallic strip thermometers
   3. Bourdon tube thermometer
   4. Thermocouple
   5. Thermistor
   6. Resistance-wire thermometer
   7. Bathythermograph

B. Laboratory Projects

   Learn operation and principle of mechanical bathythermograph, reversing thermometer, and surface bucket thermometer.

Division III. Light Transmission Measurement

A. Units of Instruction
   1. Water clarity scales
   2. Extinction coefficient
   3. Irradiance Meter
   4. Incandescent-bulb transmissometer

B. Laboratory Projects
   1. Demonstrate use and field calibration of transmissometer
   2. Trace electrical schematic of transmissometer

Division IV. Current and Water-Level Meters

A. Units of Instruction
   1. Resistive current meter
   2. Impeller-type current meter
   3. Propellor-type current meter
   4. Acoustic current meter
   5. Flow meter
   6. Tide well
   7. Spark plug wave gauge

8. Resistance wire wave gauge
9. Capacitance wave gauge
10. Downward-looking radar wave gauge
11. Microwave-scattering wave gauge
12. Differential pressure wave gauge
13. Upward-looking sonar wave gauge

B. Laboratory Projects

Trace mechanical and electrical layout of Savonius rotor current meter and direction indicator

Division V. Anemometers, Salinometers, and Chemical Sensors

A. Units of Instruction

1. Acoustic wind velocity meters
2. Acoustic current meters
3. Beaufort scale
4. Hot-wire anemometer
5. Cup anemometer
6. Bernoulli anemometer
7. Strain-gauge anemometer
8. Resistance salinometer
9. Mutual-inductance salinometer
10. Chemical sensors (pH, D.O., etc.)

B. Laboratory Projects

Construct a block diagram of a mutual-inductance salinometer. Trace out the actual circuit and relate to the block diagram.

Division VI. Types of Navigation and Geodesy

Units of Instruction

1. Dead reckoning
2. Piloting
3. Electronic navigation
4. Celestial navigation
5. Standard spheroid
6. Great circle
7. Small circle
8. Meridian and prime meridian
9. Parallel
10. Rhumb line
11. Latitude and longitude coordinates

Division VII. Chart Projection

Units of Instruction

1. Definition of map and chart
2. Desirable properties of a map
3. Mercator projection

Division VIII. Conic and Lambert Projection

A. Units of Instruction

1. Definition of projection
2. Standard parallel
3. Transverse conic
4. Oblique conic
5. Lambert conformal projection

B. Laboratory Projects

1. Plot location from two prominent landmarks using sextant
2. Discuss error sources and probable accuracy.

Division IX. Longitude and Latitude Calculation

A. Units of instruction

1. Legendre's theorem
2. Spherical excess
3. Plane calculation of ϕ' and λ'
4. Spheroidal calculation of ϕ' and λ'
5. Calculation of distance and azimuth between known points

B. Laboratory Projects

1. Locate USC & GS triangulation stations
2. Discuss requirements for useable stations
3. Demonstrate use of information on stations
4. Discuss means of calibrating navigation system

Division X. Celestial and Electronic Navigation

A. Units of Instruction

1. Instruments for celestial navigation
2. Corrections to be applied to readings
3. Time-frequency equation for electromagnetic wave
4. Range--range electronic navigation systems
5. Navigation grid characteristics

B. Laboratory Projects

1. Plot and predict actual course between known locations using dead reckoning and sextant. Compare accuracies of method
2. Plot location and course using Loran-A
3. Plot location and course using Hi-Fix
4. Compare relative accuracies of all methods

Texts and References

"Handbook of Ocean and Underwater Engineering," Myers et al, McGraw-Hill, 1969.
"American Practical Navigator," Bowditch, U.S. Navy Hydrographic Office, 1966.
"Instruction Manual for Obtaining Oceanographic Data," U.S. Naval Oceanographic Office, Third Edition, 1968.
"Geodesy," Hosmer, John Wiley & Sons, 1930.
"Data Transmission," Bennett and Dovey, McGraw-Hill, 1965.
Various Manufacturers Manuals.

MST 216: MARINE SCIENCE SEMINAR

Hours Required

Class, 2: Laboratory, 0.

Course Description

This course is designed to introduce the student to researching the literature and organization and presentation of facts. Each student will select a topic from the approved list of subjects and develop it into a tow-hour oral report, with a written report to accompany the presentation. Guest lecturers will also be invited periodically to speak on specific areas of interest.

Major Divisions

	Hrs.
I. Written and Oral Presentation of a Research Report	20
II. Participation in Group Discussion Following Guest Lecturer	10

Division I. Written and Oral Presentation of a Research Report

Units of Instruction

1. Researching the literature
2. Organizing the Material
3. Writing and presenting the report
4. Group discussion and clarification of specific points
5. Exam over major points of lecture

Division II. Participation in Group Discussion Following Guest Lecturer

Units of Instruction

1. Question and answer session
2. Inferences to be drawn from lecture material
3. Exam over major points of lecture

Seminar Topics

Tides - (causes, variations, extremes, local and regional effects, etc.)

Currents - (types and causes, patterns, instruments, velocities in oceans, bays lakes, streams etc .)

Temperature - variations in oceanic waters (present and past)

Salinity - variation in oceanic waters (present and past)

Sediment on the ocean floor, including sampling devices

Acoustic profiling systems - principles of operations and basic advantages and characteristics

Marine fouling - tupes, occurences, anti-fouling methods and effectiveness

Wind - effects on oceans, bays and lakes

Violent storms - energy, frequency, paths, forecasting and weather modification

Jelly fish - morphology, distribution, habits, etc.

Guest Lecturers and Topics

Dr. John White, Biology Dept., Del Mar College, "Speciation"

Dr. William Behrens, Marine Science Institute, University of Texas, "Origin of Ocean Basins"

Mr. Roy Thompson, Southwest Research Institute, "Data Gathering and Processing Procedures"

Mr. Jack Lancaster, Commander, Coast Guard Auxiliary, "Rules of the Road"

Dr. Jerry O'Donnell, Marine Science Dept., Del Mar College, "Methods of Pollutant Identification and Determination"

MST 412: MARINE RESEARCH TECHNIQUES

Hours Required

Class, 3; Laboratory, 3.

Course Description

This course is a continuation of MST 211, and is designed to develop the data gathered during previous MST courses, supplemented with data collected in this course, into a finished report. Lecture hours will be used primarily for individual consultation.

Major Divisions (see MST 211)

	Hours Class	Laboratory
I. Regional Area Survey	21	21
II. Detailed Area Survey	21	21

Division I. Regional Area Survey

A. Units of Instruction
1. Data, collection and handling
2. Project planning
3. Data reduction

B. Laboratory Projects
1. Outline plot of intended data paths and sampling
2. Actual plot of paths traversed
3. Actual plot of sampling sites
4. Contour map of water depth
5. Contour map of Pleistocene surface or prominent key horizon
6. Sediment distribution map

Division II. Detailed Area Survey

A. Units of Instruction
1. Map and chart drafting
2. Terminology and nomenclature

B. Laboratory Projects
1. Outline map of area surveyed
2. Outline plot of intended traverses and sediment sites
3. Contour map of water depths
4. Contour map of Pleistocene surface or prominent key horizon
5. Reef location map
6. Detailed configuration sketch of a buried reef complex
7. Plot map of faults

Texts and References

Twenhofel and Tyler, "Methods of Study of Sediments," McGraw-Hill .

Holmes, "Principles of Physical Geology," Second Edition, Ronald Press.

Leet and Judson, "Physical Geology," Third Edition, Prentice-Hall.

Shepard et al, "Recent Sediments, Northwest Gulf of Mexico," Project 51, American Petroleum Institute.

MST 415: MARINE SCIENCE PROBLEMS AND DESIGN

Hours Required

Class, 3; Laboratory, 3.

Course Description

This course is designed to teach the student the technique of systematic study and effort in problem-solving. The student will devise his own method of solving two to four (depending on complexity) problems actually encountered in previous laboratory courses, and write a weekly status report on his progress toward wolution of the problems. Lectures will be on an individual-consultation basis.

Major Divisions

	Hours Lec.	Lab.
I. Definition of the problem	3	0
II. Background	9	6
III. The Proposed Solution ..	6	12
IV. Description of Experimental Methods	12	12
V. Analysis of Results	6	9
VI. Conclusions	6	3

Division I. Definition of the Problem

Units of Instruction

1. Choice of problem
2. Examination of data showing problem

Division II. Background

A. Units of Instruction
   1. Manifestation of the problem
   2. Results of literature search
B. Laboratory Projects
   1. Search of literature for indications of the extent of the problem
   2. Search of manufacturer's and other literature for hints to solution
   3. Outline of seriousness of the problem; i.e., is it worth attempting a solution?

Division III. The Proposed Solution

A. Units of Instruction
   1. Objectives of the approach
   2. Alternatives to be considered
   3. Justification for proposed approach
B. Laboratory Projects
   1. Experimental test of proposed solution
   2. Appraisal of results and experimenta! test of necessary revisions to approach

Division IV. Description of Experimental Methods

A. Units of Instruction
   1. Objective of each experiment performed
   2. Alternatives considered
   3. Justification of experimental technique
B. Laboratory Projects
   1. Field test of proposed solution
   2. Appraisal of results of field test and consideration of alternatives
   3. Field test of altered approach if necessary

Division V. Analysis of Results

A. Units of Instruction
   1. Hazards of inductive reasoning
   2. Empirical corrections
   3. Sources of error
B. Laboratory Projects
   1. Compilation and interpretation of test data
   2. Final field test of proposed solution

Division VI. Conclusions

A. Units of Instruction
   1. Validity of the data
   2. Validity of conclusions
B. Laboratory Projects

   Preparation of final report according to above outline

Suggested Problems

1. Calibrate a Savonius Rotor Current Meter (Marine Advisors Model SW-l) in a controlled water flow.
2. Calibrate a Cup Anemometer (Hydro Products MS-950) in a controlled air flow.
3. Design and construct a portable wave height measuring device, for use in shallow water (8-40 feet).
4. Develop a method of refining the sampling of a stratified water column to allow a uniform sample of a one foot layer.
5. Develop a method of deploying a portable current meter, which does not introduce errors into the measurement.
6. Determine the relation of bottom material to the calibration of the precision depth recorder.
7. Develop a technique of taking a water sample for dissolved oxygen titration which does not aerate the sample.
8. Design improved hardware and procedure for deploying and towing a subbottom profiler transducer from a research vessel.
9. Determine quantitatively the variables that effect the accuracy and resolution of the precision navigation system.
10. Calibrate the portable salinometer against the laboratory salinometer and design the hardware and procedure for field calibration.
11. Design and construct a recording tide gage for dockside installation.
12. Develop an improved photographic "set up" for mass production copying bottom and subbottom profile records.
13. Construct a bathymetric map of North Corpus Christi Bay from combined student data produced in MST Course 412.
14. Construct a top Pleistocene or key horizon map of North Corpus Christi Bay from combined student data from MST Course 412.
15. Construct a sediment distribution map of North Corpus Christi Bay from the composite student data from MST Course 412.
16. Map the position and depth of buried oyster reefs in North Corpus Christi Bay from the composite student data from MST Course 412.

References:

1. "Instruction Manual for Obtaining Oceanographic Data," U. S. Naval Oceanographic Office, Third Edition, 1968.
2. "Handbook of Ocean and Underwater Engineering," Myers et.al., McGraw-Hill, 1969.
3. "Methods of Study of Sediments," Twenhofel and Tyler, McGraw-Hill, First Edition, 1941.
4. "Geophysical Prospecting," Dobrin, McGraw-Hill, Second Edition, 1960.
5. "Underwater Acoustics Handbook," Albers, Pennsylvania University Press, 1960.
6. "Marine Chemistry," Vol. 1, Martin, Dekker, 1968.
7. Periodicals in the Marine Field.
8. Various Manufacturers Manuals.

MST 310: UNDERWATER ACOUSTICS

Hours Required

Class, 3; Laboratory, 0.

Course Description

The course will consist of three lecture hours per week. Topics to be covered, in the order of their presentation, include:

(1) Introduction to the physics of sound
(2) Properties of wave motion
(3) Refraction and diffraction of waves
(4) Physics of sound in the sea
(5) Applications of underwater sound

The student will be expected to have a working knowledge of algebra and trigonometry, Calculus will be introduced if needed. The first four weeks will be devoted to a review of basic physics and a general discussion fo the properties of wave propagation, after which the more specific subject of underwater sound will be covered.

Major Divisions

		Hours
I.	Features of Sound	12
II.	Introductory Acoustics	6
III	Generation of Sound	3
VI.	Properties of Underwater Sound .	9
V.	Signal Detection	6
VI.	Application of Principles of Underwater Sound	9

Division I. Features of Sound

Units of Instruction

1. Analogies to other waves
2. Physical properties of sound waves
3. Traveling waves and standing waves
4. Harmonics
5. Doppler effect
6. Power and intensity-- the decible scale
7. Ultrasonics
8. Relation of sound to other waves
9. Quantum mechanical solution of wave equation

Division II. Introductory Acoustics

Units of Instruction

1. Power loss in medium
2. Reflection of sound waves
3. Diffraction of sound waves
4. Relation of harmonics to diffraction and reflection

Division III. Generation of Sound

Units of Instruction

1. Requirements of sonic generators
2. Electronic drive units
3. "Shot" devices

Division IV. Properties of Underwater Sound

Units of Instruction

1. Reflection from large bodies
2. Reflection from samll bodies
3. Surface reflection
4. Bottom reflection
5. Refraction
6. Transmission loss
7. Effects of physical discontinuities
8. Attenuation
9. Interference from marine life

Division V. Signal Detection

Units of instruction

1. Types of receivers
2. Background noise
3. Reverberation

Division VI. Application of Principles of Underwater Sound

Units of Instruction

1. Sonic ranging (SONAR)
2. Detection of objects underwater
3. Defense uses
4. Seismic exploration

Texts and References

V.M. Albers, "Underwater Acoustics Handbook," Second Edition, Pennsylvania State University Press.

Joseph, Pomeranz, Prince and Sacher, "Physics for Engineering Technology," John Wiley.

MST 310 cont.

U. S. Navy, "Principles and Applications of Underwater Sound," NAVMAT p-9674.

U. S. Navy, "Physics of Sound in the Sea," NAVMAT p-9675.

ELECTRONIC COURSE OUTLINES

EET 403: ELECTRONICS THEORY AND LAB

Hours Reauired

Class, 3; Laboratory, 3.

Course Description

An introduction to the science of electronics through the study of basic DC and AC circuits, theorems, vacuum tubes, switches, meters, magnetism, resistance, and capacitance, inductance, and application of these components in electronic circuits. Laboratory covers use and techniques os basic laboratory instruments and procedures.

Major Divisions

		Hours Lec.	Lab.
I.	Electrical Theory	3	3
II.	Fundamental Theorems	9	6
III.	Two-Element Devices	3	3
IV.	Three-Element Devices	6	6
V.	Multigrid Tubes	6	3
VI.	Circuit Components	6	3
VII.	Decibels and Sound	3	0
VIII.	Audio Elements	3	0
IX.	The Cathode-Ray Oscilloscope	6	2

Division I. Electrical Theory
- A. Units of Instruction
  1. Atomic structure
  2. Electron flow
  3. Semiconductors
  4. Series and parallel circuit analysis
- B. Laboratory Projects
  Familiarization with circuit symbols and components, resistor color code

Division II. Fundamental Theorems
- A. Units of Instruction
  1. Kirchoff's laws
  2. Thevenin's theorem
  3. Superposition
  4. Delta-wye transformation
- B. Laboratory Projects
  1. Familiarization with the vacuum-tube voltmeter
  2. Series and parallel circuits, Kirchoff's law

Division III. Two-Element Devices
- A. Units of Instruction
  1. Vacuum diode
  2. Semiconductor diode
  3. Gas-filled diode
- B. Laboratory Projects
  Diodes, half- and full-wave rectification

Division IV. Three-Element Devices
- A. Units of Instruction
  1. Vacuum triode
  2. Triode amplifiers
  3. Junction transistor
  4. Transistor amplifiers
  5. Gas-filled triodes
- B. Laboratory projects
  Triode characteristics, amplification

Division V. Multigrid Tubes
- A. Units of Instruction
  1. Tetrode
  2. Pentode
  3. Beam power tube
  4. Shielded thyratron
  5. Miscellaneous tubes
- B. Laboratory Projects
  Pentodes, multi-stage amplifiers

Division VI. Circuit Components
- A. Units of Instruction
  1. Resistors
  2. Inductors
  3. Transformers
  4. Capacitors
- B. Laboratory Projects
  Construction of filtered power supply; pi-section and L-section filters

Division VII. Decibels and Sound

Units of Instruction
1. The decibel
2. Logarithms
3. Sound levels

Division VIII. Audio Elements

Units of Instruction
1. Microphones
2. Speakers

Division IX. The Cathode-Ray Oscilloscope

A. Units of Instruction
   1. Cathode-ray tube
   2. Amplifiers and synchronization
   3. Applications

B. Laboratory Projects
   1. Characteristics and use of oscilloscope
   2. Oscilloscope examination of Class A, B, and C amplifier characteristics

<u>Texts and References</u>

Grab, "Basic Electronics," McGraw-Hill.

EET 804a: D.C. THEORY AND LABORATORY

Hours Required

Class, 3; Laboratory, 3.

Course Description

A basic direct current electricity course for technical students. An intensive study of electric current, voltage, Ohm's Law, Kirchoff's Laws, circuits, measurements, magnets, magnetism, resistors, capacitors, and inductors. Once a week the students conduct prescribed laboratory experiments pertaining to the electrical theory being studied. During these experiments measurements are made and recorded from which a report is made explaining the laboratory work.

Major Divisions

	Hours Class	Hours Laboratory
I. Basic Theory	5	6
II. Electrical Circuits	7	12
III. Laws and Theorems of Electrical Circuits	11	6
IV. Magnetism and Magnetic Circuits	6	3
V. Direct Current Instruments	3	9
VI. Electromagnetic Induction	4	3
VII. Capacitance	4	3

Division I. Basic Theory

A. Units of Instruction
1. Properties of the electron
2. Resistors, conductors, and insulators
3. Circular measure
4. Temperature coefficient of resistance
5. Wire tables

B. Laboratory Projects
1. Fundamental electrical circuits and diagrams
2. Temperature coefficient of resistance

Division II. Electrical Circuits

A. Units of Instruction
1. Ohm's Law
2. Electrical power
3. Resistors in series
4. Resistors in parallel

B. Laboratory Projects
1. Series circuits
2. Parallel circuits
3. Equivalent resistance
4. Bridge circuits

Division III. Laws and Theorems of Electrical Circuits

A. Units of Instruction
1. Kirchoff's laws
2. Electrical circuits
3. Superposition theorem
4. Thevenin's theorem
5. Maximum power transfer theorem

B. Laboratory Projects
1. Kirchoff's laws
2. Wye-delta equivalents

Division IV. Magnetism and Magnetic Circuits

A. Units of Instruction
1. Magnets
2. Electromagnetism
3. Magnetic fields
4. Flux density
5. Ferromagnetic substances
6. Permeability
7. Force of electromagnets
8. Coils
9. Hysteresis

B. Laboratory Projects
1. Magnetism and magnetic circuits (demonstration)

Division V. Direct Current Instruments

A. Units of Instruction
1. Electrodynamometer
2. Permanent-magnet type

3. Wheatstone Bridge
4. Instrument circuits
5. Shunts
6. Multipliers

B. Laboratory Projects

I. The D.C. ammeter
2. The D.C. voltmeter
3. The Wheatstone bridge

Division VI. Electromagnetic Induction

A. Units of Instruction

1. Inductance
2. Induced voltage
3. Current growth and decay
4. Time constants
5. Lenz's Law

B. Laboratory Projects

1. Inductance and inductors

Division VII. Capacitance

A. Units of Instruction

I. The capacitor
2. Units of charge
3. Dielectric
4. Capacitors in series and in parallel
5. Charging current
6. Time constants
7. Current growth and decay

B. Laboratory Projects

I. Capacitance and capacitors

<u>Texts and References</u>

Siskind, "Electrical Circuits," Second Edition, McGraw-Hill

Goffe and Wilcox, "Problems for the Calculator and Slide Rule"

EET 804b: A.C. THEORY AND LABORATORY

Hours Required

Class, 3: Laboratory, 3.

Course Description

A basic study of alternating current theory and application, including circuit parameter, wave shapes, victor algebra, circuit laws and theorems, reaction of various circuit components, three-phase circuit characteristics, measurements, and resonant circuits.

Major Divisions

	Class Hours	Laboratory Hours
I. The Sine Wave ...	5	0
II. A.C. Circuits ...	13	6
III. Resonant Circuits ...	3	15
IV. A.C. Circuit Theorems	4	3
V. Coupled Circuits ..	4	3
VI. A. C. Instruments ..	2	3
VII. Three-Phase Circuits.	9	9

Division I. The Sine Wave
- A. Units of Instruction
  1. Generator action
  2. Transformer action
  3. Voltage and current waves
  4. Frequency
  5. A. C. ampere
  6. Effective valves
  7. Average valves
  8. Addition of sine waves
  9. Victors and vector algebra
  10. Rectangular coordinates
  11. Polor coordinates

Division II. A.C. Circuits
- A. Units of Instruction
  1 Circuit components
  2 Resistive circuit
  3. Capacitive circuit
  4. Inductive circuit
  5. Combination circuits
  6. Impedance
  7. Reactance
  8. Power
  9. Power factor
  10. Volt-ampere
  11. Reactive volt-ampere
  12. Admittance
  13. Conductance
  14. Sucseptance
- B. Laboratory Projects
  1. Use of laboratory equipment
  2. Inductive reactance, air-iron cores

Division III. Resonant Circuits
- A. Units of Instruction
  1. Series resonance
  2. Parallel resonance
  3. Frequency of resonance
  4. Effects of varying R, L, C
  5. Selectivity
  6. "Q" of a circuit
  7. Pass and block filters
- B. Laboratory Projects
  1. Series R-L circuit
  2. Series R-C circuit
  3. Parallel R-L-C circuit
  4. Series - parallel circuit
  5. Series resonance

Division IV. A.C. Circuit Theorems
- A. Units of Instruction
  1. Thevenin's theorem
  2. Reciprocity theorem
  3. Superposition theorem
  4. Kirchoff's laws
  5. Maximum power transfer
  6. Wye-delta transformation
- B. Laboratory Projects
  1. Group problem-solving session

Division V. Coupled Circuits
- A. Units of Instruction
  1. Inductive coupling
  2. Capacitive coupling
  3. Resistive coup1ing
  4. Transformer coup1ing
  5. Transformer turns ratio
  6. Impedance matching
- B. Laboratory Projects
  1. Coupled circuits

Division VI. A.C. Instruments

A. Units of Instruction
1. Thermocouple
2. Iron vane
3. Electrodynamometer
4. Frequency
5. Watt-hour meter
6. Wattmeter connections

B. Laboratory Projects
1. Use and construction of A.C. instruments

Division VII. Three-Phase Circuits

A. Units of Instruction
1. Generation
2. Angular displacement
3. Wye-delta connections
4. Power and power measurement
5. Balanced loads
6. Unbalanced loads

B. Laboratory Projects
1. Balanced three-phase circuit
2. Unbalanced three-phase delta circuit
3. Unbalanced three-phase wye circuit

Texts and References

Siskind, "Electrical Circuits," Second Edition, McGraw-Hill.
Goffe and Wilcox, "Problems for the Slide Rule and Calculator"

EET 404: TRANSISTORS AND BASIC CIRCUITS

Hours Required

Class, 3; Laboratory, 3.

Course Description

The course is a basic study of the physical and electrical properties of the various currently used types of semi-conductors, including diodes, transistors, FET's, silicon-controlled rectifiers, photo devices, and thermistors. Use of all types of semiconductors in various circuit applications is stressed, with particular emphasis on amplifiers and power supplies. Laboratory experiments in line with the class material is used to improve the understanding of both basic principles and applications. The objective of the course is to acquaint the student with the basic principles of operation and the more basic applications of semiconductor devices as used in most of the fields of Engineering Technology. Stress is put upon the use of the semiconductor devices as circuit elements, with a reasonably rigid mathematical analysis developed.

Major Divisions

	Hours Class	Hours Laboratory
I. Device Physics	3	0
II. P-N Junction Devices	4	6
III. Transistors: Common-Base Configuration	4	3
IV. Transistor Miscellany	4	9
V. Field-Effect Transistor	2	3
VI. Cascaded Amplifiers and Amplifier Pairs	5	6
VII. Power Amplifiers	3	3
VIII. Negative Feedback in Amplifiers	1	3
IX. Rectifier Power Supplies	5	3

Division I. Device Physics
- A. Units of Instruction
  1. Conductors, semiconductors, and insulators
  2. Photoconductive semiconductor devices
  3. Thermistors
  4. P- and N- type semiconductors
  5. The P-N junction

Division II. P-N Junction Devices
- A. Units of Instruction
  1. Electrical characteristics of P-N junction
  2. Load-line analysis
  3. Thermal resistance and derating
  4. Applications of semiconductor diodes
  5. Diode breakdown and the Zever diode
  6. Esaki diodes
- B. Laboratory Projects
  1. Characteristics of the semiconductor diode
  2. Diode-resistor logic circuits

Division III. Transistors: Common-Base Configuration
- A. Units of Instruction
  1. Characteristic curves
  2. Carrier distribution
  3. Graphical analysis
  4. Small-signal model and analysis
- B. Laboratory Projects
  1. Basic characteristics of the transistor amplifier

Division IV. Transistor Miscellany
- A. Units of Instruction
  1. Specification sheets
  2. h-parameters
  3. Load and source resistance
  4. Transistor testing
- B. Laboratory Projects
  1. Biasing circuitry
  2. Gain and signal limitations
  3. Forward current transfer ratio

Division V. Field-Effect Transistor
- A. Units of Instruction
  1. Operating principles and graphical analysis
  2. Equivalent circuit model and analysis
  3. Parameters of the FET
  4. The MOSFET
- B . Laboratory Projects
  1. Characteristics of the FET amplifier

Division VI. Cascaded Amplifiers and Amplifier Pairs
- A. Units of Instruction
  1. General features and decibels
  2. Midfrequency response
  3. Low-frequency response
  4. High-frequency response
  5. Response of the FET
  6. Tuned-circuit coupling
- B . Laboratory Projects
  1. High-frequency response.
  2. Low-frequency response

Division VII. Power Amplifiers
- A. Units of Instruction
  1. Single-ended operation
  2. Push-pull operation
  3. Phase splitters
  4. Graphical analysis
- B. Laboratory Projects
  1. The transformer-coupled power amplifier

Division VIII. Negative Feedback in Amplifiers
- A. Units of Instruction
  1. General features
  2. Nyquist deagrams and amplifier response
  3. Noise and distortion with feedback
- B . Laboratory Projects
  1. Negative feedback in transistor circuits

Division IX. Rectifier Power Supplies
- A. Units of Instruction
  1. Properties of rectified voltages
  2. Filters
  3. Constant-voltage regulators
  4. Constant-current regulators
  5. Lilicon-controlled rectifiers
  6. Voltage multipliers
- B . Laboratory Projects
  1. Rectifier and filter circuits

Texts and References

Brazee, "Semiconductor and Tube Electronics," Holt, Rinehart, and Winston.
Meyers, "Practical Semiconductor Experimentation," Prentice-Hall.

EET 412: ELECTRICAL MACHINERY

Hours Required

Class, 3; Laboratory, 3.

Course Description

A theory and laboratory course in direct and alternating current machines. Includes Theory, operation, test, control and connection of the following equipment: motors generators, alternators, transformers, rectifiers and invertors. Objective of the course is to install adequate theory for the development of competency in the design of industrial applications of electrical machinery, when under the supervision of a Professional Engineer.

Major Divisions

	Hours Class	Hours Laboratory
I. Electromagnetic Induction	1	0
II. Dynamo Construction	1	0
III. Generator Characteristics	2	9
IV. Armature Reaction	1	0
V. Parallel Operation of Generators	1	0
VI. Motors	2	3
VII. Starting DC Motors	2	0
VIII. Dynamo Efficiency	1	0
IX. Single-Phase Transformers	4	6
X. Transformer Connections	5	15
XI. Polyphase Induction Motors	6	6
XII. Alternators	10	0
XIII. Polyphase Synchronous Motors	6	3
XIV. Single-Phase Motors	3	0

Division I. Electromagnetic Induction
Units of Instruction
1. Induced voltage
2. Lenz's Law

Division II. Dynamo Construction
Units of Instruction
1. Poles
2. Commutator
3. Armature
4. Brush rigging
5. Windings
6. Bearings

Division III. Generator Characteristics
A. Units of Instruction
1. General equation
2. Curves for
3. Build-up process
4. Generator type

B. Laboratory Projects
1. The shunt generator
2. Shunt generator load test
3. Compound generator load test

Division IV. Armature Reaction
Units of Instruction
1. Effects of
2. Brush shifting
3. Commutation

Division V. Parallel Operation of Generators
Units of Instruction
1. Connections for
2. Load divisions
3. Equalizer connection

Division VI. Motors
A. Units of Instruction
1. Torque
2. Counter EMF
3. Speed
4. Types

B. Laboratory Projects
1. D.C. motor load test

Division VII. Starting D. C. Motors
Units of Instruction
1. Manual starter
2. Automatic starters
3. Speed control

Division VIII. Dynamo Efficiency
- A. Units of Instruction
  1. Copper losses
  2. Stray power loss
  3. Stray load loss
  4. Efficiency calculations

Division IX. Single - Phase Transformers
- A. Units of Instruction
  1. Fundamentals
  2. Voltage regulation
  3. Victor diagram
  4. Constants
  5. Efficiency
- B. Laboratory Projects
  1. Transformer characteristics
  2. Transformer load test

Division X. Transformer Connections
- A. Units of Instruction
  1. Polarity
  2. Polyphase connections
  3. Special types of
- B. Laboratory Projects
  1. Transformer console familiarization
  2. Transformer connections
  3. Three-phase transformer connections
  4. Open delta connections
  5. Autotransformer connections

Division XI. Polyphase Induction Motors
- A. Units of Instruction
  1. Rotating induction motors
  2. Speed
  3. Slip
  4. Torque
  5. Power factor
  6. Efficiency
  7, Equivalent circuit
  8. Starting methods
- B. Laboratory Projects
  1. Induction motor load test
  2. Induction motor rotor current

Division XII. Alternators
- A. Units of Instruction
  1. Construction
  2. Power factor
  3. Synchronous impedance
  4. Ratings
  5. Efficiency
  6. Tests

Division XIII. Polyphase Synchronous Motors
- A. Units of Instruction
  1. Construction
  2. Starting
  3. Torque
  4. Power factor correction
  5. Filed current
- B. Laboratory Projects
  1. Synchronous motor characteristics

Division XIV. Single-Phase Motors
- A. Units of Instruction
  1. Types
  2. Characteristics
  3. Construction
  4. Applications

Texts and References

Rosenblatt and Friedman, "Direct and Alternating Current Machinery," McGraw-Hill.

EET 413: ELECTRONIC ANALYSIS AND MEASUREMENT

Hours Required

Lecture, 3: Laboratory, 3.

Course Description

Theory and application of electronic generating and measuring devices used as standard test equipment. industrial process instrumentation with emphasis on circuitry of recorders, controllers, transmitters and receivers of industrial control instruments. The objectives of this course are as follows: (1) To give the student a comprehensive understanding of the most frequently used instruments of an electronic laboratory such as meters, oscilliscopes, signal generators, frequency meters, etc. (2) To provide the student with circuit concepts of the laboratory instruments, the proper use and limitations of them, and how to predict and interpret the results of measurements. (3) To introduce the student to a variety of circuits and instruments employing electronic principles in the area of industrial process instruments, primarily from the electronic circuit standpoint.

Major Divisions

	Hours Class	Laboratory
I. Basic Instruments and Measurements . . .	3	
II. Measurement Methods .	4	
III. Electronic Instruments .	5	
IV. Specific Equipment . .	7	
V. Testing	6	
VI. Other Instruments . . .	12	

Division I. Basic Instruments and Measurements

A. Units of Instruction
   1. General
   2. Basic D.C. meters
   3. Basic A.C. meters

B . Laboratory Projects
   1 . Design and applications of a peak-responding voltmeter

Division II. Measurement Methods

A. Units of Instruction
   1. Comparison measurements
   2. Bridge measurements

B. Laboratory Projects
   1. Precision resistance measurement with a Wheatstone bridge

Division III. Electronic Instruments

A. Units of Instruction
   1. Electron devices
   2. Electronic voltmeters
   3. Recording systems

B . Laboratory Projects
   1. Voltmeter imput impedance
   2. Design and construct a digital binary counter

Division IV. Specific Equipment

A. Units of Instruction
   1 . Oscilloscope
   2. Signal generators
   3. Tube and transistor checkers

B . Laboratory Projects
   1. Analysis of waveforms with the oscilloscope
   2. Distortion measurement with the dual-trace oscilloscope

Division V. Testing

A. Units of Instruction
   1. Component testing
   2. Audio-frequency methods
   3. Radio-frequency methods

B. Laboratory Projects
   1 . Use of the tube tester and transistor curve tracer
   2. Use of the impedance bridge
   3. Determination of capacitance
   4. The “Q” of a circuit

Division VI. Other Instruments

A. Units of Instruction
   1. Radiation detecting
   2. Counting and display instruments
   3. Analog computers
   4. Specialized application

EET 413, cont.

B. Laboratory Projects
   1. The analog computer
   2. The MHz counter

Texts and References

Prensky, "Electronic Instrumentation"

EET 415: INDUSTRIAL CONTROLS

Hours Required

Class, 3; Laboratory, 3.

Course Description

The mechanics and science of electrical instrumentation. Basic and remote indicating devices and supervisory controls are studied. Servomechanisms and other control and positioning devices as used in automated systems are included. The chief objectives of the course are as follows:

(1) To provide for the student a basic coverage of the several means by which electrical principles are used in the field of instrumentation and servomechanisms.

(2) To cover for the student some of the basic physical and electrical laws governing measurements.

(3) To acquaint the student with an improved concept of the facets of sensitivity, accuracy and error as they apply to electrical measurement of physical phenomena.

(4) To encourage the student to apply his present knowledge of electrical laws and fundamentals to solution of measurement and problems.

Major Divisions

		Hours Lec.	Lab.
I.	Measurement Concepts	2	0
II.	Heat and Heat Transfer	2	6
III.	Saturable-Core Reactors and Magnetic Amplifiers	1	0
IV.	Pressure Measurement Electrical Transducers	3	3
V.	Flow Measurement Electrical Transducers	2	3
VI.	Liquid-Level Electrical Transducers	2	6
VII.	Temperature Measurement Electrical Transducers	4	3
VIII.	Potentiometric Devices	4	3
IX.	Indicating and Registering Equipment	4	3
X.	Analysis Systems	1	3
XI.	Measurement with Radio-isotopes	2	0
XII.	Humidity Measurement	1	0
XIII.	pH Measurement	1	0
XIV.	Closed-Loop Control Systems	1	0
XV.	Error Detectors	1	0
XVI.	Synchros	2	0
XVII.	Servo Motors	1	0
XVIII.	Error Amplifiers	6	12

Division I. Measurement Concepts

Units of Instruction

1. Sensitivity
2. Accuracy
3. Error
4. Concept of instrument measurement

Division II Heat and Heat Transfer

A. Units of Instruction
   1. Factors
   2. Time constants
   3. Materials
   4. Radiation instruments
   5. Electrical analogies
   6. Response of thermal bulbs

B. Laboratory Projects
   1. Properties of liquid-filled bulbs for temperature measurement
   2. Determination of time constants

Division III. Saturable-Core Reactors and Magnetic Amplifiers

Units of Instruction

1. Principles of operation
2. The two-window core
3. Hysteresis and phase relations
4. Saturation
5. Amplifiers

Division IV. Pressure Measurement Electrical Transducers

A. Units of Instruction
   1. Heat conduction gauges
   2. Thermocouple gauges
   3. Ionization gauges
   4. Mechanical-electrical pressure transducers
   5. Potentiometric devices

6. Manometer gauges
7. Electropneumatic transducers
8. Other pressure transducers
9. Differential transformer transducers

B. Laboratory Projects
Characteristics of common pressure-measuring transducers

Division V. Flow Measurement Electrical Transducers

A. Units of instruction
1. Magnetic flowmeter
2. Other electric flowmeters
3. Dry material flow measurement

B. Laboratory Projects
Characteristics of strain gauges and other electric flowmeters

Division VI. Liquid-Level Electrical Transducers

A. Units of Instruction
1. Probe-type level detectors
2. Thermistor-type
3. Fathometers
4. Capacitance level gauges
5. Radiation level gauges
6. Dry material level gauges
7. Weight indicators
8. The "foot-inch" gauge

B. Laboratory Projects
Construction and characteristics of a capacitance level gauge

Division VII. Temperature Measurement Electrical Transducers

A. Units of Instruction
1. Resistance thermometer
2. Capacitance bridge
3. Temperature difference measurements
4. Thermocouples
5. Indicating and recording instruments

B. Laboratory Projects
Characteristics of thermocouples and temperature-recording instruments

Division VIII. Potentiometric Devices

A. Units of Instruction
1. Common types
2. Automatic bridge balancing

B. Laboratory Projects
Precision temperature measurement with a potentiometer

Division IX. Indicating and Registering Equipment

A. Units of Instruction
1. Recording devices
2. Data logging
3. Other scanning-logging systems

B. Laboratory Projects
Characteristics of strip-and circular-chart recorders

Division X. Analysis System

A. Units of Instruction
1. Thermal conductivity gas analyzers
2. Mass spectrometers

B. Laboratory Projects
1. Use of the thermal conductivity detector in gas analysis

Division XI. Measurement with Radioisotopes

Units of Instruction
1. Radioactivity
2. Types of radiation
3. Thickness gauges
4. Liquid-level gauges
5. Density gauges
6. Radioisotopes as tracers

Division XII. Humidity Measurement

Units of Instruction
1. Principles, devices, and methods
2. Installation and operation

Division XIII. pH Measurement

Units of Instruction
1. Principles, devices, and applications
2. Application notes

Division XIV. Closed-Loop Control Systems

Units of Instruction
1. Open-loop vs. closed-loop systems
2. Servomechanism principles
3. Servomechanism components

Division XV. Error Detectors

Units of Instruction

1. Position-sensing transducers
2. Temperature transducers
3. Pressure transducers
4. Flow transducers

Division XVI. Synchros

Units of Instruction

Principles, operation, and applications of synchros

Division XVII. Servo Motors

Units of Instruction

Theory, construction, and applications of servo motors

Division XVIII. Error Amplifiers

A. Units of Instruction

Theory and applications of error amplifiers

B. Laboratory Projects

Group project (4 weeks): Write a 1,000-word critique of the design of some instrument (e.g., a scanning alarm system) and tell how it might be improved.

EET 416: ELECTRONIC COMMUNICATIONS

Hours Required

Class, 3; Laboratory, 3.

Course Description

Theory and design of electronic circuits utilized in electronic communications. A study of basic transmitters and receivers, including oscillators, radio-frequency amplifiers, frequency multipliers, and antennas. Objectives of the course are to give the student a thorough background in communications and to prepare the student for the FCC Radiotelephone Operator's License examination.

Major Divisions

		Hours Lec.	Lab
I.	Review and Introduction to Oscillators	8	3
II.	Oscillator identification and Familiarization	2	3
III.	Transistor Oscillators	2	3
IV.	Feedback	2	3
V.	Class A-C Amplifiers	2	9
VI.	Transmitters and Receivers	4	3
VII.	Amplitude Modulation	2	3
VIII.	Frequency Modulation	2	3
IX.	Pulse Modulation	2	3
X.	Propagation of Radio Waves	2	0
XI.	Antennas	4	6
XII.	FCC Regulations	8	0

Division I. Introduction to Oscillators
- A. Units of Instruction
  1. Oscillators as periodic devices
  2. Conversion from D.C. to oscillatory power
- B. Laboratory Projects
  Frequency measurement in the RF range

Division II. Oscillator Identification and Familiarization
- A. Units of Instruction
  Circuits of all common RF oscillators
- B. Laboratory Projects
  Construction and characteristics of common oscillators

Division III. Transistor Oscillators
- A. Units of Instruction
  1. Low frequency oscillators
  2. Radio frequency oscillators
  3. Point-contact transistor oscillator
- B. Laboratory Projects
  Construction and characteristics of transistor oscillators

Division IV. Feedback
- A. Units of instruction
  1. Principles
  2. Negative feedback and gain stability
  3. Negative feedback and distortion
  4. Negative feedback and noise
  5. Negative feedback circuits
- B. Laboratory Projects
  Comparison and contrast of amplifiers with and without negative feedback

Division V. Class A-C Amplifiers
- A. Units of Instruction
  1. Characteristics
  2. Harmonic content of amplifiers
  3. Power output
  4. Power input plate dissipation and plate circuit efficiency
  5. Problems of amplifiers
- B. Laboratory Projects
  1. The triode amplifier
  2. The phase inverter
  3. The push-pull amplifier

Division VI. Transmitters and Receivers
- A. Units of Instruction
  1. Tuned amplifiers and transmitters
  2. Calculation and design
  3. Practical adjustment
  4. Harmonic generators and oscillators
  5. Linear amplification of wideband signals
- B. Laboratory Projects
  AM signal transmission and detection

Division VII. Amplitude Modulation
- A. Units of Instruction

1. Principles
2. Sidebands
3. Methods of achieving
4. Carrier suppression and single sideband

B. Laboratory Projects

The single sideband radio receiver

Division VIII. Frequency Modulation

A. Units of Instruction

1. Analysis of FM waves
2. Frequency spectrum of FM waves
3. Phase Modulation
4. Relationship to AM waves

B. Laboratory Projects

FM signal transmission and detection

Division IX. Pulse Modulation

A. Units of Instruction

1. Pulse amplitude modulation
2. Pulse position modulation
3. Pulse code modulation
4. Pulse duration modulation
5. Pulse frequency modulation

B. Laboratory Projects

Laboratory examination over material to date

Division X. Propagation of Radio Waves

Units of Instruction

1. Factors affecting propagation
2. The ground wave
3. Reflection of waves by earth
4. Atmospheric effects
5. Effects of the ionosphere
6. Noise and static
7. Frequency effects

Division XI. Antennas

A. Units of Instruction

1. Radiation from doublet antenna
2. Directive gain
3. Antenna arrays
4. Image antennas
5. Grounded antennas
6. Impedance and mutual impedance
7. Impedance matching
8. Practical transmitting antennas

B. Laboratory Projects

1. Characteristics of transmitting antennas
2. Characteristics of receiving antennas

Division XII. FCC Regulations

Units of Instruction

1. Station application and licenses
2. Penalties
3. Logs
4. Equipment

Texts and References

Shrader, "Electronic Communications," Second Edition, McGraw-Hill.

Kaufman, "Radio Operator's License Q&A Manual," Rider.

EET 418: ELECTRICAL, ELECTRONIC LOGIC

Hours Required

Class, 3; Laboratory, 3.

Course Description

Design of basic computers and switching circuits including electronic logic and programming. A detailed study of the applications of Boolean algebra to electrcial and electronic problems.

Major Divisions

	Hours Class	Hours Laboratory
I. Number Systems ...	4	0
II. Basic Arithmetic Operations	5	0
III. Boolean Algebra ...	14	0
IV. Circuit Simplification .	2	0
V. Circuit Synthesis ...	12	0
VI. Computer Operation ..	2	3
VII. Programming	6	42

Division I. Number Systems
- A. Units of Instruction
  1. Decimal
  2. Binary
  3. Ternary
  4. Any radix
  5. Gray and other special codes
  6. Radix conversion

Division II. Basic Arithmetic Operations
- A. Units of Instruction
  1. Binary addition and subtraction
  2. Decimal subtraction by complements
  3. Binary subtraction by complements
  4. Binary multiplication
  5. Binary division
  6. Special code arithmetic

Division III. Boolean Algebra
- A. Units of Instruction
  1. Fundamental topics
  2. Switching diagram notation
  3. Logic diagram notation
  4, Universe table
  5. Truth table
  6. Duality
  7. Negation

Division IV. Circuit Simplification
- A. Units of Instruction
  1. Inference
  2. Algebraic reduction
  3. Matrix reduction
  4. Karnaugh Map technique

Division V. Circuit Synthesis
- A. Units of Instruction
  1. Specification analysis
  2. System states
  3. State diagrams
  4. Sequential logic
  5. Parity checks

Division VI. Computer Operations
- A. Units of Instruction
  1. History
  2. Analog and digital
  3. Calculator and computer
- B. Laboratory Projects
  1. Familiarization with operating procedure - machine log, card reading, card punch operation, starting and stopping computer.

Division VII. Porgramming
- A. Units of Instruction
  1. High level
  2. Low level
  3. Compiling,
  4. Logical
  5. Fixed word lingth
  6. Variable word length
- B . Laboratory Projects (3 weeks each)
  1. Assembling and executing programs on the 1401 computer
  2. Write program for solution of assigned problem. Grade of A if execution yields right answer first time, etc.
  3. Write and execute program to calculate current, capacitance, and phase angle in parallel R-L-C circuit.

EET 418, cont.

4. Write program to display truth table from assigned switching diagrams.

Texts and References

Gillis, "Binary Arithmetic and Boolean Algebra," McGraw-Hill.

Bartee, "Digital Computer Fundamentals," Second Edition, McGraw-Hill.

McCracken, "A Guide to Fortran IV Programming," John Wiley.

EET 419: PULSE CIRCUITS

Hours Required

Class, 3; Laboratory, 3.

Course Description

Design of trigger circuits, multivibrators, binary counters, and basic computer circuits. Applications of pulse generators, shaping and synchronizing circuits. Laboratory experiments including waveform and cirucit analysis. Objectives of the course are: (1) To become familiar with basic computer logical circuits including AND, OR, NAND. NOR & Inverters. (2) To learn the basic computer elements including arithmetic, control, storage, and input/output. (3) To learn rudimentary design of basic computer circuits including multivibrators, clampers limiters, and problems associated with triggering, gating and synchroization.

Major Divisions

	Class Hours	Laboratory Hours
I. Number Systems	3	9
II. Logical Circuits	1	18
III. Logical Design	10	0
IV. Computer Elements: Arithmetic Element	8	3
V. Computer Elements: Memory Element	4	0
VI. Computer Elements: Input/Output Element	2	0
VII. Computer Elements: Control	5	0
VIII. Source Voltage Generation	1	3
IX. Clamping Circuits	1	0
X. Dual -Transistor Switching	2	0
XI. Triggering, Gating, and Synchronizing	5	6

Division I. Number Systems
- A. Units of Instruction
  1. Decimal
  3. Binary arithmetic operations
  4. Parallel and serial transmission
- B. Laboratory Projects
  1. Binary counters
  2. Binary-coded decimal counters
  3. Non-sequential counters

Division II. Logical Circuits
- A. Units of Instruction
  1. Transistors in switching
  2. Transistor circuit configurations
  3. AND-OR gates
  4. NAND-NOR gates
  5. Inverters
  6. High level, low level logic
  7. Transistor flip-flop
  8. RTL, DTL, DCTL logic
- B. Laboratory Projects
  1. The AND gate
  2. The OR gate
  3. The NAND gate
  4. The NOR gate
  5. Inherent circuit delays
  6. Clock pulses

Division III. Logical Design
- A. Units of Instruction
  1. Boolean algebra
  2. Logical expressions
  3. Complementation
  4. Fundamental theorems
  5. Truth tables
  6. Switching diagrams
  7. Logical diagrams
  8. Possible functions
  9. Sequential design

Division IV. Computer Elements: Arithmetic Element
- A. Units of Instruction
  1. Basic register operations
  2. Binary half adder and full adder
  3. Parallel and serial adder
  4. Shift register
  5. Negative numbers
  6. Binary half subtracter and full subtracter
  7. Decimal adder

8. Multiplication
9. Division

B. Laboratory Projects
1. The serial adder

Division V. Computer Elements: Memory Element
A. Units of Instruction
1. Magnetic core storage
2. Timing sequence
3. Memory address and buffer
4. Magnetic film memory
5. Magnetic drum storage
6. Magnetic disk
7. Magnetic tape
8. Tunnel diode logic

Division VI. Computer Elements: Input-Output Element
A. Units of Instruction
1. Perforated tape and readers
2. Punched cards and readers
3. Buffers
4. Printers
5. Analog-to-digital converters
6. Decoders

Division VII. Computer Elements: Control
A. Units of Instruction
1. Instruction word
2. Multiple address
3. Sequence of operation
4. Branch and shift
5. Index registers
6. Floating-point operation

Division VIII. Source Voltage Generation
A. Units of Instruction
1. Rectangular
2. Trapezoidal
3. Pulse
B. Laboratory Projects
1. Threshold voltage and noise margin

Division IX. Clamping Circuits
A. Units of Instruction
1. General discussion
2. Clamp to a DC level

Division X. Dual-Transistor Switching
A. Units of Instruction
1. Transistor blocking oscillator
2. Astable multivibrator
3. Bistable multivibrator
4. Monostable multivibrator
5. Schmitt trigger

Division XI. Triggering, Gating, and Synchronizing
A. Units of Instruction
1. Triggering in transistor circuits
2. Synchronizing in astable circuits
3. Gating in AND, OR, NAND, NOR circuits
B. Laboratory Projects
1. Flip-flop trigger circuits
2. Flip-flop trigger levels

Texts and References

Bartee, "Digital Computer Fundamentals," Second Edition, McGraw-Hill.
Babb, "Pulse Circuits: Switching and Shaping," Prentice-Hall.

SUPPORTING COURSE OUTLINES

ENGLISH 601a: FRESHMAN READING AND COMPOSITION

Hours Required

Class, 3; Laboratory, 0.

Course Description

The purpose of this course is to improve the student's skill in forming and expressing thought in sentence, paragraph, and theme; to improve his knowledge and use of mechanics of composition; and to improve his ability to comprehend, to analyze the written word; and to develop in the student an ability to analyze and discuss ideas critically.

Major Divisions

		Hours
I.	Introduction Use of Dictionary	4
II	Use of Writer's Handbook	5
III.	Theme Writing, Minimum Terminology	3
IV.	Outlines, Expository and Persuasive Themes	5
V.	Paragraph Writing	4
VI.	Writing the Research Paper	5
VII.	Style, Usage, Definition	7
VIII.	Improving Sentence Structure	7
IX.	Summary and Review	5

Division I. Introduction, Use of Dictionary
Units of Instruction
1. Importance of definitive writing
2. Use of dictionary

Division II. Use of Writer's Handbook
Units of Instruction
I. Notes
2. Using the handbook to correct errors
3. Use of examples to get started

Division III. Theme Writing, Minimum Terminology
Units of Instruction
I. The writing process
2. Minimum terminology
3. Descriptive and narrative style
4. Examination

Division IV. Outlines, Expository and Persuasive Themes
Units of Instruction
I. English in business
2. Importance of outlines
3, Persuasive writing
4. Expository writing
5. Class theme

Division V. Paragraph Writing
Units of Instruction
1 Development of the paragraph
2. Definition
3. Illustration
4. Comparison and contrast

Division VI. Writing the Research Paper
Units of Instruction
1. Putting it all together
2. Library familiarization
3. Library assignment
4. Examination

Division VII. Style, Usage, Definition
Units of Instruction
1. Exposition and style
2. Diction
3. Narration
4. Class theme

Division VIII. Improving Sentence Structure
Units of Instruction
I. Usage, connotation, and denotation
2. Writing the forceful sentence
3. Examination

Division IX. Summary and Review
Units of Instruction
I. Minimum terminology
2. Class theme
3. Review for final examination

English 601a, cont.

Texts and References

Norman Brittin, "A Writing Apprenticeship," Second Edition

C.B. Spotts, "Ideas and Patterns for Writing"

L. J. Martin, "The Five-Hundred Word Theme"

Leggett, Mead, and Chavat, "Prentice-Hall Handbook for Writers," Fourth Edition

ENGLISH 304: TECHNICAL WRITING

Hours Required

Class, 3; Laboratory, 0.

Course Description

The purpose of this course is to acquaint the student with the skills required by industry to explain facts, expound theory and principles, and to analyze concepts, objects, processes, events, and data.

Major Divisions

		Hours
I.	Researching and Organizing the Report Data	3
II.	Elements of the Report and Graphic Aids.	3
III.	Grammar and Mechanics	3
IV.	Technical Correspondence	27
V.	Conferences	6
VI.	Report Form and Format	6
VII.	Oral Reporting	6

Division I. Researching and Organizing the Report Data

Units of Instruction

1. Use of the library
2. Systematic note-keeping
3. Outlining the report

Division II. Elements of the Report and Graphic Aids

Units of Instruction

1. Report objectives
2. Organization of data
3. Presentation of facts
4. Use of graphs and illustrations

Division III. Grammar and Mechanics

Units of Instruction

1. Importance of proper grammar
2. Composition and form
3. Footnotes and references

Division IV. Technical Correspondence

Units of Instruction

1. Business letters
2. Letters of inquiry
3. Claim letters
4. Adjustment letters
5. Memoranda
6. Letters of instruction
7. Resumes

Division V. Conferences

Units of Instruction

Personal conference with student to answer questions regarding term paper

Division VI. Report Form and Format

Units of Instruction

1. Correct technical paper form
2. Supplementary material: title page, table of contents, appendices, indices
3. Importance of format

Division VII. Oral Reporting

Units of Instruction

Individual presentation of term papers and group discussion of contents and presentation

Texts and References

Hook, "Writing the Research Paper," Fourth Edition, Prentice-Hall.
Weisman, "Basic Technical Writing," Merrill.

GOVERNMENT 610a: AMERICAN GOVERNMENT

Hours Required

Class, 3; Laboratory, 0.

Course Description

The state and government; the rise of constitutionalism; the American constitutional system including the federal constitution, state constitutions, and the Texas constitution; the federal system and its relation to the states; the position of the individual; political parties; suffrage and elections.

Major Divisions

		Hours
I.	Introductory Political Science	2
II.	Dynamic Forces and Challenges	3
III.	Basic Features of the American System	4
IV.	From Seaboard Settlements to Nationhood	3
V.	The More Perfect Union	1
VI.	Federalism - American Model	4
VII.	Inter-Governmental Relations	4
VIII.	State Constitutions and Powers	2
IX.	The Texas Constitution	3
X.	First Amendment Freedoms	2
XI.	Toward Equality and Fairness	2
XII.	Citizens and Voters	2
XIII.	Opinion and Group Politics	3
XIV.	Party Politics	3
XV.	The Electoral Process	3

Division I. Introductory Political Science

A. Units of Instruction
1. Scope of political science
2. Definition of terms
3. Types of government

Division II. Dynamic Forces and Challenges

A. Units of Instruction
1. Expanding population
2. Internationalism
3. Economic problems

Division III. Basic Features of the American System

A. Units of Instruction
1. The system as a product of western civilization
2. Republican government
3. Evolution of the system

Division IV. From Seaboard Settlements to Nationhood

A. Units of Instruction
1. Colonial governments
2. Articles of Confederation
3. Evolution from English origins

Division V. The More Perfect Union

A. Units of Instruction
1. The Constitutional convention
2. Clash and compromise

Division VI. Federalism - American Model

A. Units of Instruction
1. Evaluation of American federalism
2. Federalism and the supreme law
3. Delegation of powers

Division VII. Inter-Governmental Relations

A. Units of Instruction
1. Relations among the states
2. State vs. federal powers
3. Centralizotion of powers

Division VIII. State Constitutions and Powers

A. Units of Instruction
1. Features common to all state goverments
2. The state as a unitary organization
3. Length and detail of state constitutions

Division IX. The Texas Constitution

A. Units of Instruction
1. History
2. Constitution of the Republic
3. First state constitution
4. Reconstruction and the constitution of 1876

5. Chances for a new constitution

Division X. First Amendment Freedoms
- A. Units of Instruction
  1. Civil rights
  2. Freedom of communication
  3. Relative vs. absolute rights

Division XI. Toward Equality and Fairness
- A. Units of Instruction
  1. Due process
  2. Challenge to discrimination
  3. 5th and 14th Amendments

Division XII. Citizens and Voters
- A. Units of Instruction
  1. U. S. citizenship
  2. Immigration laws
  3. Requirements for voters

Division XIII. Opinion and Group Politics
- A. Units of Instruction
  1. Public opinion
  2. Influence of propaganda and censorship
  3. Political pressure groups
  4. Public opinion polls

Division XIV. Party Politics
- Units of Instruction
  1. Elections and parties
  2. Political issues and divisions
  3. Development of American political parties
  4. Selection and organization of a party

Division XV. The Electoral Process
- A. Units of Instruction
  1. Development of the nominating process
  2. Nomination of presidential candidates
  3. Constitutional provisions
  4. Primaries
  5. National elections
  6. The electoral college

<u>Texts and References</u>

Ferguson and McHenry, "The American System of Government."

McCleskey, "The Government and Politics of Texas."

MATHEMATICS 309: COLLEGE ALGEBRA

Hours Reauired

Class, 3; Laboratory, 0.

Course Description

A study of the fundamentals of algebra, including sets and numbers, algebra as a logical system, factoring, fractions, exponents and radicals, functions and their graphic representation, linear and quadratic equations, determinants, mathematical induction, and progressions.

Major Divisions

		Hours
I.	Review of Fundamentals	6
II.	The Number System of Algebra	3
III.	Axioms of a Field, Order Equations.	6
IV.	Linear and Fractional Equations.. ..	6
V.	Functions and Graphs..	3
VI.	Systems of Equations	6
VII.	Inequalities	3
VIII.	Determinants and Matrices	6
IX.	Progressions	3
X.	Binomial Theorem	3
XI.	Mathematical Induction	3

Division I. Review of Fundamentals

Units of Instruction

1. Addition and subtraction
2. Multiplication and division
3. Factoring
4. Exponents and radicals

Division II. The Number System of Algebra

Units of Instruction

1. Sets
2. The natural numbers
3. The real-number system

Division III. Axioms of a Field, Order Axioms

Units of Instruction

1. The order relations
2. Law of signs

Division IV. Linear and Fractional Equations

Units of Instruction

1. Linear equations in one unknown
2. Fractional equations
3. Solution of stated problems

Division V. Functions and Graphs

Units of Instruction

1. Ordered pairs of numbers
2. Functions
3. The graph of a function
4. Special functions
5. The inverse of a function

Division VI. Systems of Equations

Units of Instruction

1. Equations in two variables
2. Graphical solution of a system of equations
3. Consistent, inconsistent, and dependent equations
4. Algebraic methods of solution
5. Problems leading to systems of equations

Division VII Inequalities

Units of Instruction

1. Fundamental axioms and theorems
2. Conditional inequalities
3. Conditional inequalities involving absolute values

Division VIII. Determinants and Matrices

Units of Instruction

1. Determinants of the second order
2. Determinants of the third order
3. Matrices

Division IX. Progressions

Units of Instruction

1. Arithmetic progressions
2. Geometric progressions
3. Harmonic progressions

Division X. Binomial Theorem

Units of Instruction

1. The binomial formula
2. The r th term of the binomial formula
3. Binomial theorem for fractional and negative exponents

MATHEMATICS 309, cont.

Division XI. Mathematical Induction

Units of Instruction

Method of mathematical induction

Texts and References

Rees and Sparks, "College Algebra," McGraw-Hill.

MATHEMATICS 304: TRIGONOMETRY

Hours Reauired

Class, 3; Laboratory, 0.

Course Description

The aims of this course are to give the student a general understanding of the laws and principles of trigonometry, to prepare the student for analytic geometry and calculus, and to reveal something of the nature of mathematical thought to the terminal mathematics student.

Major Divisions

		Hours
I.	Review of Algebra	6
II.	Circular Functions	18
III.	Inverse Functions and Trigonometric Equations	9
IV.	Logarithms	6
V.	Angles and Applications	4
VI.	Complex Numbers	4

Division I. Review of Algebra
Units of Instruction
1. Functions
2. Order
3. Absolute value
4. Mathematical induction
5. Distance

Division II. Circular Functions
Units of Instruction
1. Properties of functions
2. Graphs of functions
3. The trigonometric functions
4. Relations among the functions
5. Periodic functions
6. Circular angles

Division III. Inverse Functions and Trigonometric Equations
Units of Instruction
1. Graphs of the inverse trigonometric functions
2. Principal values
3. Relations among the inverse functions
4. Trigonometric equations
5. Equations involving inverse functions

Division IV. Logarithms
Units of Instruction
1. Laws of exponents
2. Laws of logarithms
3. Common logarithms
4. Change of logarithm base

Division V, Angles and Applications
Units of Instruction
1. Trigonometric functions of an acute angle
2. Use of tables
3. Finding heights and distances by trigonometry

Division VI. Complex Numbers
Units of Instruction
1. Geometrical representation of a complex number
2. Polar form of a complex number
3. Multiplication of complex numbers in polar form
4. De Moivre's theorem
5. Exponential forms of a complex number

Texts and References

Robinson, "Analytical Trigonometry," Harper and Row.

MATHEMATICS 305: ANALYTIC GEOMETRY

Hours Required

Class, 3; Laboratory, 0.

Course Description

A study of lines, conics, functions, and intuitive calculus. Objectives are to provide the student with the mathematical foundation and maturity necessary for future work in mathematics, science, and engineering .

Maior Divisions

		Hours
I.	Slopes and Tangents	6
II.	Distance, Velocity, and Acceleration	6
III.	Maxima and Minima	3
IV.	Sequences, Limits, and Derivatives	6
V.	Derivatives of Functions	6
VI.	Tangents, Derivatives, and Graphs	6
VII.	Further Applications of Derivatives	3
VIII.	Solutions of $D_x Y = f(x)$	3
IX.	Areas	3
X.	Trigonometric Functions	6
XI.	Exponential and Logarithmic Functions	3

Division I. Slopes and Tangents

Units of Instruction

1. Equations of lines
2. Parallelism
3. Equation of the tangent

Division II. Distance, Velocity, and Acceleration

Units of Instruction

1. Rectilinear motion
2. The equations of motion
3. Slope, velocity, and acceleration
4. Distance as an area

Division III. Maxima and Minima

Units of Instruction

1. Local maxima and minima
2. Direction of concavity
3. Inflection points

Division IV. Sequences, Limits, and Derivatives

Units of Instruction

1. Limits of functions
2. The derivative as a limit

Division V. Derivatives of Functions

Units of Instruction

1. The process of differentiation
2. Derivatives of constants
3. Derivatives of functions
4. Derivatives of products and quotients

Division VI. Tangents, Derivatives, and Graphs

Units of Instruction

1. Geometric properties of the derivative
2. The second derivative

Division VII. Further Applications of Derivatives

Units of Instruction

1. Rate problems
2. Distance-velocity-acceleration problems
3. Applications to maxima and minima

Division VIII. Solutions of $D_x\ Y = f(x)$

Units of Instruction

1. The integration process
2. Definite and indefinite integrals

Division IX. Areas

Units of Instruction

1. Integration as a process of summation
2. Approximate methods
3. Areas beneath curves

Division X. Trigonometric Functions

Units of Instruction

1. Directed angles
2. Derivatives of trigonometric functions

MATHEMATICS 305, cont.

3. The chain rule
4. The inverse trigonometric functions

Division XI. Exponential and Logarithmic Functions

Units of Instruction

1. The functions In and exp
2. The existence of e

<u>Texts and References</u>

Moise, "Calculus: Part I," Addison-Wesley

SELECTED BIBLIOGRAPHY

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H. Barnes, "Oceanography and Marine Biology," MacMillan.
R. Carson, "The Edge of the Sea," Houghton-Mifflin.
R. E. Coker, "This Great and Wide Sea," University of North Carolina Press.
A. Defont, "Physical Oceanography," (2 Volumes), Pergamon.
H. W. Harvey, "The Chemistry and Fertility of Sea Waters," Cambridge University Press.
W. A. Herdman, "Founders of Oceanography and Their Work," Edward Arnold.
R. A. Horne, "Marine Chemistry," John Wiley.
Hans Huass, "Fishes of the World," E. P. Dutton.
C. A. M. King, "An Introduction to Oceanography," McGraw-Hill.
D. J. Martin, "Marine Chemistry," (2 Volumes), Marcel Dekker.
H. J. McLellan, "Elements of Physical Oceanography," Pergamon.
H. W. Menard, "Marine Geology of the Pacific," McGraw-Hill.
R. W. Miner, "Field Book of Seashore Life," Putnam.
H. B. Moore, "Marine Ecology," John Wiley.
G. L. Pickard, "Descriptive Physical Oceanography," Pergamon.
F. P. Shepard, "The Earth Beneath the Sea," John Hopkins University Press.
E. Sondheimer and J. B. Simeone, "Chemical Ecology," Academic Press.
J. A. Stewart, "Coasts, Waves, and Weather for Navigators," Ginn.
H. U. Sverdrup, M. W. Johnson, and R. H. Fleming, "The Oceans," Prentice-Hall.
Karl Turekian, "Oceans," Prentice-Hall
H. W. Vogel and M. L. Caruso, "The Future of Oceanography," Knopf.
P. K. Weyl, "Oceanography," John Wiley .

STUDENT SELECTION

STUDENT SELECTION

Initially, it was decided to select twenty high school graduates to participate in this program. Applicants were chosen on the basis of (1) academic achievement, (2) ACT or SAT test score results, (3) physical ability to function in the ocean environment and (4) aptitude or interest in Marine Science at all levels.

Each applicant was screened by a special admissions committee after individual interviews. Swimming requirements were established and applicants were tested. Each applicant was pre-tested aboard a research vessel under actual operating conditions. A physical examination was required.

Due to the nature of this educational program, each student was required to execute a "waiver of responsibility for bodily harm or loss of life." Parents of applicants under 21 years of age were required to sign a waiver prior to admission.

Selection Procedure

Interested students made the initial contact with the Director of Counseling or Marine Science Project Co-ordinator. This meeting was an attempt to (1) inform the student of the nature of the program, (2) discuss documents required for application, and (3) explain the mechanics of selection and actual registration. All candidates for this program were required to meet established entrance requirements listed above.

August 8, 1969, was set as the deadline for receipt of applications. On that date 28 applications had been received. Applications and documents of those 28 students who met requirements for enrollment at Del Mar were duplicated for use by the admissions committee. The committee first met on August 11, 1969, and accepted 15 students. The remainder of the class was selected on an individual basis until registration. The committee attempted to select on the basis of test scores and academic achievement, however, the experimental nature of the program was felt to be a factor in determining the types of individuals who applied. Therefore, the individual interview became a

Student Selection, cont.

rather subjective attempt to select those students by considering numerous personality factors and individual motivation as well as academic achievement. In addition, each candidate was scheduled a trip on the research vessel in order to gain a better understanding of ship board duties and responsibilities. A final selection of 26 students was made by the Selection Committee.

Services and follow-up activities

The counseling office attempted to aid in establishing rapport with the students selected by group meeting. The 16 P.F. Form "C" was administered in an attempt to learn the type of individuals who were in the program. As a group, they tended toward inner tension and projection; to be somewhat self-absorbed; more experimenting and less careful of protocol. Other data studied revealed: (ACT composite score range 5-25, ACT composite mean score 18.4, Average age 19 years 6 months.)

Mid-term saw a withdrawal of 13 of the original students selected. Grades and other data were studied, with view toward determining reason for high rate of withdrawal. Student opinions were surveyed by individual interview and it was recommended at that time to reduce the number of semester hours for beginning students, and also to attempt a more flexible curriculum with greater emphasis toward science. Additional students enrolled for spring semester to bring the group to about 16 in number. End of year one brought another group of withdrawals so that the second year began with about 7 students.

Conclusion

Data obtained during this project seem to indicate that the average MST student is individualistic, free-thinking, and not inclined to self-discipline. The students as a group showed a great deal of interest in the Marine Science courses and in the sciences but showed little interest in the electronics portion of the curriculum. Student interest was at its highest while the students were performing activities aboard the research vessel.

Student Selection, cont.

Many of the students indicated that they were uncertain about the nature of the program but decided to give it a try on the grounds that it more nearly matched their interests than any other available curriculum. These students, most of whom dropped from the program at the end of the first semester, were of two types: science-oriented students who really wished to pursue a pure-science curriculum, and water-dwellers who felt that the program would satisfy their desire to be on the water. Greater care should have been taken to explain to these students the technological nature of the program, and student selection should have been based more on electronics aptitude than interest in marine-oriented activities.

INSTRUCTIONAL AIDS

INSTRUCTIONAL AIDS

The development of instructional aids used in the marine science courses fell within the area, graphs, maps, and data sheets needed in the collection and recording of scientific information. As the accuracy of data collection is extremely important, the technician must have an organized procedure in carrying out his duties. To achieve this, the following forms, maps, and data information sheets were developed and used in the training of the marine science-electronic technician.

Many of these data records and report forms were devised by students and the instructional staff during the progress of the MST courses. It was felt that by devising cumulative records such as Figure 5, the student would recognize the difficulties inherent in designing a form to report several hundred individual data bits and yet make the overall trends of the data immediately recognizable.

RECORD FILING

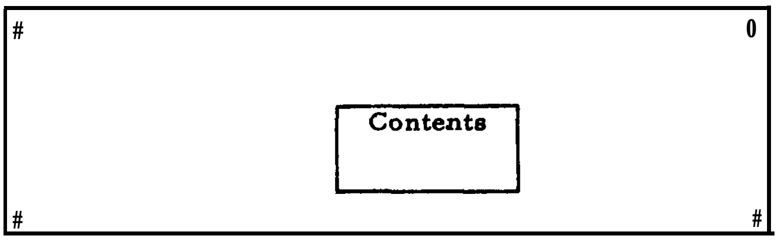
* I. All records should be filed in cabinet except when in use or drying

* II. Records should be filed before next scheduled class (5-7 days)

III. Records filed by run number

IV. Master Record Map and Grid Cards updated when filed

V. Record envelope marking:



CONTENTS

Run #.
Date:
Lines: (Lat. or Long.)-,(B, SB)-(PDR-Code, ORE-FREQ)

CODE: EC 12- Edo XDCR , Gifft Recorder 12K Hz
EG 34-Edo XDCR, Gifft Recorder 34KHz
EX - Edo XDCR, Edo XCVR
EO (freq)- Edo XDCR, Hydro Products XCVR (freq)

* Groups graded weekly on status of records.

Figure 1. Instructions for Filing Seismic Data, MST 211 and 415.

SOUTHWEST RESEARCH INSTITUTE

San Antonio, Texas 78228

Page:______________

Project:______________

pH Supporting Data

BUFFER ______

SCALE ______

ASYMMETRY ______

TEMPERATURE ______

HY-TECH SALINOMETER DATA SHEET

SAMPLE Number	RAW Cond.Ratio	TEMP. Degrees C.	TEMP. Correction	Corrected Cond.Ratio	RAW Salinity	DRIFT Correction	Salinity	pH	D. O.

Date:______________ Signature:______________

Figure 2. Data Work-Up Sheet for Laboratory Salinometer, MST 403.

DATE: ______________

______________ Profile of Corpus Christi Bay

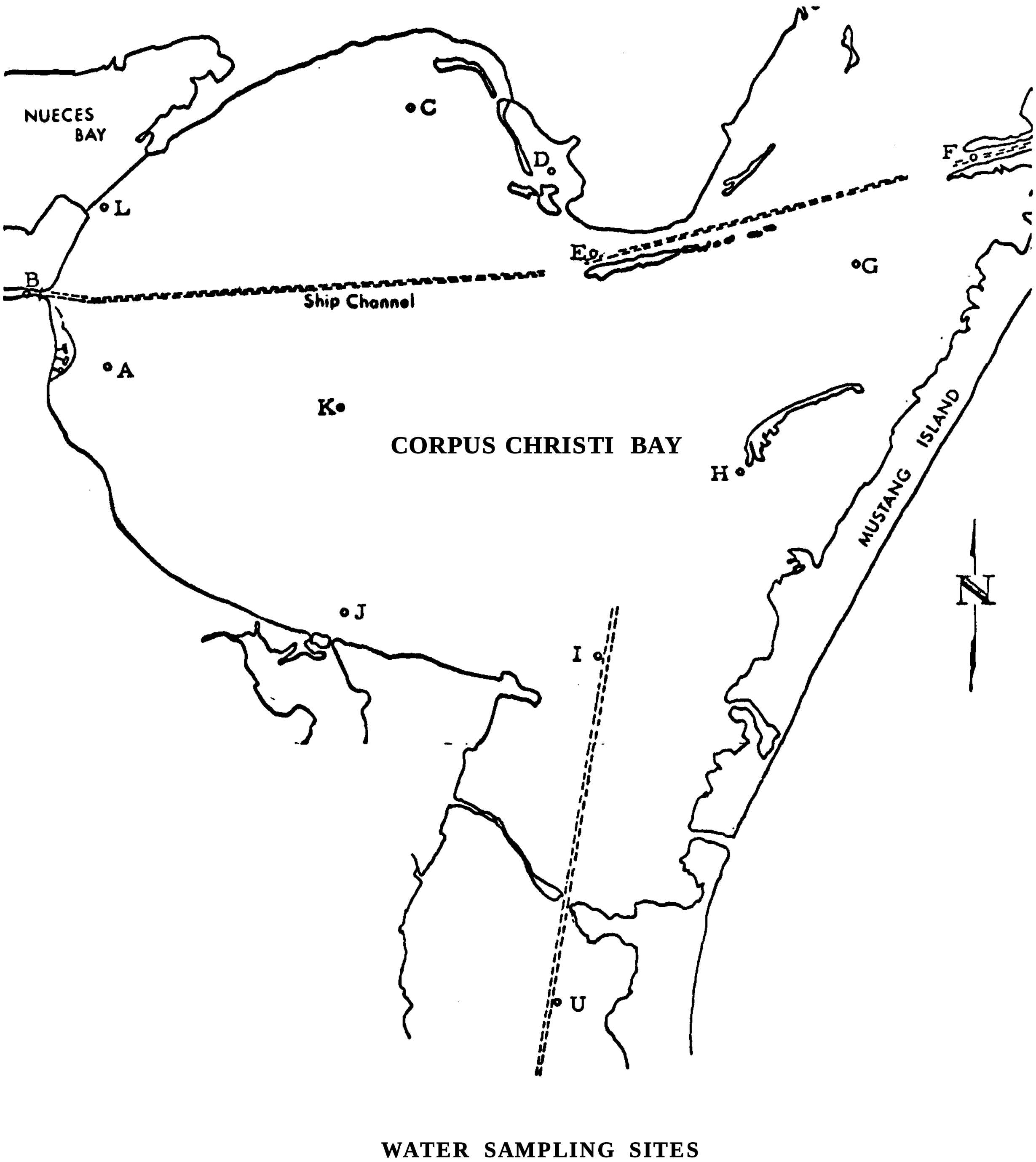
Prepared by: ____

Tides: High ______________ Low ______________ Avg. Sea State ______________

Avg. Weather ________ Wind Direction and Speed ______________

Rainfall: Cumulative since Jan. 1 ________ Total in past 7 days ______________

Comments:



WATER SAMPLING SITES

Figure 3. Map of Corpus Christi Bay Showing Water Quality Sampling Sites, MST 403.

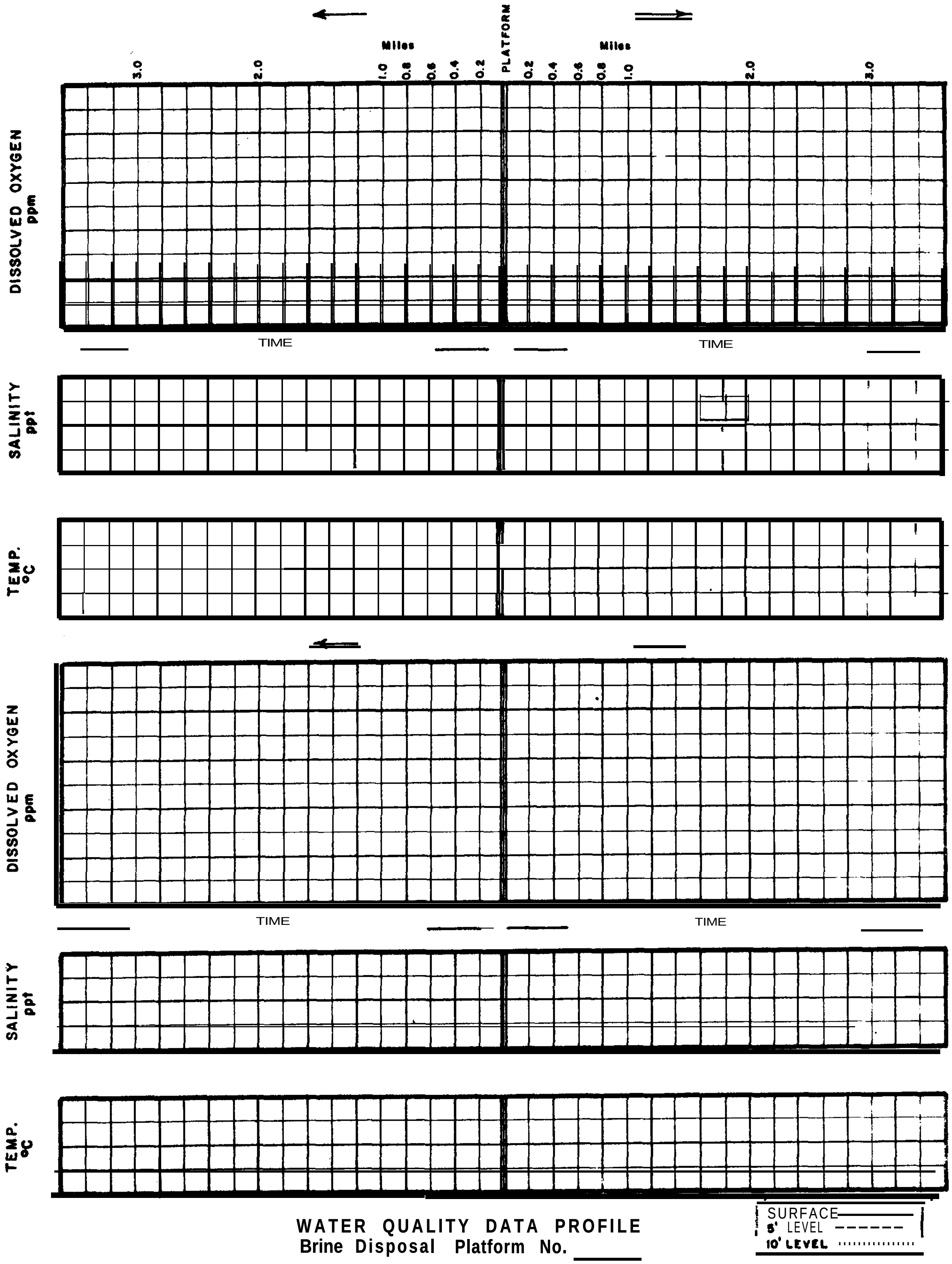
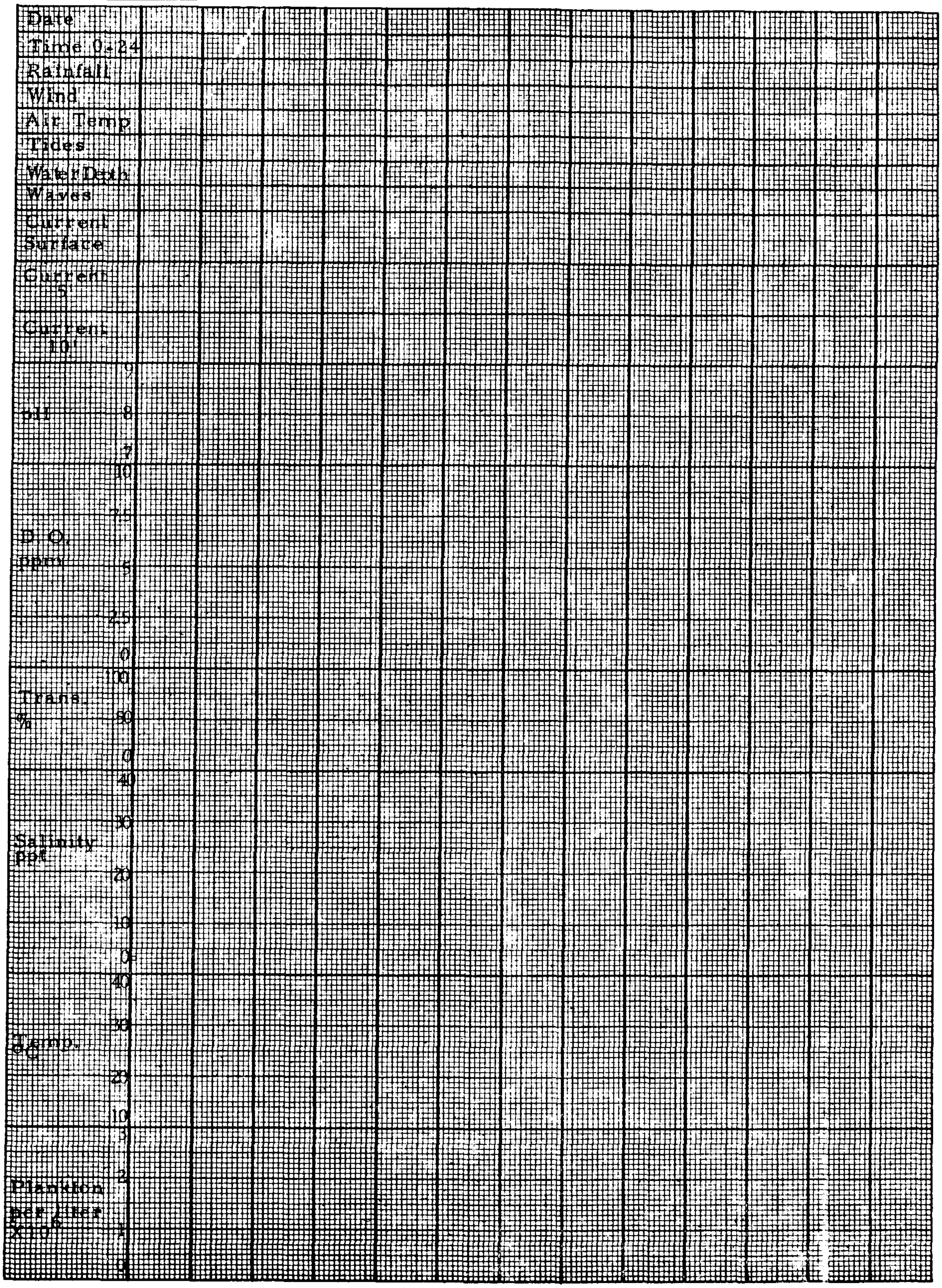


Figure 4. Radial Water Quality Profile, MST 211.

Station



K+E 10 X 10 TO THE CENTIMETER 46 1517
18 X 25 CM. • ALBANENE® MADE IN U.S.A.
KEUFFEL & ESSER CO.

Figure 5. Quarterly Water Quality Record, MST 403 and 211

PROFILE DATA SHEET

DATE :   RUN NUMBER: SIGNATURE:

EQUIPMENT:

Edo 353 XDCR(   ) Ore XDCR(   ) Edo 248B XCVR(   )

Gifft Rcdr #   Gifft Rcdr #

LINES RUN:

ID	START	STOP	ID	START	STOP

SLAVE LOCATIONS:

Slave I: Lat.   Slave II: Lat.
Long.   Long.
General   General

HI FIX CHECK IN:

READING	CORRECTED	READING	CORRECTED
I		I	
II		II	
LOC	TIME	LOC	TIME
I		I	
II		II	
LOC	TIME	LOC	TIME

WIND :   SEA:

SP	SP	HGT	HGT
DIR	DIR	DIR	DIR
TIME	TIME	TIME	TIME
SP	SP	HGT	HGT
DIR	DIR	DIR	DIR
TIME	TIME	TIME	TIME

TIDE :   DEPART: RETURN:

GIFFT RECORDER #   ATTACHED TO:
PAPER: A B C D Cont Auto   KEYING: .1 .2 5 1 Edge Cent
PROGRAM: FREQ: 12 34 SCALE: 20 40 100 400 1K 2K
GAIN: SLEW MAN. AUTO. POLARITY: t - ±

GIFFT RECORDER #   ATTACHED TO:
PAPER: A B C D Con Auto   KEYING: .1 .2 5 1 Edge Cent
PROGRAM: FREQ: 12 34   SCALE: 20 40 100 400 1K 2K
GAIN: SLEW MAN. AUTO. POLARITY: + - +

ED0 248B: GAIN:
Pulse Width .2 .5 1 2   POWER :

HYDRO PRODUCTS XCVR:
FREQ: POWER: METER:
GAIN: Fine   Coarse Xl X20 X400
TVG: Man Auto 10 100 1000
RATE: Inner   Outer   MATCHING: COMB.   SEPARATE 12345678910

Pull four inches of blank paper at the start of every run and record line (as above) time line started, vessel rpm and compass heading. If applicable. record hi fix check, wind, sea, and a summary of equipment setting changes.

Figure 6. First Page of Seismic Profile Record, MST 211 and 412.

COMMENTS: Page of

NO.	TIME	LOCATION	ENVIRONMENTAL AND EQUIPMENT CHANGES

Figure 7. Second Page of Seismic Profile Record.

TRACK PLOTTER CHARTS

I. Graded as they are used

II. Required Features
- A. Line(s) Identified (Long. or Lat. - Limits(Lats. or Longs.) Top and Bottom
- B. Location of Slave Stations, Top and Bottom
  Slave I (Lat., Long.)- (General Location,
  Slave II (Lat, , Long.)-(General Location)
- C. Date Drawn and Draftsman, Top and Bottom
- D. The file number, Top and Bottom (exposed when rolled)
- E. All Scales clearly labeled every 6"-8" and at all turns. This means PEN AND PAPER. At the turns the pen scale should be displaced about l/2" from the turn toward the applicable side. In addition to the number's, scale labels should include the Slave identifier, polarity and Grid Size
  Example: Slave II (+) (1/2")
- F. Mileage marks on all lines-preferably every l/4 mile
- G. Show all 6' contours occuring within 3 lanes of the line
- H. Each chart should have 18" - 24" of leader on top and bottom
- I. No line should START or END within 1 1/2" of the edge of the paper

III. Quality Grades
- A. Turns occur precisely on the 1" or l/2"
- B. All curves are smooth
- C. Parallel lines uniformly diverge or converge and are equally spaced
- D. Neatness

IV. Filing
- A. Filed whenever not in use
- B. Track Plotter Chart File Cross Ruff
  1) *On* 3x5 file cards

Line: (Lat. or Long.), Slave Locations I	II	Limits (Long. or Lat.)	Draft-man	Storage Number

Figure 8. instructions for Preparing Track Plotter Charts for Hy-Fix Electronic Position Fixer, MST 211, 403, and 412.

SEDIMENT SAMPLE Sample # ____

Data Site	Long.	Lat. Index Grid -	Signed	
Raw Location			Date	
			Time	
			Run #	
Field Classification			Tool	
Field Processing			H_2O Depth	
Comments			Signed	
Hi Fix Slave I	Long.	Lat. Slave II	Long.	Lat.
Sample, Stored Where?			Signed	
Analysis			Date	
Sample, Stored Where?			Signed	
Analysis			Date	
Sample, Stored Where?			Signed	

Figure 9. Sediment Sample Record, MST 211, 403, and 412.

CORE SAMPLE Sample #

Data Site Long. Lat. Index card – Signed

Raw Location Date

Time:

Run #

Water Depth Ext. Pen Core Length

General Profile Cutter Sample

Comments Signed

Hi Fix Slave I Long. Lat. Slave II Long. Lat.

Sample, Stored Where? Signed

Analysis Date

Sample Stored Where? Signed

Analysis Date

Sample, Stored Where? Signed

Figure 10. Core Sample Record, MST 211, 403, and 412.

Temp. | Sal. | DO | Trans. | PH | Misc.   Sample # ________

Data Site ____ Long. ____ Lat. Index Grid ____ Signed ____

Raw Location ____ Wind Sp ____ Date ____ Run# ____

Wind Dir. ____ Time ____

Weather ____ Sea State ____

Comments ____ Air Temp. ____ H_2O Depth ____

Tide ____ Signed ____

Hi Fix Slave I ____ Long. ____ Lat. Slave II ____ Long. ____ Lat. ____

MEASUREMENTS								SAMPLES		
Depth	Temp	Cond	Sal	DO	10 Trans	100 Trans	Misc.	S#	DO#	PH#

Figure 11. Front of Woter Quality Original Data Record, MST 403

Sample Location		Signed
Analysis		Date
Analysis		Date
Sample Location		Signed
Analysis		Date
Sample Location		Signed
Analysis		Date
Sample Location		Signed
Analysis		Date
Sample Location		Signed
Analysis		Date
Sample Location		Signed
Analysis		Date
Sample #'s	Stored Where?	Signed

Figure 12. Back of Water Quality Original Data Record, MST 403

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS AND RECOMMENDATIONS:

Del Mar College and Southwest Research Institute feel that the idea of combining Marine Science and electronics into an integrated technician training curriculum is fundamentally sound. However, certain portions of the program are in need of revision. It has been observed that:

1. The curriculum as designed requires too many hours, both credit hours and contact hours. Many programs leading to the Associate Degree require only 60 hours. This program, with its 92 credit hours and 28 contact hours per week in the third and fourth semesters, places excessive demands on the student.
2. Laboratory courses in MST have an excessive amount of boat and laboratory time scheduled, resulting in high contact hours and raising the cost of the program. Research-vessel activities are vital to the program, but the total number of hours spent aboard the vessel can be reduced without degrading the level of instruction.
3. Student selection based on interest in marine activities often results in enrolling students who have little aptitude for technology subjects (cf "Student Selection"). Most students who are interested in marine science have little interest in mathematics or electronics.
4. MST 405, as designed, gives inadequate coverage of biology and geology. This course was among the most popular of the MST program, but was severely limited by having to divide one semester between biology and geology.
5. It is a mistake to attempt to teach MST students the same electrical and electronics courses that majors in these fields take. A Marine Science-Electronics technician is being trained for a different position than a laboratory electronics technician, and his training should reflect this difference.

6. Student interest in the program flagged seriously after one semester, primarily because the students were not involved in research-vessel operations. Many students became aware after one semester that the program was not as they had speculated (see #3 above), but the large number of drop-outs was due primarily to the 9-month interval between registration and first activities on the research vessel.

To improve the curriculum and remedy the errors listed above, the following modifications are recommended:

1. The curriculum should be shortened to 67 semester hours (two academic years and one summer session).
2. The total number of research vessel hours should be reduced and the remaining hours redistributed so as to involve the students with research activities early in the program. MST 301, 302, 405, and 410 in particular should include some boat time as a part of their laboratory periods.
3. Students should be made aware from the outset of the program they are entering in a technology and not a science-oriented curriculum.
4. Electronic courses should be designed specifically for MST students and be oriented more toward a circuit approach than toward theory of individual elements.

A curriculum that encompasses these changes is shown below.

COURSE	SEM. HOURS
Marine Science Technology	31
Electronics and Instrument Technology	20
Mathematics	6
Physical Education (SCUBA)	1
Government	3
English	6
TOTAL	67

The MST courses would include 301, 302, 403, 310, 414, 415, and 216 from the existing curriculum. MST 405 would be expanded to two separate courses (405 and 410) in biology and geology. Electronics technology courses would be designed specifically for marine science. Supporting courses would be as before, with the exception that Technical Mathematics I and II (606a and 606b) would be substituted for College Algebra and Trigonometry (309 and 304) in the existing curriculum. The revised curriculum is shown in Figure 15.

In summary, we believe that our experience with the Marine Science-Electronics curriculum supports the conclusion that the basic premise is sound. We believe that this curriculum with revisions is capable of producing a well-qualified technician for employment in the marine industries. We believe that a sound background in basic electronics and instrumentation is essential for the production of a marine technician who is to operate and maintain the sophisticated instruments common to oceanography today. A successful and viable program must include the following:

1. Faculty with both theoretical and practical knowledge of marine science.
2. Regularly scheduled boat laboratory periods which stress accurate data and which are goal-oriented rather than just drill in methodology.
3. Advance information on prospective employers.
4. A careful student selection and counseling program to precede registration. Counselors should be closely advised by MST faculty. The student should be made aware of the technological nature of the program; he should understand that the program is essentially terminal and that transfer into a four-year program cannot be done without considerable penalty.
5. The name, "Marine Science - Electronics Technology" should be dropped in favor of a more descriptive title such as "Marine Electronics Technology" to emphasize the electronics basis of the program and to prevent the common misconception that the program is science-oriented.

Associate-degree Marine Science is a fairly new concept in education, although similar programs in other technologies have been in effect for many years. The continuing success of associate-degree technician-training programs is proof that the idea is basically good. It is our belief that the curriculum which is the subject of this report is an excellent program for the training of marine technicians, and we believe that the program should be continued.

MARINE SCIENCE-ELECTRONIC TECHNOLOGY

(A Two-Year Curriculum Leading to the Associate in Applied Science Degree)

This curriculum is the result of a two-year study and pilot program offered by Del Mar College and funded under Sea Grant No. GH-57 from the National Sea Grants Program Office, U. S. Department of Commerce.

			Lec.	Lab.	Sem. Hrs.
First Semester (First Year)					
M.S.T.	301	Marine Science Environment	2	3	3
E.E.T.	402	D.C. and A.C. Fundamentals	3	3	4
E.E.T.	403	Electronics Theory and Laboratory	3	3	4
Math	606a.	Technical Mathematics - one	3	0	3
English	303	Communication Skills	3	0	3
			14	9	17
Second Semester (First Year)					
M.S.T.	302	Chemical Oceanography	2	3	3
M.S.T.	405	Marine, Geology	3	3	4
E.E.T..	406	Marine Science Electrical Circuits	3	3	4
Math	606b.	Technical Mathematics - two	3	0	3
M.S.T.	403a.	Marine Science Lab - one	0	6	2
			11	15	16

Summer Session:

It is recommended that marine science majors seek summer employment with a company or agency involved in marine science activities.

			Lec.	Lab.	Sem. Hrs.
First Semester (Second Year)					
M.S.T.	310	Underwater Acoustics	2	3	3
M.S.T.	403b.	Marine Science Laboratory - two	0	6	2
E.E.T.	415	Industrial Control Circuits	3	3	4
M.S.T.	410	Marine Biology	3	3	4
English	304	Technical Writing	3	0	3
			11	15	17
Second Semester (Second Year)					
M.S.T.	414	Marine Science Instrumentation	3	3	4
M.S.T.	216	Marine Science Seminar	2	0	2
Govt.	610a.	U. S. Government	3	0	3
Inst.	412	Analytical Instruments	3	3	4
M.S.T.	413	Marine Science Problems	3	3	4
			14	9	17