Summary of the Interamerican Workshop on Marine Resources

held June 14-18, 1982

in Manzanillo, Colima, México

Sponsored by

Universidad de Colima
Instituto Oceanográfico de Manzanillo, and the
International Sea Grant Program through the
Oregon State University Sea Grant College Program

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INTRODUCTION

Background of the Workshop

Mexico has experienced a rapid increase in population in recent years. The corresponding expansion of the work force (estimated at more than 800,000 workers per year) has intensified Mexico's need to develop her marine resources, particularly food, energy, and recreation. The country has about 9900 km of coastline, almost 500,000 hectares of coastal lagoons, and an exclusive economic zone extending 200 nautical miles from the coast. These coastal areas have significant potential for minerals, offshore energy, aquaculture, fisheries, tourism, and recreation. To insure that coastal development takes place with a minimum of damage to the environment, and to resolve the inevitable conflicts among users, Mexico must plan viable, well-designed strategies and then carry them out. To do this, the country needs more professionals trained in marine resource development and management, a complex field embracing ocean engineering, marine resource management, and marine advisory/extension (hereafter referred to as marine extension).

In consideration of the impending needs of Latin American countries in general and Mexico in particular, Oregon State University, Universidad de Colima, and the Instituto Oceanográfico de Manzanillo (Secretaría de Marina) sponsored the Interamerican Workshop on Marine Resources, 14-18 June 1982, at the Instituto Oceanográfico de Manzanillo. The U.S. International Sea Grant Program provided partial funding for the workshop through the Oregon State University Sea Grant College Program. The workshop was organized and directed by

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Goals of the Workshop

The workshop was designed to provide information and, when appropriate, to offer recommendations to institutions in Latin America concerning three areas: (1) the establishment or improvement of marine extension programs, (2) the development of an undergraduate curriculum in marine resource management, and (3) the development of an undergraduate curriculum in ocean engineering. Consequently, the workshop was divided into three sections: marine extension programs, marine resources and management, and ocean engineering. The session also provided an opportunity for professionals in marine science and engineering to discuss the current and future needs of marine programs in Mexico and other Latin American countries.

This report considers some of the basic material covered by the workshop and presents proposed curricula in marine resources administration and ocean engineering.

MARINE EXTENSION PROGRAMS

In the United States, marine extension programs are closely allied with marine resource management and the national Sea Grant program. All three groups forge links between those who are interested in the use of marine resources: professionals (for example, marine scientists and economists), administrators, regulatory personnel (government), and user groups (including both the general public and private enterprise).

More specifically, the extension programs pass on knowledge and technology, nurture innovation, develop self-reliance, assist fishermen and others in adapting to change, and encourage public and private groups to plan for the wise use of resources (including human resources). Extension programs also encourage applied research and organize specific educational programs. This multifaceted work requires the cooperation of professionals in such various fields as oceanography, engineering, economics, law, political science, business, and communications.

The careful selection and training of extension personnel is important because agents and specialists must work closely with other people and because extension programs must be efficiently organized and managed to provide the kinds of services needed.

The speakers listed below explained the concepts behind marine extension programs and described how such programs are organized, administered, and evaluated.

Dr. Daniel Panshin
U.S. Deptartment of Agriculture, Extension Service
Washington, D.C., USA

Dr. Frederick Smith
Department of Agricultural and Resource Economics
Oregon State University
Corvallis, Oregon, USA

Dr. Jens Sorenson
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Dr. Ron Johnson
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Mr. Anthony Rock
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The specific needs of marine extension programs in Mexico and other Latin American nations and the international aspects of such problems were addressed by the following speakers.

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Dr. Miguel Guzmán
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Finally, the following speakers and panelists considered marine resources, problems of marine resource management, and the education of persons for resource management and extension.

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Scripps Institution of Oceanography
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Dr. Vazquez de la Cerda
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Dania, Florida, USA

Dr. David Fischer
Coastal Studies Program
University of West Florida
Pensacola, Floridan, USA

FIVE-YEAR MARINE RESOURCES ADMINISTRATION CURRICULUM

Introduction

Mexico and many other Latin American nations are rich in marine resources. Furthermore, they are rapidly developing marine-oriented educational programs and are interested in implementing marine resource management programs. With the increased use of marine resources comes the need for more intensive and more intelligent resource management.

The marine-oriented educational institutions of Latin America can make a major contribution to such management. Traditionally, this contribution has required the time and talent of scientists whose primary responsibilities are research and teaching and not administration. This document outlines a method which allows marine-oriented educational institutions to make a greater contribution at less cost to their research and teaching effort.

A proposed curriculum for a five-year B.S. or B.A. degree to be offered by academic institutions in Mexico and other Latin American countries is given below. It was developed at the workshop (12-18 June 1982) in Manzanillo by

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This curriculum was developed as a response to the needs expressed by officials in Mexico. The purpose of training in marine resources administration is to graduate professionals who can participate in and contribute to the administration of marine resources. Success of this training will relieve professional researchers and teachers from the burden of administration so that they may play a more important role in research and teaching.

We anticipate that this curriculum will prepare people to enter employment in government service or private industry and to assist and enhance decision making at all levels. We also anticipate that these people will move to higher positions of authority in such government agencies as fisheries, energy, ocean transportation, or tourism and to important positions in private industry involved in fishing, ports, shipping, offshore oil development, aquaculture, and so on.

Marine resource managers should have these characteristics:

1. A basic understanding of marine science.

2. A basic understanding of the political, social, and cultural aspects of their country.

3. An understanding of public and private administrative theory and practice.

4. Analytical and technical skills.

5. The ability to communicate and work effectively with people of various backgrounds who are involved in marine resource use.

6. The ability to integrate information from various sources and make rational and well-justified decisions.

The curriculum presented in this paper is designed to develop the above characteristics through five years of coursework and internship.

Explained in the following pages are, first, the major, which is intended to provide a foundation in marine resources and science, and then the minor. An outline of important courses in both the major and minor is followed by suggested courses in the humanities and social sciences. Finally, we present a sequence of courses for five years.

<u>Major in Marine Resources Administration</u>

Approximately 40 percent of the students' total credits should be taken in business and public administration courses. This concentration makes it desirable that the curriculum in marine resources administration be offered at an institution which has an established program in business administration and economics. Our belief is that it would be more efficient to build the new courses required for the minor than for the major. We assume that a well-developed business administration program would offer most of the courses required.

These courses would include the following subject matter:

business organization
organization theory
budgeting
business and government ethics

financial accounting
financial analysis
public accounting
project planning and management
decision-making procedures
risk analysis
group dynamics
conflict management
data management
personnel management
benefit/cost analysis
public finance

Introductory courses in marine resources taken during the first year will be an important part of the major. They will give students an appreciation for the diversity and value of marine resources and help them to select a minor. The four introductory courses are

Introduction to marine resources administration:

marine resources
common property problems and market failure
allocation process
institutions (including cooperatives)
careers in marine resources administration

Introduction to fisheries:

world fish resources
national fish resources
national fish production
principal world fishing methods
national fishing methods
issues (development, administration, research, and so on)

Introduction to oceanography:

biological oceanography
chemical oceanography
physical oceanography
geological oceanography

Introduction to marine energy, marine minerals, and the use of coastal resources:

energy issues
marine minerals issues
coastal resource conflicts
coastal recreation/tourism
marine transportation and port development

The following courses are also recommended for the major:

Computer applications:

- modeling concepts
- developing algorithms
- data manipulation
- hardware systems
- software systems

Statistical analysis:

- sampling
- inference
- regression

Communication:

- composition
- technical writing
- public speaking
- teaching methods

Minor for Marine Resources Administration

The purpose of the minor is to give the student a strong foundation in one of the natural or physical sciences common to marine resources. The student would choose one of four options for the minor and take approximately 25 percent of the total credit hours in this minor. Credit hours in other minors could be taken as electives. Each of the minors is listed below with a description of its required courses.

Options

A. Minor in fisheries

- population dynamics
- fishing techniques
- seafood processing and marketing
- aquaculture
- marine pollution

B. Minor in marine minerals and energy

- marine minerals technology
- marine geology
- marine pollution
- energy technology
- public administration of marine minerals and energy
- minerals and energy pricing

C. Minor in ports and marine transportation

port engineering and operation
port administration
maritime transportation
port siting and use of resources
marine pollution

D. Minor in tourism and recreation

recreational use
regional economic development
coastal zone management
recreational policy
recreation industry and tourist behavior

Humanities and Social Science Requirements

These courses are intended to give the student a better understanding of the social, cultural, historical, political, and economic setting in which marine resource administration must take place. Approximately 14 percent of the students' total credits should be taken in these subjects. Humanities and social science requirements should include the following types of courses:

microeconomics
macroeconomics
economic system of Mexico
international trade
national history
sociology
theory and concept of cooperatives
cultural anthropology
national government and administration and law
psychology
ethics and philosophy

Prerequisites and Electives

Most of the courses taken for the major and many for the minor will have prerequisites. Mathematics, biology, zoology, geology, chemistry, physics, accounting, and other subjects will be prerequisites for the required upper division courses. About 23 percent of the students' credit hours are available for these prerequisites plus any electives that may be desired.

Sequencing of Courses

The following five-year list suggests only the types of courses, rather than the specific courses, that should be taken in each year. However, the four introductory courses should be taken in the first year. The sequence is as follows:

Year 1

Introduction to marine resource administration
Introduction to fisheries
Introduction to oceanography
Introduction to energy, minerals, and the use of coastal resources
Communications
Statistics
Computer applications
Prerequisites

Year 2

Social science and humanities courses
Beginning courses in the major
Prerequisites

Year 3

Continue social sciences and humanities courses
Continue the major
Begin courses in the minor (i.e., options A, B, C, or D)
Begin electives

Year 4

Continue courses in the major
Continue courses in the minor
Complete social sciences and humanities
Continue electives

Year 5

Internship (three to five months of work experience in government, academia, or private industry)
Continue courses in the minor
Continue electives

FIVE-YEAR OCEAN ENGINEERING CURRICULUM

This section presents a five-year degree program in ocean engineering designed for a two-semester academic year. The curriculum meets the requirements of the Accreditation Board for Engineering and Technology (ABET), which certifies all accredited baccalaureate engineering programs in the United States of America. The curriculum emphasizes technical skills required for the analysis and design of offshore and coastal structures while providing essential courses in marine, coastal, and estuarine processes. This emphasis is consistent with current and projected employment trends in the ocean industry.

Completion of semesters one through eight will satisfy ABET requirements for a baccalaureate degree in civil engineering with a combined structures-marine resources major. The ninth and tenth semesters satisfy ABET requirements for a post-baccalaureate degree at the master's level. The fifth year is devoted entirely to ocean engineering analysis and design studies.

The proposed curriculum is analytically rigorous with broad exposure to basic ocean science and applied ocean engineering. It is intended that this background produce a technically competent yet environmentally sensitive graduate. In addition, the fundamental nature of the basic math and science courses should permit the graduate to keep abreast of a rapidly evolving technical field.

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FIVE-YEAR OCEAN ENGINEERING CURRICULUM

ABET ACCREDITED

1st Semester

Calculus I
Chemistry I
Writing Composition
Graphics
English I
Introduction to Ocean Engineering

2nd Semester

Calculus II
Chemistry II
Speech
Technical Report Writing
English II
Aquatic Biology & Ecosystems

3rd Semester

Ordinary Differential Equations
Physics I
Engineering Statics
Biological and Chemical Oceanography
English III
Humanities & Social Science

4th Semester

Probability and Statistics
Physics II
Engineering Dynamics
Mechanics of Materials
Computer Programming
Humanities & Social Science

5th Semester

Numerical Methods
Fluid Mechanics
Structural Analysis
Soil Mechanics
Engineering Economics
Humanities & Social Science

6th Semester

Systems Analysis
Hydraulic Engineering Design
Steel Structural Design
Electrical Circuits & Electronics
Thermodynamics
Humanities & Social Science

7th Semester

Applied Differential Equations
Marine Geotechnique
Concrete & Wood Structural Design
Physical Oceanography
Ocean Wave Mechanics
Humanities & Social Science

8th Semester

Applied Integral Mathematics
Mechanics of Sediment Transport
Structural Dynamics
Ports and Harbors
Environmental Engineering
Humanities & Social Science

9th Semester

Estuarine Hydraulics
Air-Sea Interaction
Wave-Structure-Foundation Interaction
Coastal Engineering
Oceanographic Data Analysis
Project

10th Semester

Oceanographic Instrumentation
Ocean Structural Design
Marine Materials & Corrosion
Project
Project
Project

ABET FOUR-YEAR CURRICULUM REQUIREMENT SUMMARY

One academic year = 12 semester courses (sc)

Curriculum Area	Requirements	
Mathematics	One-half year beyond trigonometry (6 sc)	Calculus I (1), Calculus II (2), Ord. Differential Eqs. (3), Probability and Statistics (4), Numerical Methods (5), Applied Differential Eqs. (7), Applied Integral Mathematics (8)
Basic Sciences	One-half year (6 sc)	Chemistry I (1), *Chemistry II (2), Aquatic Biology & Ecosystems (2), Physics I (3),* Physics II (4), Biological & Chemical Oceanography (3), Physical Oc. (7)
Engineering Science	One year (12 sc)	Introduction to Ocean Engineering (1), Engineering Statics (3), Engineering Dynamics (4), Mechanics of Materials (4), Fluid mechanics (5), Structural Analysis (5), Soil Mechanics (5), Electrical Circuits & Electronics (6), Thermodynamics (6), Systems Analysis (6),Ocean Wave Mechanics (7), Environmental Engineering (8), Mechanics of Sediment Transport (8)
Engineering Design	One-half year (6 sc)	Hydraulic Engineering Design (6), Steel Structural Design (6), Marine Geotechnique (7), Concrete & Wood Structural Design (7), Ports & Harbors (8), Structural Dynamics (8)
Humanities & Social Science	One-half year (6 sc)	Six elective courses plus Engrg. Economics (5)
Communication Skills	Written and oral competency, specifically in English	Writing Composition (1), Graphics (1), English I (1), Speech (2), Technical Report Writing (2), English II (2), English III (3), Computer Programming (4)

ABET FIFTH-YEAR "ADVANCED LEVEL" CURRICULUM REQUIREMENT SUMMARY

One academic year = 12 semester courses (sc)

Curriculum Area	Requirements	Suggested Courses (semester number)
Mathematics and Engineering Science	One-third year (4 sc)	Air-Sea Interaction (9), Oceanographic Data Analysis (9), Oceanographic Instrumentation (10), Marine Materials and Corrosion (10)
Engineering Design	One-third year (4 sc)	Estuarine Hydraulics (9), Wave-Structure-Foundation Interaction (9), Coastal Engineering (9), Ocean Structural Design (10)
Projects	Exposure to advanced level research or special projects	Equivalent to one-third year or four semester courses on a specific problem in Ocean or Coastal Engineering with a written and oral final report

UNDERGRADUATE CURRICULUM: COURSE DESCRIPTIONS

MATHEMATICS

Calculus I

Analytical geometry, limits, derivatives, Mean Value Theorem, applications of derivatives, integrals, Fundamental Theorem of Calculus, applications of integrals, techniques of integration, improper integrals, infinite series, exponential and logarithm functions.

Calculus II

Introduction to calculus of several variables, real valued functions of several variables, multiple integration; differential calculus of several variables, spatial derivatives, directional derivative, gradient.

Ordinary Differential Equations

Linear equations w/constant and variable coefficients, series solutions, Laplace transforms, systems of differential equations, initial value problems, series solutions, singularities, uniqueness and existence.

Probability & Statistics

Discrete and continuous random variables, special distributions, joint distributions, expectations, data collection, tabulation and presentation, statistical inference and hypothesis testing.

Numerical Methods

Approximations; curve fitting; numerical techniques of differentiation, integration, interpolation and extrapolation; numerical solutions of algebraic and differential equations; finite difference techniques, stability, convergence and error minimization.

Applied Differential Equations

Classification of differential equations, mathematical formulation and solution of partial differential equations of mathematical physics and engineering,separation of variables; boundary-value problems; complex variables; Laplace transforms, Fourier transforms; special functions.

Applied Integral Equations

Mathematical formulation and solution of integral equations in mathematical physics and engineering; calculus of variations and variational principles; introduction to Finite Element Modeling.

BASIC SCIENCES

Chemistry I

Fundamental chemical concepts of composition and stoichiometry; atomic structure; bonding and molecular structure; chemical reactions, states of matter including solutions; principles of mass conservation; laboratory.

Chemistry II

Acid-base reactions, homogeneous and heterogeneous equilibra, electrochemistry, and descriptive aspects of inorganic, organic, nuclear and biochemistry; laboratory.

Aquatic Biology & Ecosystems

The biology of ecosystems: energy, patterns of ecosystems and populations, interspecies interactions, diversity and development applied to flora and fauna of an aquatic environment; introduction to microbes, physical and biochemical characteristics and adaptions of aquatic organisms.

Physics I

Topics include vectors, laws of motion, classical mechanics, conservation principles, rotational motion, oscillations, gravitation, and thermodynamics.

Physics II

Topics include kinetic theory of gases, electric and magnetic fields, electric currents and circuits, motion of charged particles, wave motions including optics and acoustics, and atomic and nuclear structure.

Biological and Chemical Oceanography

Biological productivity and trophic relationships in Plankton, Nekton and Benthos; community ecology of selected habitats and adaptation of organisms to the marine environment; chemical processes which control the composition of the oceans, including chemical equilibria, biological cycling of nutrients. The origin and chemical history of the oceans.

Physical Oceanography

Overview of physical aspects of oceanography. Topics include the equations of state of seawater, energy transfer to the ocean by thermal, radiation and mechanical processes; heat budget; oceanic boundary conditions; waves, tides and currents.

ENGINEERING SCIENCE

Introduction to Ocean Engineering

Identification of mathematics, science and engineering skills required to solve applied problems in ocean and coastal engineering; faculty and industrial presentations on classical, contemporary and future problems in ocean engineering.

Engineering Statics

Principles of equilibrium for planar and three-dimensional system; frictional resistance; shearing force and moment diagram; moment of inertia; transformation of principal axes.

Engineering Dynamics

Dynamics of particles, system of particles and rigid bodies; kinematics, momentum relations; energy methods, vibrations, Euler's equation of motion.

Mechanics of Materials

Stress and strains; unsymmetrical bending; torsion; compound stress; phase relationship; stability and theories of failures; energy methods.

Fluid Mechanics

Properties of fluid; fluid statics, fluid kinematics; conservation of mass: continuity equation; momentum theorem; energy principle; similitude and models; application to engineering problems on laminar and turbulent flows in pressure conduits and open channels; flow measurements. Accompanied with laboratory experiments.

Structural Analysis

Principles of analysis of statically determinate structural systems; deformation and deflections of elastic systems; statically indeterminate beams, arches and frames; moment distributions; secondary stresses; introduction to stiffness method and matrix structural analysis.

Soil Mechanics

Geological derivation and physiochemical characteristics of soils; compression, shear strength, stability and consolidation; seepage problems; preliminary foundation design procedures for footings, embankments, pile foundations and retaining walls. Accompanied with laboratory experiments.

Electrical Circuits and Electronics

Network analysis and theorems; transient analysis; transformers; semiconductor physics and circuits; power amplifiers; modulations and demodulations; pulse, digital and switching circuits introduction to instrumentation. Accompanied with laboratory experiments.

Thermodynamics

Fundamental laws of thermodynamics and heat transfers; application to actual and perfect gases and vapors; energy concepts; processes; application to electrical system, air conditioning & power plants.

Systems Analysis

Analysis of large scale economic, environmental, social and physical systems. Simple modeling of complex systems; simulation and optimization; decision analysis and multi-objective evaluation; application of linear programming and dynamic programming.

Environmental Engineering

Water quality criteria and fundamental consideration of acceptability; natural purification of surface and ground water; physical, chemical and biological processes employed in the treatment of waste waters for disposal or reuse; turbulent mixing and dispersion; solid waste management, submarine outfalls.

Ocean Wave Mechanics

Small amplitude and finite amplitude wave theories, superposition of fundamental waves; wave energy and wave energy propagation; wave refraction and diffraction characteristics and representation of extreme waves; energy spectra; stability and wave breaking.

Mechanics of Sediment Transport

Properties of sediments; bed shear stress and shear velocity; initiation and entrainment of sediment motions; sediment loads: bed loads and suspended loads; sediment discharge formulas in rivers and streams; sediment transport by waves; modeling problems; introduction to coastal processes.

ENGINEERING DESIGN

Hydraulic Engineering Design

Application of continuity, momentum and energy principles to the design of pipe systems, hydraulic machinery and open channels; semi-empirical relation of flow resistance; nonuniform flow analysis in open channels; flow transitions, water hammer analysis; reservoirs and dams and other hydraulic structures; pumps and turbines; multiple purpose hydraulic projects.

Steel Structural Design

Basic design and proportioning of structural steel members, and connections in buildings and bridges; static methods utilizing plastic and elastic analyses and appropriate codes.

Marine Geotechnique

Marine sediment and geological processes; seafloor composition and morphology; marine soil properties, sampling and testing; seismic surveys, penetrometers, nuclear probes, marine location surveys; foundations and anchorages.

Concrete and Wood Structural Design

Structural design in timber and reinforced and pre-stressed concrete utilizing ultimate strength and limit analysis; similar and dissimiliar material connections; design limitations and building codes; fabrication and construction procedures.

Ports and Harbors

Functional planning and design criteria of nearshore and harbor facilities including piers, docks and ship moorings; harbor resonance, circulation, flushing; ship queuing theory; interface with land based transportation; dredging and dredge spoil disposal.

Structural Dynamics

Numerical and closed form solutions for single and multi-degree of freedom vibrating systems; time and frequency domain analyses; continuous and lumped parameter systems; behavior of structures under environmental forces; support and ground motions.

HUMANITIES AND SOCIAL SCIENCE

Engineering Economics (required)

Time value of money; supply and demand analysis; competition and monopoly; economic study techniques, depreciation, taxes, retirement and replacement of engineering facilities; cost benefit analysis.

Electives: may not be skill type courses (e.g., language, drawing, etc.)

Typical subjects include:

- History
- Sociology
- Philosophy
- Art History
- Music Appreciation
- Law
- Psychology
- Literature
- Political Sciences
- Religion
- Anthropology

COMMUNICATION SKILLS

Writing Composition

Composition of short papers, with emphasis on sentence structure, paragraph development and paper organization.

Graphics

Details of engineering drawings; free hand sketches, orthogonal projections, principles of descriptive geometry, detailed drawing of equipment components and assembly drawings, interpretation of engineering drawings.

English I

English as a foreign language.

Speech

Theory and practice of spoken communication; factors and methods of influencing and determining the success of interpersonal, small group and public communication experiences; presentation of technical materials.

Technical Report Writing

Clarifying, reducing, expanding and synthesizing such technical materials created by others as manuals, annual reports, and technical articles and reports.

English II

English as a foreign language.

English III

English as a foreign language.

Computer Programming

Progamming of digital computers using a structured language; algorithms, program structure; use of scientific subroutine packages; use of peripheral equipment; engineering applications.

FIFTH-YEAR, ADVANCED LEVEL CURRICULUM: COURSE DESCRIPTIONS

MATHEMATICS AND ENGINEERING SCIENCE

Air-Sea Interaction

Review of basic equations and concepts of global meteorology and turbulent transfer in geophysical flows, air-sea interaction processes, theory of wind-generated ocean surface waves, turbulent transfers in the planetary boundary layer of the marine atmosphere, directional wave and current spectra.

Oceanographic Data Analysis

Application of time series analysis to ocean measurements; basic problems of single and multiple parameter estimation, spectrum and cross spectrum estimates, Finite Fourier Transforms, filtering techniques, transfer functions; introduction to Markov techniques; ocean position surveying calculations.

Oceanographic Instrumentation

Fundamentals of measurement systems in the ocean; design of measurement systems, or selection of instrumentation used to evaluate oceanographic parameters of scientific and engineering interest; introduction to laboratory and field measurements; celestial, inertial, eletronic and satellite navigation principles; offshore communication systems.

Marine Materials and Corrosion

Properties of marine structural materials; effect of various loads on stress and deflection; tensile, impact and creep behavior; cyclic loads and fatigue behavior; phase diagram; measurement technique for stress and strain; statistical methods; brittle fracture; fundamentals of metallic corrosion and passivity; electrochemical nature of corrosive attack; corrosion forms and rate factors; methods of corrosion protection including surface coatings, sacrificial anodes; marine lubricants. Accompanied with laboratory experiments.

ENGINEERING DESIGN

Estuarine Hydraulics

Hydromechanics of tidal and density flows in estuaries; water quality analysis and waste disposal in estuaries and nearshore areas; principles of diffusion and dispersion of dissolved and particulate matters in marine waters, design of estuary boundary alterations with environmental impact analysis.

Wave-Structure-Foundation Interaction

Diffraction analysis of wave forces on ocean structures; radiation and scattering forces; use of Morison's equation; visco-elastic seabed models.

Coastal Engineering

Coastal environments, applications of sediment transport, littoral drift, beach profiles, tidal inlets, coastal structures and sediment interactions. Selected topics dealing with the design of marine structures in the nearshore including breakwaters, groins, seawalls, bulkheads and jetties.

Ocean Structural Design

Finite element analyses applied to the design of ocean structures utilizing commercially available software and state of the technology improvements from the technical literature; includes a design project which synthesizes wave and current forces, structural and foundation response.

PROJECTS

Objective: Opportunity for individual effort at problem formulation, analysis and design.

Purpose: Introduce the student to the complexity of ocean engineering design including a recognition of environmental factors, costs and uncertainties.

Product: Each student must prepare a detailed design report and present it to a faculty committee. Topic will be chosen by student with faculty approval.

Typical Topics: ocean platforms, breakwaters, moorings, outfalls, erosion control structures, marinas, artificial reefs, undersea habitats.

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