Guide to
Graduate Study and Research in
Ocean and Resources Engineering
University of Hawaii at Manoa

Spring 2013 (updated November 12, 2013)
Effective for students admitted for the Fall 2013 semester or later

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BACKGROUND

Hawaii's unique location, climate and marine-oriented activities make the University of Hawaii at Manoa (UH) an ideal place for education and research in ocean and resources engineering. The graduate program in ocean engineering at UH was initiated in 1966 and is one of the first in the United States. It became an academic department in the College of Engineering in July 1968. In July 1977, the department was accredited for its Master of Science program by the Engineer's Council for Professional Development (ECPD), now known as the Accreditation Board for Engineering and Technology (ABET). In October 1988, UH officially integrated all marine-oriented programs into the School of Ocean and Earth Science and Technology (SOEST). The Department of Ocean Engineering and the Hawaii Natural Energy Institute of the College of Engineering became part of SOEST to form the technology component of this school. In July 1999, the department changed its name to Ocean and Resources Engineering (ORE) to better reflect the research thrust of the faculty.

Educational and research emphasis is placed on coastal engineering, offshore engineering, and ocean resources engineering. These areas are of vital importance to the State of Hawaii, the nation, and the world. Coastal engineering deals with coastal and harbor problems, sediment transport, nearshore environmental engineering, and coastal flood hazards. Offshore engineering is concerned with structures and systems used in the deeper parts of the ocean, including the continental shelf. It includes hydrodynamics of fluid-body interaction, seakeeping and dynamic responses of ships and platforms, and hydroelasticity of very large floating structures, such as floating airports. Ocean resources engineering is concerned with the engineering systems to develop the energy, mineral, and living resources of the oceans, the use of the ocean for waste disposal, and the environmental and economic aspects of these activities. The educational and research programs in the department have a good balance between numerical and laboratory modeling as well as field observation.

ACADEMIC PROGRAM

Program Objectives

ORE offers a graduate program leading to the Master of Science (MS) and Doctor of Philosophy (PhD) degrees. The goal of the program is to prepare students for the engineering profession and to conduct research in support of the education program.

The objectives of the program at the MS level are to produce graduates who, during the first few years following graduation,

1. are effective and creative engineers applying knowledge of mathematics and science to the solution of practical engineering problems;

2. have general understanding of and ability to work in the ocean and resources engineering disciplines;
3. are proficient in one or more of the ocean and resources engineering disciplines;
4. are aware of professional, managerial, legal, ethical, and other non-technical issues commonly encountered in engineering practice;
5. can communicate and work effectively with peers, clients, and the general public in promoting new ideas, products, or designs; and
6. can adapt to the changing needs and technology of the ocean and resources industry.

The program at the PhD level shares these objectives with the additional emphasis to produce graduates, who

7. are productive researchers conducting original research and developing new technology in ocean and resources engineering, and
8. have the experience to publish in refereed journals.

This additional emphasis prepares PhD graduates to pursue research careers in industry or academia.

These objectives along with the curriculum described in this guide were developed in collaboration with the advisory panel members listed in Appendix A.

MS Degree

The ORE program at the MS level has the following requirements:

- Pre-program,
- MS General Exam,
- Core, option-area, and elective courses, and
- MS thesis (Plan A) or independent project (Plan B).

The pre-program, which includes a general education component, one year of college-level mathematics and science, and one and one-half years of basic engineering topics, provides students a broad education background and covers technical and non-technical issues commonly encountered by engineers in professional practice. Students with an undergraduate engineering degree would satisfy the pre-program requirements. Not all students in the program have an undergraduate degree in engineering. The department requires these students to make up the deficiencies by taking basic engineering courses listed in Appendix B.

The MS degree can be earned under either Plan A (thesis) or Plan B (independent project) option. The program requires a minimum of 30 academic credits. At least 24 credits must be earned in advanced courses numbered 600 or above. Up to two credits of directed reading and six transferred credits can be counted toward the MS requirements. Students who satisfy the pre-program requirements are required to take

the General Examination during the first semester of their full-time enrollment to test their knowledge in mathematics, science, and basic engineering, and their preparation for the graduate-level coursework. Passing the exam advances the students to master's candidacy. Students who passed the Fundamentals of Engineering (FE) examination within the last three years are exempted from taking the General Examination.

The core, option-area, and elective courses offered by the department are listed in Appendix B. The core courses provide the students a broad understanding of the ocean and resources engineering disciplines that include hydrostatics, oceanography, water waves, fluid-structure interaction, and underwater acoustics. The laboratory course connects materials covered in the classroom with observations made and data gathered in the ocean. The option-area courses prepare students for specialization in coastal, offshore engineering, or ocean resources engineering. The capstone design project is team-taught by faculty members and practicing professional engineers. Its objective is to familiarize students with the planning and design of a real-life engineering project in a consulting firm setting. Students are required to read a number of engineering case studies and write a paper on issues related to ethics and professional practice. All MS students are required to attend 15 seminars that cover the latest development and research as well as contemporary issues related to ocean and resources engineering. The core and option-area courses and seminar requirement amount to 25 academic credits and the remaining credits are to be chosen to form a coherent plan of study.

Students complete their study with a Plan A thesis or Plan B independent project. The Plan A thesis is research oriented and students receive six academic credits for the work. The Plan B independent project focuses on engineering application or design and carries three academic credits. Both require a proposal outlining the subject area, objectives, proposed methodology, sources of data, and anticipated results that must be approved by a committee of at least three graduate faculty members with at least one ORE departmental faculty member. The majority of the committee should either be ORE departmental or cooperating faculty members. The committee must be approved by the Graduate Chair of the department who may appoint an additional member to the committee after consultation with the Committee Chair. The project provides students an opportunity to explore and contribute to the development of the latest technology in an ocean and resources engineering discipline. The work results in a thesis or a report that demonstrates both mastery of the subject matter and a high level of communication skills. The student must present and defend the work at a final examination, which provides the faculty a final opportunity to assess the student's understanding and ability to integrate his or her work at the MS level.

PhD Degree

Students pursuing the PhD degree are required to achieve a broad understanding of the principal areas of ocean and resources engineering, as well as a thorough understanding of a specific area. Students must, at a minimum, possess the knowledge covered by the

core courses of the MS degree in ocean and resources engineering as well as a minimum of three other courses relevant to their research topic.

The ORE program at the PhD level has the following requirements:

- Pre-program,
- Required coursework,
- PhD qualifying exam,
- PhD comprehensive exam, and
- PhD dissertation and defense.

The pre-program, core course, and seminar requirements are the same as those for the ORE program at the MS level. PhD students are also required to take an advanced mathematics course at the graduate level. Coursework requirements are listed in Appendix B.

All intended candidates for the PhD degree must take a written qualifying examination preferably before or during the third semester of full-time enrollment. In addition to covering the basic undergraduate fundamentals, the 4-hour examination tests the students' understanding of ORE 411, 603, 607, and 609. The examination is conducted by the Ph.D. qualifying exam committee of the department and the outcome is determined by a vote of the departmental faculty.

After passing the qualifying examination and being advanced to candidacy, the student may begin preparation of the dissertation proposal and forms a dissertation committee consisting of a minimum of five graduate faculty members with at least one ORE departmental faculty member and at least one member from outside ORE. The majority of the committee should be either ORE departmental or cooperating faculty members. The committee must be approved by the Graduate Chair of the department who may appoint an additional member to the committee after consultation with the Committee Chair. Upon completion of the dissertation proposal, the student must take a comprehensive examination conducted by the dissertation committee to test his or her ability to carry out original research and preparation for the proposed dissertation topic. The examination consists of a presentation of the student's proposed research work followed by an oral component in which the student must defend the novelty of the proposed research, address any issues brought up by the committee, and demonstrate his/her ability to successfully conduct the research.

PhD students are expected to publish their research work in refereed journals in order to obtain feedback from the research community and to develop a publication track record prior to graduation. The student must present and defend the dissertation at a final examination, which is conducted by the dissertation committee.

Responsible Conduct of Research Training

The University of Hawai‘i values research integrity. To help ensure compliance with UH policies, all ORE students are required to complete Responsible Conduct of Research (RCR) training before submission of research proposals. The RCR training consists of two successive parts: 1) Collaborative Institutional Training Initiative (CITI) Certification; 2) Interactive Session Attendance. Details are available on the UH RCR website: http://manoa.hawaii.edu/ovcr/research/rcr.html

Admission

Students are admitted for graduate study on the basis of their scholastic records. Degree candidates for the MS program usually have a bachelor's degree in an engineering discipline that provides an adequate background in mathematics, physics, chemistry, and mechanics. Students seeking admission to the PhD program should have an MS in engineering or equivalent qualification. However, exceptionally well-qualified students with a BS in engineering, who do not have a master's degree, may petition to be admitted to the PhD program directly. Students with mathematics, physics or other science backgrounds may be admitted to the program, but are required to take specific undergraduate engineering courses to satisfy the pre-program requirements as outlined in Appendix B.

Deadlines to submit applications for admission to the graduate programs are January 15 for Fall semester admission and August 15 for Spring semester admission. The ORE application checklist (available on the ORE website) lists all the forms and supporting documents that need to be submitted; some forms and documents are submitted to graduate division while other are submitted directly to the ORE Department.

Detailed graduate division requirements and forms are available at the University of Hawaii Graduate Division Admissions web page(http://manoa.hawaii.edu/graduate/content/prospective-students). Official scores in the GRE General Test are required from all applicants. Official TOEFL scores are required from all non-native English speaking students.

Forms required by the Department can be downloaded from the ORE admissions web page (http://www.ore.hawaii.edu/OE/ore_admission.htm):

- Supplemental information form
- Statement of objectives
- Letter of recommendation form
- Graduate assistantship application

Once an application is complete, graduate division performs an initial screening to assure that university admission requirements are satisfied. The Admissions Committee

and Department Chair then evaluate the application and determine the admissibility of the applicant to the ORE program.

Advising and Progress

Upon admission, the Department Chair meets with each incoming student at a preliminary conference to discuss the program requirements. For students from non-ABET accredited undergraduate programs, the Graduate Chair will determine any pre-program deficiencies through evaluation of the transcript and course descriptions. The UH Graduate Division requires that all transfer credits must not have been used in obtaining a prior degree and must be approved during the first semester of enrollment. The ORE program allows up to six transfer credits of courses taken elsewhere. These courses must be equivalent to the core and option-area courses of the program and approved by the instructors upon evaluation of the course notes, assignments, and exam questions. The Department Chair will then recommend to the Associate Dean of Graduate Division to approve the transfer credits.

The Department Chair serves as the advisor to students without an undergraduate engineering degree until they satisfy the pre-program requirements. Once pre-program requirements are met, the Department Chair appoints an academic advisor from the pool of ORE departmental faculty. The academic advisor is tasked with helping students navigate through the requirements of the program and ensuring that the guidelines are met. At the start of the research phase of their studies, students select a research advisor to guide their research and serve as their Committee Chair.

All information on student progress is recorded in student progress forms, which provides data for subsequent program assessments. Graduate Division requires that several forms are submitted during the program to track progress. These forms can be found on the Graduate Division website: http://manoa.hawaii.edu/graduate/content/forms. In addition to the Graduate Division forms, PhD students are required to submit internal Form I-A (Dissertation Committee and Proposal, available in the ORE office) prior to scheduling their comprehensive examinations. Their research proposal must be attached to the form and submitted to the Graduate Chair for approval.

Policies regarding conduct and harassment are available on the ORE website: http://www.ore.hawaii.edu/OE/OE/ore_documents.htm.

Timeline

The minimum residency requirement for an MS degree at UH is two semesters full-time. The following chart outlines the typical timeline to satisfy the requirements in the MS program. Since the core and option-area courses are offered in the fall-spring semester

sequence, most students begin their enrollment in the fall semester. Students with an undergraduate engineering degree proceed directly to the program coursework and take the General Examination during their first semester. Most of them complete the degree requirements between 16 months and two years. Students with pre-program deficiencies typically spend three years full-time to complete the program.

Table 1. ORE MS timeline

MS Requirements	Semester			Semester			Semester		
	Fall	Sp	Sum	Fall	Sp	Sum	Fall	Sp	Sum
Pre-program									
General Examination									
Coursework									
Approval of research									
Research									
Final Examination									

The minimum residency requirement for a PhD degree is three semesters full-time. Based on Graduate Division statistics, the average time to complete a PhD degree in ORE is 5.5 years. The following chart shows the typical timeline to satisfy the PhD program requirements. Most students admitted into the PhD program have already satisfied the pre-program requirements and proceed directly to the program coursework. Students normally take the PhD Qualifying Examination after a year of coursework and take the Comprehensive Examination within three years after enrollment.

Table 2. ORE PhD timeline

PhD Requirements	Semester			Semester			Semester			Semester			
	Fall	Sp	Sum	Fall	Sp	Sum	Fall	Sp	Sum	Fall	Sp	Sum	Fall
Pre-program													
Program Coursework													
PhD Qualifying Exam													
Approval of research													
Research													
PhD Comprehensive Exam													
Dissertation Defense													

Students failing any one of the general, qualifying, comprehensive, and final examinations twice will be dropped from the program. Students, who do not complete all requirements within seven years after admission, will be automatically dropped from

the program. Reinstatement for a limited period of time is possible only upon submission of a petition to the Department Chair providing a detailed degree plan and new limited timeline for completion of all degree requirements.

FACULTY

Departmental Faculty

ORE has 7 departmental faculty members. All faculty members are graduate faculty with the UH Graduate Division and are responsible for the instruction, research, and administration of the department. To administer the Department, faculty serve rotational terms as Department Chair, Associate Chair and Graduate Chair. The faculty members are:

- K.F. Cheung, PhD, PE, Professor of Ocean and Resources Engineering – Coastal and offshore engineering, hydrodynamics, computational methods, water wave mechanics, sediment transport
- R.C. Ertekin, PhD, Professor of Ocean and Resources Engineering – Hydrodynamics, hydroelasticity, computational methods, nonlinear water waves, offshore mechanics, ocean renewable energy
- B.D. Greeson, PhD, U.S. Navy Captain (Ret.), Specialist and Chief Engineer, Hawaii Undersea Research Laboratory – Offshore engineering, hydrodynamics ROV/submersible operations
- B.M. Howe, PhD, Research Professor – Ocean acoustics including tomography and ambient sound, ocean observing sensor webs including fixed (e.g., cabled) and mobile platforms (e.g., gliders and profilers), navigation, and communications
- G.C. Nihous, PhD, Associate Professor of Ocean and Resources Engineering,– Ocean Thermal Energy Conversion (OTEC), wave energy, methane hydrates, ocean carbon sequestration
- E.-M. Nosal, PhD, Assistant Professor of Ocean and Resources Engineering – Passive acoustic monitoring methods, ocean ambient noise, sediment acoustics, bioacoustics, signal processing, inverse methods
- J.C. Wiltshire, PhD, Specialist and Director, Hawaii Undersea Research Laboratory – Submersibles, ROVs, deep-sea mining technology, ocean energy systems

Cooperating Graduate Faculty

ORE has a number of cooperating faculty members from other research or academic units at UH:

- J.M. Becker, PhD, Associate Professor of Geology and Geophysics – Coastal processes, currents
- B.S. Bingham, PhD, Assistant Professor of Mechanical Engineering – AUVs, navigation and control systems
- M. Chyba, PhD, Professor of Mathematics – Robotic control theory and systems
- R. Ghorbani, PhD, Assistant Professor of Mechanical Engineering, Renewable energy
- B.T. Glazer, PhD, Assistant Professor of Oceanography – Instrumentation
- H.J. Krock, PhD, PE, Emeritus Professor of Ocean and Resources Engineering – Offshore energy systems, OTEC
- S.M. Masutani, PhD, PE, Associate Researcher, Hawaii Natural Energy Institute – Thermodynamics, energy systems
- G.M. McMurtry, PhD, Associate Professor of Oceanography – Deep sea instrumentation
- M.A. Merrifield, PhD, Professor of Oceanography; Director, UH Sea Level Center ; Director, Joint Institute for Marine and Atmospheric Research (JIMAR) – Statistics, coastal circulation, current flows and mixing
- H.R. Riggs, PhD, Professor of Civil and Environmental Engineering – Structural engineering, numerical methods
- J.R. Smith, PhD, Specialist (Marine Geophysical) and Science Program Director, Hawaii Undersea Research Laboratory – Marine mapping technology and instrumentation

Their research areas include: Applied mathematics, marine acoustics, marine bioprocesses, coastal processes, nonlinear water waves, ocean currents, ocean resources, seafloor mapping, sedimentology, and structural mechanics. The cooperating faculty members give seminars on their research, serve on student research committees, and advise students on their theses or independent research projects.

Affiliate Graduate Faculty

ORE has a number of affiliate faculty members from the engineering and scientific communities:

- W. Bucher, PhD, PE, Oceanit Laboratories, Inc., Honolulu, Hawaii
- E. G. Pawlak, PhD, Associate Professor of Mechanical and Aerospace Engineering, University of California San Diego
- D. Rezachek, PhD, PE, Alternate Energy Specialist, Energy, Resources, and Technology Division, Department of Business, Economic Development and Tourism, State of Hawaii, Honolulu, Hawaii
- J. Van Ryzin, PhD, PE, President and Senior Engineer, Makai Ocean Engineering, Inc., Kailua, Hawaii

- D. Vithanage, PhD, PE, Technical Director and Vice President, Oceanit Laboratories, Inc., Honolulu, Hawaii

These affiliate faculty members volunteer their time and bring individual expertise, external perspectives and real-world engineering experience to the academic program. Some of them serve on student research committees and team-teach the capstone design project with the ORE faculty.

RESEARCH FACILITIES

Computing Facility

ORE operates four AIX and five Linux systems and a network of Pentium-based PCs. All students are given computer accounts on at least one of the Unix systems and the PC network. In addition, faculty members operate computer clusters for their individual research group to which their students have access.

ORE maintains a number of software packages that are available to the students for coursework and research. These include:

- ArcGIS
- AutoDesk Mech, Map Series, Civil Series, V1Z4, and Express Viewer
- AutoCAD
- Automated Coastal Engineering System (ACES)
- Coastal Engineering Manual (CEM)
- DELFTSHIP (Hydrostatics package)
- Matlab
- MathCAD
- Mathematica
- Microstation SE
- Photoshop
- Tecplot (graphics)
- Absoft Fortran

Students taking ORE 630 are also given access to the finite element package ANSYS, which is maintained by the Department of Mechanical Engineering.

Environmental Fluid Dynamics Laboratory

ORE's Environmental Fluid Dynamics Laboratory (EFDL) focuses on the study of coastal marine processes including turbulent dispersal of pollutants and nutrients, wave dynamics, and sediment transport. Instrumentation for lab and field measurements

includes acoustic Doppler current meters (ADCMs) and acoustic Doppler current profilers (ADCPs), for ocean current and wave measurement, an acoustic doppler velocimeter (ADV), which obtains high frequency, single point, 3-component velocity measurements and pressure sensors, and thermistors. Several tanks are accessible for small-scale research experiments and teaching demonstrations. The tanks allow demonstration of a range of fluid flow phenomena including wave breaking, down-slope currents, internal waves in stratified fluids along with rotational effects such as spin-up, Ekman flow and geostrophy.

Kilo Nalu Oahu Reef Observatory

The Kilo Nalu Oahu Reef Observatory, on the south shore of Oahu, provides a window into the nearshore coral reef physical, biological and chemical environment. The setting for Kilo Nalu is the region offshore of Kakaako Waterfront Park, east of downtown Honolulu and west of Waikiki and Ala Moana. The observatory is managed and maintained by ORE. Kilo Nalu provides data and power connections to a suite of observational instruments that resolve waves, tides, currents and nearshore water quality.

Field Work and In-Ocean Experiment

ORE maintains research facilities at Kewalo Basin and Snug Harbor for field work and in-ocean experiments. These facilities include field research equipment and instrumentation and machine shop support. ORE has access to various ocean vessels. In addition to the large ships, *Kilo Moana* and *Ka'imikai-O-Kanaloa*, this includes the *Kilo Kai*, a 25-ft Force Marine twin-outboard motorboat for local work, and the *Ho'okele*, a 38-ft twin diesel inboard motorboat suited for long-range work. Other local boats can be hired as necessary. A 7 acre in-ocean test range off Kewalo Basin extends from 5 to 20 meters depth with test platforms equipped with land-based power supply outlets and data connections. Field equipment includes SCUBA diving gear, acoustic current profilers, current meters, wave gauges, anemometers, buoys, and mooring equipment. The field research facilities support study of ocean and coastal structures and materials, wave dynamics and sediment transport.

The Hawaii Undersea Research Laboratory (HURL) is one of six national laboratories comprising the National Oceanic and Atmospheric Administration's National Undersea Research Program. HURL operates two deep diving (2000m) submersibles, the PISCES IV and PISCES V, and a remotely operated vehicle. The ROV and submersibles operate off the 225-foot research vessel, *Kaimikai-O-Kanaloa*, obtained for the university and largely supported by HURL. The submersibles, ROV and their mothership conduct a wide range of engineering and science research activities. Time on the submersibles and ROV is available to the faculty and students through submission of proposals. In addition, many students in the ORE program find thesis projects, financial support, and advisors

studying various aspects of the dynamics of submersible and ROV operations as well as new instrumentation, control and equipment applications. HURL and ORE have a very close working relationship at all levels.

The ALOHA Cabled Observatory provides another observation window into the ocean for faculty and students. Since June 2011, the ALOHA Cabled Observatory (ACO) is providing power, network communications and timing to a seafloor node and instruments at 4728 m water depth 100 km north of Oahu. The ACO is a prototypical example of a deep observatory system that uses a retired first-generation fiber-optic telecommunications cable. The cabled observatory system will provide the infrastructure for continuous, interactive ocean sampling enabling new measurements and new modes of ocean observing that integrate ship and cabled observations. Present sensors measure currents, pressure, temperature, and salinity, along with video and acoustics. Students will be able to analyze data from the ACO for projects, design and fabricate new sensors for the system, and participate on service cruises with a state-of-the-art ROV.

FINANCIAL SUPPORT AND RESEARCH PROJECTS

Financial support is available in the form of graduate assistantships (research and teaching), which include tuition waivers and a subsidized fringe benefit package. A limited number of tuition waiver scholarships are also available. Research projects not only provide financial support for graduate assistants, but also furnish students with an opportunity to participate in engineering studies to familiarize themselves with current theoretical, numerical, and experimental methods.

Details and assistantship application forms are available on the ORE admissions web page: http://www.ore.hawaii.edu/OE/ore_admission.htm

PLACEMENT DATA

Statistics from the 2007-2012 graduates provide a clear picture of where the students are coming from and where they are heading after graduation. Approximately 20% of the students were recruited from Hawai‘i (those who went through high school or undergraduate education in Hawaii), 40% from other parts of the U.S., and 40% from foreign countries. Of the 2007-2012 ORE graduates, 35% found work in Hawaii, 34% found work outside of Hawaii, 25% continued studies in Hawaii, and 6% continued studies outside of Hawaii. Almost all of the graduates obtained employment or continue to study in the ocean and resources engineering disciplines.

Career opportunities for graduates in ocean and resources engineering exist in several areas. Approximately 45% of the 2007-2012 graduates found work in private industry including oil companies, consulting and environmental service firms, classification societies, and construction firms in the U.S. About 10 % of them joined or continued their employment with federal agencies such as the Army Corps of Engineers and the Navy; and 10% found work with state agencies. Another 25% entered Ph.D. programs or received post-doctorate positions at U.S. universities. The 10% of graduates who went abroad continue to study, or work for government agencies and in academia.

FURTHER INFORMATION

FOR FURTHER INFORMATION, WRITE:
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APPENDIX A. ADVISORY PANELS

The ORE faculty regularly assess and update the education objectives, program outcomes, assessment processes, and academic program with input from surveys of alumni and their employers as well as panels of professionals representing the ocean and resources engineering communities. ORE maintains local and international panels that participate in assessments and provided input to the education objectives and academic program described in this guide.

APPENDIX B. COURSEWORK REQUIREMENTS

Pre-program requirements

ORE offers a graduate program and relies on the students' undergraduate education to fulfill the pre-program requirements that include

1. a general education component including economics, management, and humanities;
2. one year (32 credits) of college level mathematics and basic science; and
3. one and one-half years (48 credits) of basic engineering science and design.

These requirements cannot be satisfied with graduate-level courses. Students with undergraduate engineering degrees normally satisfy these requirements and can directly proceed to the graduate-level ORE program. Students with undergraduate degrees other than engineering will be required to make up deficiencies in basic engineering courses including

- statics (CEE 270),
- dynamics (CEE 271 or ME 271),
- fluid mechanics (CEE 320 or ME 322),
- mechanics of materials (CEE 370 or ME 371), and
- probability and statistics (CEE 305),
- advanced engineering mathematics (ME 403 or equivalent)

and elective courses in the following subjects depending on the student's intended option area in the department:

- computer aided design (CAD),
- surveying,
- hydraulics,
- civil engineering materials,
- structural mechanics,
- geotechnical engineering,
- environmental engineering,

- corrosion engineering,
- thermodynamics,
- heat transfer, and
- material science and engineering.

The Graduate Chair, in the consultation with the academic advisor, may waive the requirement for one or more pre-program courses provided that the majority of the course content is taken by the student during the undergraduate studies.

Course requirements

The ORE graduate program (both MS and PhD) includes a 15-credit that covers:

- ORE 411 Buoyancy and Stability (3 credits)
- ORE 601 Ocean Engineering Laboratory (3)
- ORE 603 Oceanography for Ocean Engineers (3)
- ORE 607 Water Wave Mechanics (3)
- ORE 609 Hydrodynamics of Fluid-Body Interaction (3)

The minimum required grade for the prerequisites of the 5 core courses in the department is B-.

All students must also take the 1-credit ORE 792 Seminar by attending 15 seminars that are related to ocean and resources engineering.

Additional course requirements: MS program

In addition to the course requirements listed above, the MS program requires an option-area program. The students must select a 9-credit option-area program in coastal engineering, offshore engineering, or ocean resources engineering. The course requirements for these option areas are listed below.

Coastal engineering:

- ORE 661 Coastal and Harbor Engineering (3)
- ORE 664 Near-shore Processes and Sediment Transport (3)
- ORE 783B Capstone Design Project – Coastal (3)

Offshore engineering:

- ORE 612 Dynamics of Ocean Structures (3)
- ORE 630 Structural Analysis in Ocean Engineering (3)
- ORE 783C Capstone Design Project – Offshore (3)

Ocean resources engineering:

- ORE 677 Marine Renewable Energy (3)
- ORE 678 Marine Mineral Resources Engineering (3)
- ORE 783D Capstone Design Project – Ocean Resources (3)

Additional course requirements: PhD program

In addition to the course requirements listed above, PhD students are required to take an advanced mathematics course at the graduate level (GG 600 Equations of Geophysics or equivalent).

Other course requirements/options

Although the UH Graduate Division requires a minimum of 30 credits for graduation, most students take more than the required minimum, averaging around 33 credits.

Students are encouraged to take courses in other option areas as electives. In addition, the department offers the following electives:

- ORE 330 Mineral & Energy Resources of the Sea (3)
- ORE 654 Applications of Ocean Acoustics (3)
- ORE 608 Probability and Statistics for Ocean Engineers (3)
- ORE 641 Environmental Fluid Dynamics (3)
- ORE 699 Directed Reading or Research
- ORE 707 Nonlinear Water Wave Theories (3)
- ORE 766 Numerical Methods in Ocean Engineering (3)
- ORE 791 Special Topics

Other departments offer a number of courses relevant to ORE. These courses are approved on an individual basis as electives by the academic advisor.