ABET
Self-Study Report

for the

Department of Ocean and Resources Engineering

University of Hawaii at Manoa
Honolulu, Hawaii

July 1, 2015

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Program Self-Study Report

for
ABET-EAC Reaccreditiation

Ocean and Resources Engineering
Master of Science
University of Hawaii at Manoa

BACKGROUND INFORMATION

A. Contact information

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B. Program History

1. Name

Master of Science (MS) in Ocean and Resources Engineering (formerly Master of Science in Ocean Engineering).

The Ocean and Resources Engineering Department (ORE) does not offer an undergraduate degree. It is a graduate only, research-oriented department and, hence, is accredited at the Master's level. Undergraduate ABET requirements are satisfied by students completing an ABET accredited undergraduate engineering degree before beginning the master's program (verified by the Department) or by incoming students making-up sufficient undergraduate courses (as assigned by the Department) at the University of Hawaii ABET-accredited College of Engineering to fulfill basic ABET undergraduate requirements.

The degree name was changed in Spring 2000. Students admitted before Spring 2000 received an MS in Ocean Engineering upon graduation. Students graduating after December 2003 received an MS in Ocean and Resources Engineering. Between 2000 and 2003 students could select either name. The University of Hawaii conferred the first MS degree in Ocean and Resources Engineering in December 2000 and conferred the last MS degree in Ocean Engineering in December 2003.

2. General History

The program began in 1966, founded by famed Coastal Engineer, Dr. Charles Bretschneider. The Department was originally part of the College of Engineering. In 1987, the Department elected to join the newly formed School of Ocean and Earth Science and Technology (SOEST). The thought was that the department would form the technology aspect of this school and grow under the increasing resources pumped into the newly formed school. This proved not to work as well as originally hoped and the department languished for some years. In the late 1990's the department was further stressed by the closing of its major research facility, the J.K.K. Look Laboratory of Ocean Engineering, an aging off-campus facility. Beginning in 2002, under the leadership of Dr. Kwok Fai Cheung and a new vision of the department in the SOEST Dean's office, a major turnaround has been accomplished. ORE has shown remarkable advancement over the last three ABET cycles. In 1997, the program was reeling under its loss of laboratory space and faculty. By 2003, this had been corrected and the present program was instituted with its current master's course plan and assessment processes. This has been sustained over time. During the last six years, the earlier gains have been consolidated with new faculty hires, significantly stronger support from the administration, additional space, many new grants, a stable number of students, and much higher morale. New faculty have been hired (most recently Dr. Huang). The department is stabilized compared to its situation only 10 years ago, is optimistic and morale is high. In general the last six years have not been a time of major program change. Following the positive ABET-Engineering Accreditation Commission (EAC) review during the 2009-2010 Accreditation Cycle, the Department has worked to consolidate and institutionalize the major gains and changes made to that point rather than to again change what is a very successful program.

Building on the mission of the University of Hawaii and the School of Ocean and Earth Science and Technology (SOEST), the Department of Ocean and Resources Engineering (ORE) has developed and continued its Mission Statement, expanded this into a series of objectives, and honed these objectives into a set of student outcomes anticipated to produce the desired objectives. The program outcomes are measured by 12 rubrics consisting of six direct measures and six indirect measures. These rubrics are presently under revision to increase the number of direct measures of student outcome and reduce the data collected by general survey. The measured rubrics show a very clear picture; ORE has fully achieved its program outcomes and objectives.

C. Options

The program has three option areas: Coastal Engineering, Offshore Engineering and Resources Engineering.

D. Program Delivery Modes

The program is delivered by normal-day, on-campus programs at the advanced level. There are no evening, summer, web based or remote programs. Classes are taught in lecture, seminar and research lab mode depending on the course. There are no evening, off-campus or online options for any courses.

E. Program Locations

The program has a single location which is the Manoa Campus of the University of Hawaii. No parts of the program are taught elsewhere.

F. Public Disclosure

Program Educational Objectives (PEOs), Student Outcomes (SOs), annual student enrollment and graduation data are all posted on the department website. This website is www.soest.hawaii.edu/ORE. The PEOs are posted at http://www.soest.hawaii.edu/ORE/OE/ore_objectives.htm. The SOs are posted at http://www.soest.hawaii.edu/ORE/OE/ore_outcomes.htm. The current enrollment is under the student section and is 17 . This includes 10 Master's students and 7 Ph.D. students. This website is updated at least yearly. In addition all of this data is available electronically or in hard copy form from the ORE department office at the University of Hawaii.

G. Deficiencies, Weaknesses or Concerns from Previous Evaluation(s) and the Actions taken to Address them

The 2009 ABET review did identify two concerns. One concern was the Department's ability to assess the attainment of its Student Outcomes. Part of the concern was that the department was viewed as relying too heavily on surveys, essentially indirect methods for assessing outcomes. The view here was that just because a student, employer or alumni says they have achieved an outcome does not mean they have. To correct this the department is increasingly relying on direct methods –assessment of specific exams, design projects and theses to assess the positive attainment of outcomes. This is an ongoing correction and is further described below.

The second concern was that master's theses and projects need to be of the highest standard of scholarship and show all data and analysis used to reach conclusions. The Department has addressed this concern by insisting students put their data in the thesis where possible (all theses are available for ABET inspection) and that thesis and project work be published in the peer-reviewed literature if possible. The Department is fortunate in that two of its faculty members are Editors-in Chief of peer reviewed engineering journals (Dr. Ertekin for *Journal of Ocean Engineering and Marine Energy* and Dr. Wiltshire for *Marine Geotechnology and Georesources*) and have been available to assist students.

This 2009 ABET-EAC review found the program had no deficiencies or weaknesses. The department has worked with its advisory committees, faculty and students to maintain the improvements it had undertaken over the previous accreditation cycle. These improvements include more tightly wording its student outcomes which are reproduced below:

The graduate program in Ocean and Resources Engineering channels the students' previous education and work experience to ocean-related engineering careers. Students, upon graduating from the program, will have:

1. A broad education necessary to understand the impact of engineering solutions in a global and societal context;

2. An ability to apply knowledge of mathematics, science, and basic engineering topics that include statics, dynamics, fluid mechanics, solid mechanics, and probability and statistics;
3. Proficiency in the core program that comprises hydrostatics, oceanography, water waves, fluid-structure interaction, underwater acoustics, laboratory and at-sea experience;
4. Working knowledge of at least one of the three option areas that include coastal, offshore, and ocean resources engineering;
5. An ability to use the techniques, skills, and latest engineering tools necessary for ocean and resources engineering practice;
6. An ability to identify, formulate, and solve ocean and resources engineering problems;
7. An ability to design and optimize engineering systems to meet the needs of the marine community;
8. An ability to work independently and function on multi-disciplinary teams;
9. An appreciation of professional and ethical responsibilities;
10. An ability to communicate effectively to technical and non-technical audiences;
11. An awareness of latest research and contemporary issues in and beyond the marine community; and
12. A recognition of the need for, and an ability to engage in life-long learning and continuing professional development.

Perhaps the largest improvement is the range of rubrics now used to measure the effectiveness of the ORE program. The basic philosophy of this change is to shift from survey type evidence to more direct assessment methods. This change is on-going but has now been underway for several years.

<u>Broader rubrics (listed below) are now used to measure the effectiveness and achievement of the outcomes.</u>

Rubrics have been honed to accurately measure the achievement of both program objectives and student outcomes.

<u>Direct Measures</u>

1. The master's qualifying exam
2. Committee verification of undergraduate ABET requirements and assignment of remedial action
3. Capstone Design Class
4. Master's thesis defense and evaluation of thesis for outcome elements
5. Circulation and review of thesis proposals by all the faculty
6. Student employment placing, particularly repeat hires by employers

<u>Indirect measures</u>:

7. Local and International Advisory Panels
8. Employer Surveys
9. Student Exit Interviews
10. ABET course reviews done at the end of each course by both students and faculty

11. Alumni Surveys
12. Student advising meeting to determine fulfillment of undergrad requirements and progress (new form and process implemented in 2015)

A major series of new assessment measurements have been strengthened since the last program review. These include a more thorough preliminary conference and group evaluation of qualifying exam results, clearer definition of the course outcomes matrix, broader evaluation of thesis projects, and closer association with employers and employer feedback. Since the last program review, courses and thesis projects are reevaluated every year to more closely correspond to the input from these rubrics. Several rubrics are being added to or strengthened. In general we are trying to switch from more general survey type assessment methods to more specific course based assessment methods.

CRITERION 1. STUDENTS

A. Student Admissions

The University of Hawaii Graduate Division screens all applicants for admission to assure validity of their prior degrees and satisfaction of the university admission requirements. Minimum university admission requirements for a master's program are as noted on the graduate division website and are as follows:

"To be eligible, an applicant must hold or expect to hold prior to matriculation a bachelor's degree from a regionally accredited U.S. college or university, or an equivalent degree from a recognized non-U.S. institution of higher education. At minimum, the applicant needs to demonstrate above average academic performance (B average, usually a 3.0 on a 1.0-4.0 scale) for undergraduate course work and for any post-baccalaureate or graduate course work. Because the number of qualified applicants exceeds the number of spaces available, admission is competitive. Meeting minimum admissions standards does not guarantee admission."

The Department Chair, in consultation with the Graduate Chair, evaluates the applicants and determines their admissibility to the Ocean and Resources Engineering program after discussion with the full faculty. The Department Chair also provides consultation to applicants, assists in their fellowship or education-leave applications, and matches applicants of research assistantships with research projects.

Most applicants to the Ocean and Resources Engineering program at the MS level have undergraduate degrees in engineering, and satisfy the pre-program requirements that include:

- A general education component,
- One year of college-level mathematics and science, and
- One and one-half years of engineering topics

as outlined in the ABET Engineering Accreditation Commission (EAC) Criteria. The Department also admits outstanding highly motivated students with undergraduate degrees in mathematics and science. Typically, students in this category would be about 10% of total

admissions. These students, who normally have a general education component and a year of college-level mathematics and science, are given conditional acceptance. The Department requires those students to make up the deficiencies in basic engineering courses that at a minimum include:

- Computer aided design,
- Statics and dynamics,
- Solid mechanics and laboratory,
- Fluid mechanics and laboratory,
- Probability and statistics,

and at least five undergraduate engineering courses complementing the intended specialization in the program. These additional courses amount to approximately one and one-half years of study as required by the ABET-EAC Criteria. A department committee verifies that these students meet a-k requirements by completing approved course work in the University of Hawaii ABET accredited College of Engineering. This verification is certified in the student's file.

Entering non-native English speaking students are required to have taken a TOEFL examination to evaluate their English language abilities. Depending on their scores, these students are individually evaluated at the University of Hawaii English Language Institute and assigned English-as-second-language (ESL) courses if needed. The English Language Institute offers a number of courses on technical writing and communication for native and non-native English speakers in graduate studies.

The University of Hawaii Graduate Division requires that all transfer credits must not have been used to obtain a prior degree and must be approved during the first semester of enrollment. The Ocean and Resources Engineering program allows up to six transfer credits from ABET accredited engineering programs. 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 Graduate Division to approve the transfer credits.

The Department administers a General Examination to the MS students, except those with pre-program deficiencies, during their first semester of enrollment. Students who passed the Fundamentals of Engineering (FE) examination within the last three years are exempted. The questions in the two-hour examination are similar to those in the FE Examination and measure the students' ability to apply knowledge of mathematics, science, and mechanics in the solution of basic engineering problems. Passing the examination completes the pre-program requirements and advances the students to master's candidacy.

B. Evaluating Student Performance

Each year the Chairman receives a progress report from the University of Hawaii Graduate Division. This highlights the courses and progress each student has made with respect to the anticipated time lines for graduating. As the department has only about 20 students (typically about 15 Master's students and 5 PhD students), it is not a difficult task to monitor each student's transcript and progress individually on an annual basis. Unlike an undergraduate program, course work for the Master's degree typically takes only 18 months to two years (3 to 4 semesters).

When clear deficiencies are noted these are discussed both with the student and the advisor. This continuous assessment begins with the initial admittance.

Upon admission and as continuous documentation, the progress of each student from the preliminary conference to the exit interview is recorded in a student progress form, which is kept in the student's file. The appendix provides a copy of the progress form, which consists of six sections:

- Pre-program requirements,
- Prior education and work experience,
- Program requirements,
- Research work,
- Exit interview, and
- Post-graduation monitoring

C. Transfer Students and Transfer Courses

The department does not usually accept transfer students. If a student has taken a course equivalent to one of the core courses, this course requirement can be waived on submission of a transcript and course syllabus of the course proposed and having a designated faculty member evaluate the course to determine that it is in fact equivalent. This is noted in a memo to Graduate Division and the equivalency is noted in the students file. Normally the student would still take 30 credits at UH to get the master's degree.

The University of Hawaii Graduate Division requires that all transfer credits must not have been used to obtain a prior degree and must be approved during the first semester of enrollment. Formally, the Ocean and Resources Engineering program allows up to six transfer credits from ABET-EAC accredited engineering programs. 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 the Graduate Division to approve the transfer credits.

D. Advising and Career Guidance

At the beginning of each semester, the Department Chair meets with each incoming student at a preliminary conference to discuss the student's prior education and work experience, determine any pre-program deficiencies, and discuss the coursework and research requirements. The student identifies an area of study from one of the three option areas:

- Coastal engineering,
- Offshore engineering, and
- Ocean resources engineering,

The student selects an academic advisor from the departmental faculty, who specializes in that area of study. If the student is supported by a research assistantship, the faculty member providing the support will serve as the academic advisor. The Department Chair serves as the

advisor to the students without an undergraduate engineering degree until they satisfy the pre-program requirements and select academic advisors from their areas of study.

The academic advisor formulates a program of study for the student based on the student's background and interest and performs periodic review of the progress to assure satisfaction of the program coursework requirements. The MS degree program requires a minimum of 30 academic credits. At least 24 credits must be earned in advanced-level courses number 600 or above and only two credits of directed reading or research can be counted toward the MS requirements. Each student must also satisfy the coursework requirements, consisting of 15 credits of core courses, 9 credits of option-area courses, and 1 credit of seminar. The core courses cover the basic disciplines that include:

- Hydrostatics
- Oceanography
- Water waves
- Fluid-structure interaction
- Underwater acoustics
- Laboratory and at-sea experience

The option-area courses allow students to specialize in coastal engineering, offshore engineering or ocean resources engineering, culminating with a capstone design that integrates the program coursework in a project team-taught by the faculty and practicing engineers. The 1-credit seminar requirement includes attendance of 15 seminars during the student's time in the program on relevant subjects selected by the students.

The student will have a research advisor as well as an academic advisor. Most often this is one in the same faculty member. The research advisor, who serves as the chair of the student's thesis committee, identifies elective courses to form a coherent research program and guides the student through the research work. The research or independent project normally takes one to three semesters to complete and is an important component of the program that tests the student's ability to carry out independent research work and introduces the student to the latest technological developments in ocean and resources engineering. The work results in a thesis or a report that demonstrates both mastery of the subject matter and a high level of communication skills as required for Master's level programs. The student must present and defend the work at a final examination, which provides the faculty a final opportunity to test the student's understanding and ability to integrate his or her work at the MS level.

The Department provides informal career guidance through bringing the students in contact with engineering companies through professional society events, professional engineers involved in the capstone design course and internships. The Department also encourages student participation in extracurricular and engineering community activities. They elect a representative, who serves as the liaison with the Ocean and Resources Engineering faculty and the University of Hawaii Graduate Student Organization. Through their representative, the students participate in activities at the department, university, and community levels. Most of the students are members of the Student Chapters of the Marine Technology Society and the Society of Naval Architecture and Marine Engineering.

E. Work in Lieu of Courses

The Department does not recognize work in lieu of courses. However, with the support of a faculty member, an ORE 699 course (directed research) could be structured for a student that could include elements of work performed for a legitimate engineering company. Sometimes students on internships use material from a corporate engineering project as part of their thesis or research project (plan B).

F. Graduation Requirements

The graduation requirements (ABET undergraduate degree or equivalent, ORE 411, 601, 603, 607, 609, 683, 792, 6 credits of option area courses and a thesis) are clearly stated and checked by both the Department and university Graduate Division. All graduating students must be cleared by the university computer system as having met all requirements. Independently, the Department Chairman, administrator and student's advisor check all requirements on the student's transcripts with the student progress form. Only when all of these checks agree does the Department Chairman sign the release form, which then goes to the University Graduate Division for final verification before a degree is awarded. Table 1-1 below outlines the usual progress of a student toward the master's degree. Table 1-2 shows the 28 graduates of the program from 2009-2014 and where they went after graduating giving a real idea of the program's success in getting trained ocean engineers working in the profession.

Table 1-1. Timeline for Completion of MS Degree

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

Table 1-2. Program Graduates

Name	Year Matriculated	Year Graduated	Prior Degree(s) if Masters Student	Certification / Licensure	Initial or Current Employment/ Job Title/Other Placement
1. Quintero, Miguel R.	FA 2007	MS 2009	BS, OE		Naval Surface Warfare Center Carderock Div, West Bethesda, MD
2. Shu, Shi	FA 2007	MS 2009	BE, Mar Engr		Hunan Provincial Communication Plan. & Design Institute -engineer
3. Wilkinson, David P.	FA 2007	MS 2009	BS, OE		Naval Facilities Engineering Service Center, Port Huememe, CA
4. Chen, In Chieh	FA 2007	MS 2009	BS, Mech Materials		Makai Engineering Inc. Waimanalo
5. Pisciotto, Nicholas V.	FA 2008	MS 2010	BS, CE	EI, FE, PE	Brown and Caldwell; Engineering firm; Honolulu
6. Vaganov, Victoria M.	FA 2007	MS 2010	BS, Ear Sci		PhD Student; Victoria University; Wellington, New Zealand
7. Heitmann, Troy W.	FA 2007	MS 2010	BS, OE	EI	ORE Graduate Student - PhD
8. Arinaga, Randi A.	FA 2003	MS 2010	BA, Bio & Soc		General Atomics, Kauai
9. Eisen, Blue D.	FA 2007	MS 2010	BS, OCN		Oceanic Co. Inc. Honolulu; Project Engineer
10. Tyler, Jacob G.	FA 2007	MS 2011	BS, CE	FE	Instructor Kapiolani Community College; PhD student ORE
11. Keller, Vanna J.	FA 2009	MS 2011	BS, OE		Ocean Imaging Consultants; Project Engineer; Honolulu
12. Tuthill, Lauren K.	FA 2009	MS 2012	BS, Biomed Engr		AECOM , Honolulu; Environmental Engineer
13. Field, Charles D.	FA 2010	MS 2012	BS, ME & OE		Navatek, Ltd. Honolulu
14. Duarte Quiroga, Pablo	SP 2006	MS 2012	BS, OCN		ESA-PWA, San Francisco
15. Casilio, John F.	FA 2011	MS 2012	BS, Aeronautical Engr		US Navy; Naval Air System Command; Ocean System IPT Lead
16. Morita, Matthew M.	FA 2009	MS 2012	BS, CE	FE	LYZ Inc./subsidiary of PER Inc. (Aiea) Project Engineer
17. Anast, Peter Z.	FA 2010	MS 2013	BS, ME		Boeing - Seattle
18. Young, Max	FA 2009	MS 2013	BS, ME	FE	UH Manoa; HURL

Name	Year Matriculated	Year Graduated	Prior Degree(s) if Masters Student	Certification / Licensure	Initial or Current Employment/ Job Title/Other Placement
					Hawaii Undersea Research Lab
19.Nolte, Jerica D.	FA 2011	MS 2013	BS, OE	FE	Marine Innovation & Technology; Berkeley, CA
20.Miyamoto, Adam I.	FA 2010	MS 2013	BS, Bio Engr	FE	SWCA Environmental Consultants
21.Barnes, Austin T.	FA 2010	MS 2013	BA, Astrophysics	FE	Peace Corp, Africa
22.Anderson, James P.	FA 2007	MS 2013	BS, CE	EIT	UH Manoa - Hawaii Undersea Research Lab ; UHM- ME APT
23.Carmichael, Allan R.	FA 2007	MS 2014	BS, Chem Engr		Makai Ocean Engineering , Kailua
24.Frederick, Michael D.	FA 2011	MS 2014	BS, ME		Sea Engineering, Santa Cruz, CA
25.Miyakita, Shino	FA 2009	MS 2014	BS, CE & MS, CE	FE	Post grad education- Japan
26.Schwartz, Andrew K.	FA 2011	MS 2014	BS, Physics	EIT	Kauai Island Utility Cooperative, Lawai, HI
27.Templeton, William J.	FA 2011	MS 2014	BS, CE	EI	Hatch Mott MacDonald Seattle, WA
28.Silver, Kara	FA 2012	MS 2014	BS, ME	FE	Consultant, Boston,MA
29.Linsley, Derek	FA 2013	MS 2015	BS, CE	FE	Sea Engineering, Honolulu, HI
30.Alexander, Stephenson	FA 2012	MS 2015	BS, MS, CE	FE	Sea Engineering, Honolulu, Hawaii

CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVES

A. Mission Statement

The common purpose of the University of Hawaii (UH) system of institutions is to serve the public by creating, preserving, and transmitting knowledge in a multi-cultural environment. The University is positioned to take advantage of Hawaii's unique location, physical and biological environment, and rich cultural setting. At all levels in the academy, students and teachers engage in the mastery and discovery of knowledge to advance the values and goals of a democratic society and ensure the survival of present and future generations with improvement in the quality of life. In this context the published mission of the University of Hawaii is to:

- Provide all qualified people in Hawaii with equal opportunity for high quality college and university education and training.

- Provide a variety of entry points into a comprehensive set of post-secondary educational offerings, allowing flexibility for students to move within the system to meet individual educational and professional needs.
- Advance missions that promote distinctive pathways to excellence, differentially emphasizing instruction, research, and service while fostering a cohesive response to state needs and participation in the global community.

As the only public higher education institute in Hawaii, the UH system bears a special responsibility to prepare a highly educated citizenry. In addition, the system supports the creation of quality jobs and the preparation of an educated workforce to fill them. Building on a strong liberal arts foundation, the UH system prepares the full array of workers from technicians, physicians, and scientists to artists, teachers, and marketing specialists – who are needed in a technologically advanced and culturally diverse island state (Excerpt from the University of Hawaii System Strategic Plan – The System Mission, June 2002).

The Department of Ocean and Resources Engineering is part of the School of Ocean and Earth Science and Technology (SOEST) at the University of Hawaii Manoa campus. UH Manoa is the flagship campus of the University of Hawaii system and is a research university with "core commitments on Research, Educational Effectiveness, Social Justice, Place, Economic Development, Culture, Society and The Arts, and Technology" (University of Hawaii at Manoa Strategic Plan). These commitments are outgrowths of the UH system missions with additional emphasis on research and graduate education as well as the unique oceanic location of Hawaii. SOEST fills this mission through its focus on earth science and its supporting technology.

This mission clearly includes the mission of the Department of Ocean and Resources Engineering (ORE).

The published mission of ORE (http://www.soest.hawaii.edu/ORE/OE/mission.htm) is to provide high quality education, research and service to its constituents.

The specific mission statement goals of the Department are to:

1. Educate top quality ocean and resource engineers to meet the needs of Hawaii, the nation and the engineering profession.
2. Conduct and disseminate research in the field of Ocean and Resources Engineering.
3. Provide service to the State of Hawaii, Pacific Basin and engineering profession through such opportunities as seminars, conferences, consulting, work with government agencies and professional societies.

The Department mission statement reproduced above is found at the front of the Department's website.

B. Program Educational Objectives

The Ocean and Resources Engineering program has three option areas: coastal, offshore engineering, and ocean resources engineering. The ORE program and its educational objectives were developed over a number of years working in close association with our advisory panels and professional engineering societies. These Educational Objectives are published on the

Department website (www.soest.hawaii.edu/ORE). The Educational Objectives of the MS program are to produce graduates who attain within a few years of graduation the following traits:

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, ethical, managerial, 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.

Since the Department of Ocean and Resources Engineering only offers graduate programs, a concomitant goal is to conduct research in support of the education program. The strong PhD program and the culturally diversified PhD student body expose the MS students to the latest research and development in an international setting.

C. Consistency of the Program Educational Objectives with the Mission of the Institution

The ORE department has, in close consultation with its constituents, developed a set of objectives consistent with its mission statement. The objectives are more specific than the department mission, elucidating the expected results of study of our program. In the same way, the ORE mission takes our parent School of Ocean and Earth Science and Technology's mission to study earth systems and focuses it onto the area of ocean engineering education and research. Similarly, the School of Ocean and Earth Science and Technology (SOEST) mission is a refinement of the UH mission to provide top quality higher education and focus area research for the people of Hawaii and the Pacific Basin.

The mission of the University of Hawaii is to provide higher education and relevant research to the people of Hawaii to train them for 21st century jobs and living. The university emphasizes its Asia-Pacific heritage and marine setting. As part of this mix SOEST has a four-part goal of describing the marine and earth environment. ORE goals fit in with those of SOEST in the area of graduate education and research. ORE is in some respects the 'T'(technology) in SOEST. The ORE mission dovetails perfectly with that of SOEST, which is in turn an integral part of that of UH.

Our Educational Objectives also dovetail with the missions of the University of Hawaii by taking advantage of Hawaii's mid-ocean location, providing a quality education program vital to Hawaii, disseminating new ideas and techniques to the community through training, and most importantly, supplying qualified ocean engineers to sustain the changing needs of Hawaii and the nation. Although only 5% of the 2010-2015 graduates originated from Hawaii, 60% of them stayed in Hawaii after graduation. The graduates constitute the majority of the practicing ocean engineers in Hawaii and have contributed significantly to the infrastructure development all over the Pacific Basin. Many of the early graduates have founded companies or been serving as senior officers in the local marine industry. Their activities generate ocean-related engineering jobs in

Hawaii and provide employment opportunities for recent graduates. This continuing process has made the program an integral part of the local and Pacific basin-wide marine industry.

For the Government of the State of Hawaii, ORE provides several key functions. The ORE coastal program provides wave modeling and tsunami inundation maps critical for public safety. The program is intimately tied in with the State Department of Civil Defense. The ocean alternative energy program links closely to the State goal of providing 30% of its energy from renewables by 2020. The ocean observation program ties directly to the State's response to Global Climate Change. ORE is critically tied to high priority State areas.

The Ocean and Resources Engineering program is also an active participant in the global community. Many of the graduates moved to various parts of the US mainland or returned to their home countries that include Canada, China, India, Japan, France, South Africa, Thailand, Ecuador, Germany, Brazil, Spain, Korea, Belgium, Taiwan, the Netherlands, the Philippines, and the United Kingdom. Many of them now hold senior positions in major corporations, universities, or government agencies. The strong ties maintained by the graduates with the Department indicates satisfaction with the education they received and fulfills an important mission of the University of Hawaii in reaching out to the global community.

D. Program Constituencies

The program has a series of constituents:

- The most basic constituents of the program are the students who rely on the program for training and inspiration toward becoming productive engineers.
- The second level of constituents are the employers who will later employ our students and expect well-trained professionals.
- The next level of constituents are the faculty who have invested their careers in the Department to train the next generation of Ocean Engineers and for the opportunity of research advancement.
- The final level of constituents are the alumni and donors who expect the Department to instill knowledge and professional practice skills into a new generation of engineers to foster the engineering profession and its associated professional societies.

The needs of these constituencies are assessed by our advisory committees and by our faculty's discussions with professional societies with whom they work closely. Surveys are also sent out to graduates, alumni and employers every 3 years.

The Ocean and Resources Engineering program is structured to provide a curriculum and the associated assessment processes that meet the Educational Objectives as outlined above. The constituents above are routinely consulted to determine that their needs are met. 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 educational background and covers technical and non-technical issues commonly encountered by engineers in professional practice and addresses the objectives at the most basic level. In addition, MS students are required to take the General Examination to test their knowledge in mathematics, science, and basic engineering, and their preparation for the advanced-level program. This ensures the engineering basis is solid for all students. The master's program then

goes on to build on this base. The success of each course is assessed each year to make sure it is meeting its assigned role. The students, faculty, employers and alumni are polled both formally and informally to determine that their needs are met.

E. Process for Establishing Program Educational Objectives

During the previous ABET-EAC cycle the faculty conducted a series of workshops to review the criteria for establishing educational objectives and to realign the Ocean and Resources Engineering program with the objectives. We developed and strengthened our assessment processes in compliance with the requirements. We involved our constituents heavily in this process through discussions on an individual basis and through formal reports from advisory committees. University administration was closely involved to insure our educational objectives are in line with the university's mission. This was significantly handled through monthly meetings with the school's Dean and Vice Chancellor for research.

The Department met with two ABET consultants to refine our processes. We organized the program constituencies, which include the students, the local marine industry, and the ocean engineering community, into the following advisory panels. The student advisory panel included both MS and PhD students in the Department. The Local Professional Advisory Panel is mostly composed of senior executives of organizations that employ the graduates of this program in Hawaii. Their background is quite diversified and includes academia, management, operations, engineering consulting and government. Most of these people are involved in ongoing informal discussions with the Department often through providing internships to our students. The International Professional Advisory Panel members, on the other hand, all specialize in various aspects of ocean and resources engineering and come from a broad spectrum of academia and industry. In Spring 2015, we asked to the local and international advisory panels to write one large joint report. It will be available with detailed faculty commentary with the departmental file and support materials in the ABET-EAC review. The panel members are listed below. Some of the panel members, indicated by an asterisk(*), are graduates of the Department.

<u>Student Advisory Panel</u>

1. Yaprat Onat (Chair), Ph.D. Candidate in Ocean and Resources Engineering
2. Arouch, Ghizlane, MS Candidate in Ocean and Resources Engineering
3. Queima, Andeia , MS Candidate in Ocean and Resources Engineering
4. Rocha, Courtney, MS Candidate in Ocean and Resources Engineering
5. Ryan, Kyle, MS Candidate in Ocean and Resources Engineering
6. Varamo, Vincent, MS Candidate in Ocean and Resources Engineering
7. Wesley, Matthew, MS Candidate in Ocean and Resources Engineering

<u>Local and International Professional Advisory Panel</u>

1. Zeki Demirbilek, PhD, PE, FASCE, Research Hydraulic Engineer, Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, U.S. Army Corps of Engineers, Vicksburg, Mississippi
2. Jose Andres*, PhD, PE, President, Makai Ocean Engineering Inc., Waimanalo, Hawaii.

3. Roger Babcock, PhD, PE, Associate Professor, Department of Civil and Environmental Engineering, University of Hawaii, Honolulu, Hawaii.
4. Warren Bucher*, PhD, Vice President, Oceanit Laboratories, Inc., Honolulu, Hawaii.
5. Robert Rocheleau*, PE, CEO, Sea Engineering Inc., Waimanalo, Hawaii.
6. Elaine Tamaye*, PE , President, EKNA Services, Honolulu, Hawaii.
7. Thomas Mathai, PhD (Chair), Senior Analyst, The Glosten Associates, Inc., Seattle, Washington.
8. Sander Calisal, PhD, PEng, Professor Emeritus, Department of Mechanical Engineering, University of British Columbia, Vancouver, B.C., Canada.
9. John Halkyard, ScD, PE, President, Halkyard Associates , Houston, Texas.
10. Paul Palo, PhD, PE, Mechanical Engineer, Ocean Facilities Department (retired), Naval Facilities Engineering Service Center, Port Hueneme, California.
11. Solomon Yim, PhD, Glenn Willis Holcomb Professor, Department of Civil and Construction Engineering, Oregon State University
12. Joong Woo Lee*, PhD, Professor, Department of Civil Engineering, Korea Maritime and Ocean University, Busan, Korea. Vijay Panchang, PhD, PE, Regents Professor, Texas A&M University System: Chair, Mechanical Engineering Program Texas A&M University Qatar; Powell Professor, Maritime Systems Engineering and Marine Engineering Technology, Texas A&M University at Galveston

The panels were provided with a draft self-study report and were tasked to comment on the educational objectives and to evaluate the program attributes in its ability to deliver these objectives. The Department appointed a faculty member to serve as the coordinator for the student, local and international professional panels. This faculty member primarily serves as the liaison between the panels and the Department and did not participate in panel discussions. The international professional panel members conducted their discussion and deliberation through electronic media. Both the local and international professional panels are familiar with ABET processes and other similar engineering programs in the US.

Although the Educational Objectives, by ABET's definition, are applicable to graduates during the first several years of employment, our surveys and solicited comments (available in the appendices to this study) covered the graduates over a longer period to provide more comprehensive data. The survey questions are structured to gather quantitative data to assess the effectiveness of the academic program in meeting the educational objectives of these two major constituencies. Although this report addresses specifically the MS program, the survey also covered PhD graduates, who went through the same coursework and requirements as the MS graduates, but with a more intensive research project culminating with a dissertation.

Using the advisory panel input and survey results, the Ocean and Resources Engineering faculty reviews and revises, if necessary, the program educational objectives every 5 years, assessment process every year, and curriculum every 2 years. The last major program revision was following the SOEST external review panel and its detailed recommendation in 2013. For curriculum changes, the University of Hawaii graduate division must approve any revisions to the curriculum. This is done in several steps. The Department has implemented a revised curriculum and assessment process as described later in this self-study report. Table 2-1 shows the assessment process and review cycle. The exit interview and survey are continuing processes.

The faculty review the student comments from all courses and annual reviews and then make minor adjustments to the program on an ongoing basis. According to this schedule, the next major revision to the Ocean and Resources Engineering program will be made in 2015-2016.

Overall, the Department has found its six objectives to have been well received by the department's constituents. The University administration and the administration of the School found the objectives to be highly consistent with those of the University as a whole and the School of Ocean and Earth Sciences and Technology in particular.

Table 2-1. Assessment Process and Review Cycle for Educational Objectives

Assessment Process	2013		2014		2015	2015
	S	F	S	F	S	F
Exit interview	✓	✓	✓	✓	✓	✓
Exit survey	✓	✓	✓	✓	✓	✓
Minor adjustment	✓					✓
Alumni survey				✓		✓
Panels		✓			✓	
ABET review						✓

The Department organized the panel reviews and alumni and employer surveys. The survey questionnaires are in the Appendix. Two of the panel reports are rather lengthy and the survey results are quite comprehensive. Criterion 4 describes the revisions to the program. Although both the panel reviews and questionnaire surveys directly address the Educational Objectives and curricular elements, the interpretations of the two sets of results are different. The panel reports reflect the views of the constituencies on the Educational Objectives and curricular elements as outlined in this self-study report, while the survey results represent an evaluation of the program over the past 10 years.

The Department sent out surveys to all the graduates and received 19 responses with 11 MS and 8 PhD respondents. This response rate is not high, but is reasonable for this type of survey. Alumni were asked to rate 22 curricular elements with a scale from 1 to 5 on the importance they perceive and the preparation they received from the program (5 representing highest importance and preparation). The 22 curricular elements are grouped according to the Educational Objectives and the results are summarized in Table 2-2. The difference between the two ratings provides a quantitative measure of the program effectiveness in achieving the Educational Objectives. The alumni consider the development of communication and interpersonal skills to be the most important Educational Objective, followed by a general understanding of the

program disciplines. The remaining Educational Objectives get about the same "moderately important" rating. The program receives high ratings on the items viewed as important by the alumni and achieves its Educational Objectives on the technical aspects, but falls short of meeting the expectation of the alumni on the non-technical issues.

Table 2-2. Alumni Survey of the Educational Objectives

Educational Objectives	Importance	Preparation	Difference
1. Applying knowledge of mathematics and science to the solution of practical engineering problems	3.7	3.9	0.2
2. General understanding of and ability to work in the ocean and resources engineering disciplines	4.0	4.0	0.0
3. Proficient in one or more of the ocean and resources engineering disciplines	3.7	3.7	0.0
4. Aware of professional, managerial, legal, ethical, and other non-technical issues	3.6	3.1	-0.5
5. Ability to communicate and work effectively with peers, clients, and the general public	4.3	3.8	-0.5
6. Adaptation to the changing needs and technology of the ocean and resources industry	3.5	3.3	-0.2

CRITERION 3. STUDENT OUTCOMES

A. Student Outcomes

Based on the program objectives and the ABET-EAC a-k criteria, the ORE program has chosen a series of 12 student outcomes in consultation with various university committees and outside advisory committees. These outcomes are stated and documented on the department website. The graduate program in Ocean and Resources Engineering takes as its goal to channel the students' previous education and work experience to ocean-related engineering careers. Students upon graduating from the program will achieve the following outcomes:

1. A broad education necessary to understand the impact of engineering solutions in a global and societal context;
2. An ability to apply knowledge of mathematics, science, and basic engineering topics that include statics, dynamics, fluid mechanics, solid mechanics, and probability and statistics;
3. Proficiency in the core program that comprises hydrostatics, oceanography, water waves, fluid-structure interaction, underwater acoustics, laboratory and at-sea experience;
4. Working knowledge of at least one of the three option areas that include coastal, offshore, and ocean resources engineering;
5. An ability to use the techniques, skills, and latest engineering tools necessary for ocean and resources engineering practice;
6. An ability to identify, formulate, and solve ocean and resources engineering problems;
7. An ability to design and optimize engineering systems to meet the needs of the marine community;
8. An ability to work independently and function on multi-disciplinary teams;

9. An appreciation of professional and ethical responsibilities;
10. An ability to communicate effectively to technical and non-technical audiences;
11. An awareness of the latest research and contemporary issues in and beyond the marine community, and;
12. Recognition of the need for, and an ability to engage in life-long learning and continuing professional development.

The ORE student outcomes are very close to the standard a-k ABET criteria. Essentially the ORE criteria are just specific restatements specifically applied to ocean engineering. The ABET-EAC outcomes are listed below.

ABET Student Outcomes

The program must have documented student outcomes that prepare graduates to attain the program educational objectives. Student outcomes are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.

(a) An ability to apply knowledge of mathematics, science, and engineering
(b) An ability to design and conduct experiments, as well as to analyze and interpret data
(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) An ability to function on multidisciplinary teams
(e) An ability to identify, formulate, and solve engineering problems
(f) An understanding of professional and ethical responsibility
(g) An ability to communicate effectively
(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) A recognition of the need for, and an ability to engage in life-long learning
(j) A knowledge of contemporary issues, and
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

At the graduate level, the program depends on the students' prior education and remedial undergraduate courses outside the department to fulfill Student Outcomes 1 and 2. The coursework, capstone design, and independent research together deliver Student Outcomes 2 through 10, while attendance of seminars and participation in student and professional activities addresses Student Outcomes 11 and 12.

Students satisfying the pre-program requirements should possess the attributes listed in the outcome requirements *a* through *k* of the standard ABET engineering education criteria. The department adopted all of the *a* through *k* requirements with additional emphasis on the unique characteristics of an ocean engineering program. These include references to the specific subjects required of an ocean engineering program. Although at-sea experience is not part of the ABET requirements, it is an important Program Outcome as viewed by the Local Professional Advisory Panel.

Table 3-1. Relationship between Program Outcomes and ABET Engineering criteria

Program Outcomes	ABET Engineering Criteria										
	a	b	c	d	e	f	g	h	i	j	k
1. Broad education								✓	✓	✓	
2. Basic science, math, engineering	✓	✓									
3. Ocean engineering core	✓	✓	✓	✓	✓	✓					✓
4. Ocean engineering specialization	✓		✓		✓	✓					✓
5. Use of latest tools in ocean eng		✓	✓								✓
6. Problem formulation & solution	✓	✓	✓		✓						
7. Design & optimization	✓	✓	✓		✓	✓					
8. Independent & team work				✓			✓				
9. Professional issues						✓		✓			
10. Communication skills							✓				
11. Research & contemporary issues								✓	✓	✓	
12. Need for life-long learning									✓	✓	

B. Relationship of Student Outcomes to Program Educational Objectives

The Ocean and Resources Engineering Student Outcomes are formulated on the Educational Objectives described in the previous section under Criterion 2, as well as detailed incorporation of the standard ABET outcome requirements of ABET *a* through *k* as shown above. Table 3-2 maps the Student Outcomes to the Educational Objectives and shows how the Ocean and Resources Engineering program achieves the Educational Objectives formerly established by our constituencies and advisory panels. In particular, Student Outcomes 2 through 7 contribute to the technical Educational Objectives 1 through 3. Student Outcome 1 stresses the importance of a broad educational background for the understanding of non-technical issues in engineering, while Student Outcomes 8 through 12 complement the non-technical Educational Objectives 4 through 6. The Student Outcomes have been endorsed by our advisory panels, as well as the ORE faculty through lengthy discussion both recently and over many years.

Table 3-2. Relationships between Student Outcomes and Educational Objectives

Student Outcomes	Educational Objectives					
	1	2	3	4	5	6
1. Broad education				**	*	*
2. Basic science, math, & engineering	***	**	*			
3. Ocean engineering core	*	***	**	*		
4. Ocean engineering specialization	*	**	***	*		
5. Use of latest tools in ocean eng	*	**	***			
6. Problem formulation & solution	*	**	***	*		
7. Design & optimization in ocean eng	*	**	***	*		
8. Independent & team work			*	**	**	
9. Professional issues				***	**	
10. Communication skills					***	
11. Research & contemporary issues						***
12. Need for life-long learning						***

*slightly, **moderately, ***highly relevant

CRITERION 4. CONTINUOUS IMPROVEMENT

A. Student Outcomes

The ORE program is committed to a process of continuous improvement. This commitment has been instilled in the faculty, students, office staff and student helpers. We have indicated its importance to the higher levels of the administration of SOEST with some success. The information used for program improvement comes from a variety of sources. Most significant among these sources is the annual UH Assessment Office review of our program, the student exit interviews, the 2013 blue ribbon SOEST review panel and reports written by our student, local and international advisory panels in 2015. We also consider our student, faculty, alumni employer and surveys as well as ongoing discussions with our student, local and business

advisors. We solicit input from professional engineering societies and many of our faculty members serve in various positions in these societies. We solicit information from all of these sources and then filter it as to what is needed and what we can accomplish in the current time frame. Obviously, many of the recommendations involve expenditures well beyond what can be made available in the current budget climate. Nonetheless, even in the current tight fiscal times much real progress has been made. In no case is this more evident than the support of the school in growing the faculty from four in 2007 to current eight.

The evaluation procedures currently used are listed below:

Direct Measures:

1. The master's qualifying exam
2. Committee verification of undergraduate ABET-EAC requirements and assignment of remedial action
3. Capstone Design Class
4. Master's thesis defense and evaluation of thesis for outcome elements
5. Circulation and review of thesis proposals by all the faculty
6. Student employment placing, particularly repeat hires by employers

Indirect measures:

7. Local and International Advisory Panels, annual UH assessments
8. Employer Surveys
9. Student Exit Interviews
10. ABET course reviews done at the end of each course by both students and faculty
11. Alumni Surveys
12. Student advising meeting to determine fulfillment of undergrad requirements and progress

Most of these assessments are carried out yearly. On the suggestion of the UH assessment office we are decreasing the frequency and importance placed on alumni and employer surveys and increasing the weight put on direct measures of outcome attainment. There are essentially two reasons for this. The first is that the surveys are inaccurate because of the low statistical numbers. Over a five-year period we had 28 graduates. Even with a 50% rate of return of email surveys, which is historically high, we would only get 14 responses, which is not usually enough for much statistical significance. Second even when we do get enough data to work with, the responses tend to be biased by how well the person liked the program, their experience at UH generally and how they fared in the job market on graduating rather than on whether they objectively achieved the desired outcomes or not. Current assessment is leaning more strongly to objective results such as the departmental qualifying exam, the capstone design project, student presentations, the thesis defense and thesis project. All of these pieces of hard evidence are graded by a group. To be considered to have achieved the relevant outcome, a grade of B minus or better must be obtained. All of the relevant evaluations are in the 28 complete student files of the graduates that will be available during the ABET-EAC evaluation. With the new student progress form, the student and advisor together go through each of the 12 student outcomes (which are printed on the form) and document which of these the student has successfully completed in the given year and which need extra work. The form is in the appendix. Each student's annually completed form is in their student file available for ABET-EAC review.

Summaries of the results of course evaluations, alumni survey and the exit interview forms are provided in the appendix of this report.

The results of our evaluation processes are in the department files, usually also in the student files to the extent that they are student specific. Some to the generalized material is posted on the web site. It is also submitted annually in October to the University Assessment Office who usually want it in summary form although often request interviews later to confirm specifics.

Relationship of Courses in the Curriculum to the Student Outcomes

Many of the student outcomes are fulfilled by various courses. Each of the courses taught in the core program and three optional areas fulfills one or more of the outcome requirements. Together a complete package is achieved with all of the Student Outcomes completed. Full course syllabi are provided in Appendix A. The specific student outcomes fulfilled by each course is listed on that course syllabus. The measurement of the success of achieving these outcomes is also presented in summary form in the Appendix.

Table 4-1 shows the course outcome matrix developed by the faculty by course number and option area (coastal-ce, offshore-oe, resources-or). The table shows the emphasis of each course in terms of the Student Outcomes. The core and option-area coursework was intended to deliver Student Outcomes 2 through 10. The ORE program relies partly on students' previous general education to achieve Student Outcome 1 and their participation in the professional activities and ORE seminars to achieve Student Outcomes 11 and 12.

Table 4-1. Course Outcome Matrix

Student Outcome	411 **co**	601 **co**	603 **co**	607 **co**	608 **el**	609 **co**	612 **oe**	630 **oe**	654 **el**	661 **ce**	664 **ce**	677 **or**	678 **or**	783	792 **co**
1															
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
3	✓	✓	✓	✓		✓								✓	
4							✓	✓		✓		✓	✓	✓	
5	✓	✓	✓	✓	✓			✓		✓	✓			✓	
6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
7								✓		✓		✓		✓	
8		✓												✓	
9	✓	✓						✓	✓	✓		✓	✓	✓	
10		✓												✓	✓
11															✓
12															✓

co – core, **oe** – offshore eng, **ce** – coastal eng, **or** – ocean resources, **el** - electives

Ever since Fall 2003, students are required to fill out a Course Outcome Questionnaire for all Ocean and Resources Engineering courses at the end of each semester. The questionnaire asks the students to rate the level of achievement of the Student Outcomes in each course with a scale of 0 to 4. Table 4-3 summarizes the average ratings of each Student Outcome for the courses. The results, in general, confirm the course outcome matrix in Table 4-1. In contrast to our initial interpretation, the program coursework does have significant contributions toward Program Outcomes 1, 11, and 12 in the minds of our students. The summary data for these conclusions is presented in the appendix. Both summary and raw data will be available during the program evaluation.

For the 28 students who completed the Master's program between 2009 and 2014, each of the student outcomes has been successfully achieved and has been documented by the department Chairman and student's advisor. As each student has come in with a different background, has done very different research theses or projects and has taken different options, each student has fulfilled the outcomes in a slightly different way. This is documented for each student in their student file.

In general the following rubrics were used to measure the effectiveness and achievement of the outcomes:

1. The Master's qualifying exam: All graduating students passed an FE equivalent exam demonstrating mastery of engineering math and science fundamentals. The preferred option here is to take the FE exam itself. All students are encouraged to take the FE exam.
2. Committee verification of undergraduate ABET-EAC requirements and assignment of remedial action: All graduating students have an ABET-EAC certified undergraduate degree or have taken the equivalent make up courses. A form is completed by the Graduate Chair to certify this and is in the student file.
3. Capstone Design Class: Professional engineering community evaluation of student design work. ALL students must complete this course (ORE 783). Evaluations of the design projects are by University faculty and local engineering company officials. A student must get a B minus minimum in this design work to be considered to have achieved the outcome.
4. Master's thesis defense and evaluation of thesis for outcome elements: Faculty verification of students fully addressing a large number of outcomes. Each thesis or project has an evaluation committee of three. Both the thesis itself and its presentation and defense are evaluated. The theses and projects of each student and publications resulting from this work will be available for ABET-EAC evaluation.
5. Circulation and review of thesis proposals by all faculty : Wide faculty verification of students fully addressing the learning outcomes associated with research plans and demonstrating a knowledge of the latest techniques in ocean engineering. The proposal for each student is available in the student file.
6. Student employment, placing particular emphasis on repeat hires by employers: Very high, over 90% placement of graduates in engineering positions on graduation. This is verified in Table 1-2 and is the major rubric used by the University of Hawaii Assessment Office in their annual assessment of the department.

7. Local and international advisory panels: Strong support by a range of local, national and international advisory bodies. The strong support is demonstrated by repeated hiring of graduates and the comments made in advisory committee reports.
8. Employer surveys: Employers generally very pleased with the knowledge and attitude of graduates. A summary of the employer survey and all of the comments are reproduced in the Appendix.
9. Student exit interviews: Students generally felt that they have achieved the program outcomes and will reach the program objectives. Each student exit interview form is available in the students file. The Chairman conducts and verifies the student exit interview with a checklist (available with the departmental files) to ensure all student outcomes have been met.
10. ABET course outcome evaluations done at the end of each course by both students and faculty: Courses are generally on track for achieving the outcomes selected for that course (shown in Table 4-1). The course evaluation data is presented in the Appendix
11. Alumni Surveys: Alumni are pleased generally with their progress in the engineering profession and credit this in part to the ORE program. The alumni survey data and comments are presented in the appendix.
12. Student advising meeting to determine fulfillment of undergraduate requirements and progress: Annual and periodic progress meeting with students show students to understand, support and generally be on track with the program. A new student progress form has been devised in 2015 and is now completed annually by the student with concurrence by the advisor to show fulfillment or progress on each of the student outcomes. This form is available in each student file. Students are now also required to show completion of an NSF ethics in research on line study session and seminar.

Tables 4-2 and 4-3 lists the internal and external assessments and shows how they determine whether the MS graduates of Ocean and Resources Engineering have the attributes listed in the Student Outcomes. The internal assessment is conducted and gauged by the faculty to maintain the standard of the curricular elements. The external assessment results, which are obtained from the constituencies including the students at the time of graduation, indicate the effectiveness of the curricular elements in achieving the stated Student Outcomes. Not all of the Student Outcomes are quantitatively measurable and not all students achieve the same level of competency in each outcome.

The preliminary conference is the first step of the internal assessment process. It determines any pre-program deficiencies in general education, mathematics, science, and basic engineering and identifies remedial courses if necessary. The MS General Examination further assures that students can apply basic mathematics, science, and mechanics in the solution of engineering problems. The examination results of the core and option-area courses provide indications of the learning outcome, while the course evaluations by the students provide feedback on the course contents and curricula. The capstone design project tests the students' ability to integrate the course materials, optimize engineering design, work in a team, and communicate to technical and non-technical audiences. The course is team-taught with practicing professional engineers, who also provide an independent assessment. All students are required to attend 15 approved seminars and submit reports to show their understanding of the topics covered. The thesis or research project tests the students' ability to work independently and to communicate orally and in writing. The MS final exam validates the student's study in the program, while the exit interview and survey allow feedback from the student.

Table 4-2. Internal Assessment Process for Student Outcomes

Assessment Process	Student Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
Preliminary conference	✓	✓										
MS General Examination		✓										
Course examinations			✓	✓	✓	✓						
Course eval by students			✓	✓	✓							
Capstone design project				✓	✓	✓	✓	✓	✓	✓		
Seminar reports											✓	✓
Thesis/research report				✓	✓	✓		✓		✓		✓
Defense/final exam		✓	✓	✓						✓		

Students are encouraged to submit papers to national and international competitions and for publications as an external assessment. This allows feedback from the national and international professional communities on the quality of the student's work in the program. The percentage of students obtaining jobs in the ocean and resources engineering fields provides a strong indication of the effectiveness of the program. The exit interview conducted by the Department Chair provides a comprehensive assessment of the Program Outcomes. The exit, alumni, and employer surveys are the most objective and comprehensive external assessments. In addition, a portfolio records the progress of each student from the preliminary conference to the exit interview. The faculty members touch base with the students and keep track of their employment history for three years after graduation. This provides data to assess the Educational Objectives and close the loop of the assessment process.

The qualitative and quantitative data gathered from the assessment process is used on a continuing basis to monitor the achievement of the Student Outcomes. This section summarizes the external assessment results obtained from the constituencies. Additional materials including assessments by the faculty will be provided to the ABET team during the visit. Table 4-3 summarizes the exit survey results. They rated 10 out of the 12 student outcomes as having above average importance and indicated they received average or above average preparation in 9 of the student outcomes. In terms of lifelong learning, the department has been encouraging students to become active members of professional societies, sponsoring membership fees. The department will continue this practice as a way to encourage their recognition of the need for life long learning through participation in professional society activities.

Table 4-3. Exit Survey Results on the Student Outcomes (4 is high , 0 is low)

Program Outcome	Importance	Preparation	Difference
1. General education	1.5	1.3	-0.2
2. Basic science, math, & engineering	2.8	2.5	-0.3
3. Ocean engineering core	2.8	2.3	-0.5
4. Ocean engineering specialization	2.5	3.0	0.5
5. Use of latest tools	2.5	2.1	-0.4
6. Problem formulation & solution	3.0	2.5	-0.5
7. Design & optimization	2.8	2.3	-0.5
8. Independent & team work	2.8	2.0	-0.8
9. Professional issues	2.5	2.0	-0.5
10. Communication skills	2.5	2.0	-0.5
11. Research & contemporary issues	1.5	1.5	0.0
12. Life-long learning	2.5	1.5	-1.0

Placement (2009-2014)

The Ocean and Resources Engineering program graduated 28 MS students during the 2009-2014 academic years. Table 4-4 provides the placement data of the graduates (specifics are in Table 1-2 for each graduate). Over 95% of the graduates obtained employment or continued to study in engineering fields immediately after graduation. The number of graduates directly employed in ocean-related engineering fields held stable over time at 60%. This indicates the positive influence of the program on the graduates and their inclination to work in ocean engineering fields. Only 15% of the graduates worked in fields not directly related to engineering including being a Peace Corps volunteer and a Community College Instructor. The Department has held a stellar track record with virtually 100% employment of graduates and more local demand for graduates than the department can fill (on an earlier survey we found that about half the annual demand for ocean engineers in Hawaii was being filled by department grads).

Table 4-4. Placement and Employment Data of 2009-2015 MS Graduates

	At Graduation	Spring 2015
Ocean-related engineering jobs	17	16
Engineering PhD program	3	2
Other engineering jobs	5	6
Non-engineering jobs or not known	3	4
Total	28	28

Companies and government agencies that have provided engineering employment to these graduates include:

- Naval Surface Warfare Center, Maryland
- Brown and Caldwell Inc, Honolulu
- Hawaii Undersea Research Laboratory, Waimanalo, Hawaii
- Honolulu Seawater Air Conditioning LLC, Honolulu
- Kapiolani College, Honolulu
- Makai Ocean Engineering, Inc., Hawaii
- Ocean Imaging Consultants, Honolulu, Hawaii
- Navatek, LTD, Honolulu
- Naval Facilities Engineering Service Center, California
- AECOM, Inc., Hawaii
- Oceanit Laboratory Inc., Hawaii
- Oceanic Company Inc, Honolulu
- Naval Air System Command, US Navy, Hawaii
- Sea Engineering, Inc., Santa Cruz
- University of Hawaii Research Associate, Hawaii
- US Army Corps of Engineers, Hawaii
- Boeing Co, Seattle
- US Navy Facilities Engineering Service, Virginia
- Marine Innovation & Technology Inc., Berkeley, California
- SWCA Environmental Consultants, Honolulu

Government agencies currently employ 20 percent of the 2009-2014 graduates. Of the three graduates who presently are not working in engineering fields, one is teaching math and science at a community college, one has just returned to China, and one is working with the Peace Corps (using engineering skills). Many Hawaii based employers, including Oceanit, Makai Ocean Engineering and Sea Engineering consistently return to the department to hire new graduates and in some cases have half a dozen ORE graduates on staff. This is a major vote of confidence by three employers for the quality of our graduates.

Alumni Survey

The responses of the alumni on the 22 curricular questions in the survey are grouped according to the Student Outcomes and the results are summarized in Table 4-5. The results mirror those for the Educational Objectives, as both are compiled from the same source. The difference between the “importance” and “preparation” ratings provides a quantitative indication of the program effectiveness. The results show that the program generally achieves its Student Outcomes on the technical aspects, but falls somewhat short of meeting the expectation of the alumni on the non-technical issues.

In addition, the alumni were asked to answer additional questions as listed in Table 4-6. The results show the alumni, in general, work in ocean-related engineering fields. They give a high rating on their satisfaction with the Ocean and Resources Engineering program. However, only 40.5% of the alumni are registered Professional Engineers. Although the alumni state in Table 4-6 that the program did not sufficiently motivate them for life-long learning, Table 4-6 shows that, in fact, 71.4% of them participated in continuing education and 90.5% attended professional or technical conferences.

Table 4-5. Alumni Survey Results on the Program Outcomes (5 is high, 1 is low)

Program Outcome	Importance	Preparation	Difference
1. Broad education	3.3	3.1	-0.2
2. Basic science, math, & engineering	3.7	3.9	0.2
3. Ocean engineering core	3.8	3.5	-0.3
4. Ocean engineering specialization	3.9	4.2	0.3
5. Use of latest tools	4.1	3.9	-0.2
6. Problem formulation & solution	3.7	3.7	0.0
7. Design & optimization	3.8	3.6	-0.2
8. Independent & team work	4.4	3.6	-0.8
9. Professional issues	4.2	3.4	-0.8
10. Communication skills	4.5	3.9	-0.6
11. Research & contemporary issues	3.6	3.0	-0.6
12. Need for Life-long learning	4.3	3.5	-0.8

Table 4-6. Additional Questions in Alumni Survey related to the Program Outcomes

Questions	Response
Are you working in a field related to ocean and resources engineering? (1 = not related at all, 5 = very related)	4.29
Overall, how satisfied are you with the education you received at UH? (1 = not satisfied at all, 5 = very satisfied)	4.38
Are you a licensed professional engineer?	40.5%
Have you passed the Fundamentals of Engineering Exam?	59.5%
Did your employer hire other ORE graduates within the last 10 years?	47.6%
Have you participated in continuing education activities?	71.4%
Have you attended professional or technical conferences?	90.5%

B. Continuous Improvement

As part of the accreditation procedure ORE undertakes a process of continuous improvement. This includes improvements in faculty, courses, equipment and administrative processes. These improvements are rigorously documented.

Courses

The courses achieved their desired student outcomes. For this reason, most courses have not been significantly changed since 2010. However, one advisory panel and several students identified in their annual reviews or mentioned that more instruction in the area of acoustics would be beneficial. For this reason, an acoustics course, ORE 654, was put together and updated several

times by our acoustics faculty member and Chair, Dr. Bruce Howe. The syllabus for ORE 654 is in the Appendix. This course has now been taught for several years to growing acclaim. Discussion is underway as to whether it can be structured as the center piece of a new ORE track in acoustics and instrumentation. A major course modification was also undertaken in ORE 766 (Numerical Methods) taught by Eva Marie Nosal. The improvement has now been incorporated for several teaching cycles to considerable positive comment. This responds to the request by the advisory panels for greater basic mathematical training and access to computer programs packages. The student panel requested more ocean energy courses. To address this, the former OTEC course, ORE 677, was redesigned as a Marine Renewable Energy course. The new syllabus is in the Appendix. It has now also gone through several teaching cycles to very positive review. As with all courses, it undergoes minor upgrades and improvements each time it is taught including new information, clearer teaching slides and improved exercises.

The 2013 SOEST blue ribbon review panel urged ORE to develop and teach more undergraduate and introductory classes with a view to ultimately developing a complete undergraduate Ocean Engineering Program. ORE recognizes this as a worthy long-term goal and is working toward it. In the same vein, the University administration has requested more STEM (science, technology, engineering, math) classes. ORE developed a new class - ORE 202 Ocean Technology to address these two requests. ORE 202 was first taught in Spring 2015. It was well received with positive course reviews. It will be fully evaluated and improved over the summer. One commercial course developer has approached the department to make this course into a wide distribution on-line course. ORE hopes both to make this course more popular and to develop follow-on undergraduate courses in the same vein.

Facilities

One of the other notations of the advisory panels was the lack of access to experimental facilities. After much deliberation, the department chooses to handle this in several ways. First the Kilo Nalu Nearshore Observatory has been made more accessible to students. This near shore observatory is fully described in Criterion 7. This is a state of the art instrumented facility for the direct measurement of sediment-ocean interactions. It is used in our ORE 601 lab class which is mandatory for all master's students. This is a major international facility housed within the department. Associated with this is the availability of a 25-ft coastal boat for dive and near-shore operations managed through the University of Hawaii Marine Center (UMC).

Administrative Processes

ORE has also implemented several new processes and process committees to verify departmental procedures. All transcripts of incoming students are checked to verify that ABET undergraduate requirements have been met. This is done jointly by the Chairman and Professor Fai Cheung, PE, a senior faculty member and our graduate chair. Students not meeting the requirements are assigned courses in the UH College of Engineering to make up deficiencies. Other Departmental committees deal with the admission and ongoing monitoring of students to insure their progress. In late 2014, a new form to be filled out annually by the students was designed and is being implemented in Spring 2015. It measures progress in each of the 12 Student Outcomes specifically and attempts to quantify the result.

\Equipment

ORE has also forged a very close working relationship with the Hawaii Undersea Research Lab (HURL). HURL senior staff provide 2 of 8 ORE faculty positions. HURL has provided 2-3 student research assistantships with student activities working on submersible equipment design in the past. In an effort to reorganize, HURL is now focused on Remotely Operated Vehicles (ROV) rather than submersibles. The university has recently obtained a 6000 m depth capability ROV. This new technology will also soon be available for student research and projects.

Larger Ongoing Program Revisions

Some alumni commented that the ORE program emphasized mathematics and theories instead of practical issues needed for engineering practice. More real world engineering experience was requested along with business training. Both earlier Local and International Professional Advisory Panels commented on the small size of the faculty and recommended the Department leverage resources from within the University of Hawaii and from the local professional community. The faculty members are aware of the situation and have continually implemented change where possible to address both of these perennial problems.

While the total extramural funding awarded directly to the departmental faculty during 2009-2015 is over $10M, there is still a lack of student assistantships. This is the main reason for less than a full cadre of entering students. Concern has been raised by a number of reviewers as to new ways of providing abundant research assistantships to students and greater opportunities to interact with both public and private sectors.

Department has responded with the following measures:

- The department has modified the format of the capstone design to introduce real-world engineering experience into the curriculum. Since this modification, the course has been team-taught by departmental and affiliate faculty members leveraging other university and external elements where possible.
- The capstone project varies every semester to reflect the latest engineering experience of the affiliate faculty members. The students work on a real-life engineering projects in a consulting-firm setting that emphasizes teamwork, communication skills, and consultant-client relations. The course covers all typical steps of an engineering project from the proposal to the final report and incorporates realistic constraints that include economic, environmental, ethical, social, and liability considerations.
- The department is also trying to initiate more ocean engineering internships. The internship is in the form of a research assistantship. These were initially with Navatek Ship Ltd. and Honolulu Shipyard Ltd. Since the initial internship program in the early 2000's, this program has been maintained at several internships but unfortunately has not grown substantially in recent years.
- The department is now requiring students to present their proposals and report the progress of their research at the Department seminar series ORE 792 or special session. This provides additional experience to the students on public speaking and the use of presentation media.
- The department is now allowing students to take graduate-level business administration courses as electives and use the credits to satisfy the MS degree requirements in Ocean

and Resources Engineering. In addition to covering important business issues related to engineering, these courses also provide training on teamwork and public speaking.

- The department has added an "ALPHA" designation to ORE 783 Capstone Design Project, with ORE 783B, 783C, and 783D for the coastal, offshore, and ocean resources options respectively. This allows the students, who prefer a more professionally oriented program, to take the capstone design course twice and receive six credits for their MS degree. It also tailors the capstone design experience to the Departmental specialty areas.

Small Program Revisions

Although not publicized in the department literature, the core courses ORE 411, 601, 607, and 609 have been enhanced to include address non-technical engineering issues. Both the panels and survey findings encourage the faculty to increase this component in their classes. In addition, the Department initiated a number of small program revisions over the last several years mainly to specific classes. These include:

1. Reviewed the Educational Objectives and Student Outcomes of peer programs. The wording of the student outcomes was modified slightly to conform with wider norms.
2. Added emphasis to hydrostatics, oceanography, and underwater acoustics taught in the core program. Both oceanography and underwater acoustics are covered by the core course ORE 603.
3. Augmented the core course ORE 411 Buoyancy and Stability to include dimensional analysis. The course as it has been taught already included basic naval architecture topics as suggested by an earlier Professional Advisory Panel.
4. Implemented and maintained the new advising forms and procedures for all current students after the last ABET-EAC review. This assures that all students satisfy the ABET requirements.
5. Augmented the core course ORE 601 Ocean Engineering Laboratory to leverage the resources made available through the Hawaii Undersea Research Laboratory. The course now covers laboratory modeling, ocean measurements, at-sea experience, and submersible and ROV operations.
6. Continued the Ocean and Resources Engineering Enrichment Fund Campaign. The donated funds pay for student (first-time) professional society dues and support student professional activities. The students formed and continue the student chapters of the Marine Technology Society and the Society of Naval Architects and Marine Engineers.
7. Continued publication of the Ocean and Resources Engineering newsletter *Hana O Ke Kai* "Work of the Ocean". The newsletter informs the alumni of the latest developments in the Department. It also serves as an open forum for the faculty and alumni to exchange ideas and develops a sense of community and belonging.
8. Increased the use of engineering tools such as Ship Hydrostatics and Stability Program (SHCP) and Coastal Engineering Manual (CEM) in classes.

The revisions to the curricular elements above address many of the comments made by a series of program participants and reviewers over several years. Although the impact of all of these revisions is surely small, the effort does indicate our commitment to ongoing and continuous improvement. We believe this continuous improvement we have implemented as a standard

operational procedure has been and will continue to be successful in meeting the programs objectives.

Suggestions Made but Declined by the Department

The Department carefully considered some of the comments received but decided not to implement the changes suggested for the following reasons:

1. With respect to mandating publication of master's work, the faculty believes it's too stringent to mandate publication of MS thesis work at professional conferences or in journals as a formal degree requirement. Students, however, are strongly encouraged to submit their thesis work for publication or participation in paper competitions organized by professional societies. This is particularly true now that two of the faculty are Editors-in-Chief of two significant international peer reviewed journals both of which will consider student work for publication.
2. With respect to admitting all applicants as the job market needs them, the Department declined the suggestion to admit students on the basis of market need. The Department admits students solely based on their scholastic records. Most students, however, require financial support to enroll. The awards of research assistantships match the students' interest with funded research projects. This encourages enrollment in areas that have the most funded research projects, and in a way, responds to market needs.
3. With respect to building costly new lab facilities both on and off campus as well as hiring additional faculty, the Department cannot advocate this position in the light of the University budget crisis generated by large budget cuts at the decision of the State legislature. The Department's former off-campus laboratory, the JKK Look Laboratory of Ocean Engineering, was closed some years ago due to earlier budget cuts and re-development of the downtown waterfront area. Although at one time it was supposed to be replaced, the repair of this now deteriorating facility and its remote location are no longer an issue and are not under discussion. SOEST has stepped up to provide an on-campus laboratory to the Department and has made arrangements for the faculty to conduct fieldwork through the redesigned facilities at the University Marine Center being redeveloped at Pier 35, through the Kilo Nalu Nearshore Observatory and through the Hawaii Undersea Research Laboratory at Makai Pier. Beyond this additional financial resources are not available.

C. Additional Information

Full documentation of the rubrics discussed to make the assessments reported in this self study will be available at the site visit. To assess the achievement of the program in each of the student outcomes is a complex multi-dimensional process. Much of the data is student specific and is in each of the student files. It is not easy to group results in a tabular summary form to cover the all 28 students.

This documentation will include the following materials which will be available for review during the ABET visit:

1. Ocean and Resources Engineering Newsletters
2. Student files and portfolios including records of exit interviews
3. MS General Examination questions

4. Course notes, assignments, examinations as well as how performance in the courses is used to assess learning
5. Capstone design reports
6. List of seminars
7. Thesis/research reports
8. Student publications and awards
9. Alumni, employer, and exit survey results
10. Alumni employment data
11. Original advisory panel reports with faculty comment on each of the points raised
12. Worksheets used in compiling results of the rubrics discussed above

Other materials will be available upon request.

CRITERION 5. CURRICULUM

A. Program Curriculum

Ocean and Resources Engineering is an advanced-level program and relies on the students' undergraduate education or remedial courses offered at the University of Hawaii to fulfill the Professional Component, which includes:

1. A general education component including economics, management, and humanities;
2. One year of college level mathematics and basic science; and
3. One and one-half years of engineering science and design.

For administrative purpose, these are classified as pre-program requirements that all students entering the advanced-level program must satisfy. Students with ABET undergraduate engineering degrees satisfy these requirements and can directly proceed to the Ocean and Resources Engineering program. In some cases, students with an electrical or chemical engineering degree are required to make up some undergraduate courses required by the program such as fluid mechanics and solid mechanics.

Students with undergraduate engineering degrees from foreign countries are carefully evaluated to assure that they satisfy the requirements in the Professional Component. The Department Chair and Graduate Chair review the transcript along with the student at the preliminary conference. All the courses taken by the student are categorized according to the three areas of the Professional Component and additional requirements of the Program Criteria for an ocean engineering program. Based on past experience, all foreign students have more rigorous training in mathematics, science, and engineering topics than their US counterparts. All of these students have extensive experience in the use of design code and most have a capstone design or practical training (similar to co-op in the US) every year complementing their coursework. Most of the foreign students, however, have a general education component that focuses on economics, management, and engineering practice. The Department views that being from a different culture itself is a general educational experience that serves the Educational Objectives well, and therefore, does not require these students to take additional courses in humanities.

The Department also accepts students with undergraduate degrees in mathematics and science. These students usually have a broad-based general education component and satisfy the requirement for mathematics and science. Some students knew they would enter graduate engineering programs and had taken basic courses in engineering mechanics before being admitted into the program. Similar to the foreign students, the Department Chair and Graduate Chair review the transcript with each student at the preliminary conference and categorizes all the courses according to the three areas of the Professional Component and additional requirements of the Program Criteria. These students are required to make up deficiencies in undergraduate engineering courses. The Department Chair serves as the advisor to these students to assure that all pre-program requirements are satisfied consistently. Students can structure their pre-programs based on their intended specialization in the Ocean and Resources Engineering program.

During the course of the study, each student selects a research advisor and forms a committee with at least three faculty members and completes the MS degree requirements with a Plan A thesis or Plan B independent project. The Plan A thesis is research oriented and the work must be original and of publication quality. Students receive six academic credits for the thesis. The Plan B independent project focuses on an engineering application, design, or optimization, 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 presented at a department seminar and approved by the committee.

Credit Hours

The program provides a 31 credit hour degree. The University requires that Master's degrees be at least 30 credit hours. The ORE department has a required seminar, which takes one credit hour longer.

Design Experience

The design experience in the program is in two parts. The first part is the capstone design class ORE 783. All students must complete this design course with a grade of at least a B minus (as with all core courses). The second part of the design experience is the master's thesis (plan A) or project (plan B). All students must successfully complete both parts of the design experience. Students normally take the capstone design class near the end of their program. It requires the knowledge and skill acquired in earlier course work. The design class is the design of a real-world engineering problem. It is supervised by professional engineers, who are part of our adjunct faculty. The design is written up and presented in a seminar environment. The students are made used to the fact that they will have to publicly defend their designs. The design work is done as a team. The design involves costs, permits, environmental impacts and all of the other constraints of a real world project. In fact, many of the projects are planned or ongoing projects taken from the files of consulting engineering companies. There is a separate design course for each of the three option areas. Each of these design projects tries to incorporate as much as possible of the course work related to the option area.

The second and final design project is the thesis (6 credits) or project (3 credits). While ORE 783 is purely a design course, the design elements of a thesis will vary considerably from one thesis to the next. Recent Master's theses involving almost solely design elements include a thesis designing a hybrid AUV- underwater glider and a second thesis designing a remote bottom camera system for quantitative fisheries management. All theses have some design element.

Theses must go through a proposal defense stage, an individual research stage and then a final examination and public defense. These various stages of scrutiny clearly force serious thinking and clear examination of the design process. The thesis committee insists that realistic constraints based on faculty experience are incorporated at each stage.

Curricular Components

The pre-program provides a broad-based education that prepares students for the engineering profession as well as the advanced-level program. The advanced-level Ocean and Resources Engineering program offers:

1. One year of engineering science and design that include a laboratory course, a capstone design project, and attendance of 15 seminars; and requires
2. A thesis or an independent research project.

The one-year of coursework consists of the core, option-area, and elective courses. The core and option-area courses cover 50% of engineering science and 50% of design. Students can slightly shift the emphasis on engineering science or design by choosing appropriate elective courses. The appendix lists the Ocean and Resources Engineering course syllabi. Table 5-1 provides a list all of the department's courses. The program does not allow for cooperative education although internship with local engineering companies are encouraged to aid in the students design training.

The minimum residency requirement for an MS degree at the University of Hawaii is two semesters full-time. Table 1-1 outlines the typical timeline to satisfy the program requirements. 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 pre-program deficiencies spend the first year taking undergraduate engineering courses, while students with an undergraduate engineering degree from an ABET accredited program proceed directly to the program coursework and take the General Examination during their first semester. Students normally begin their research work after completing two semesters of the program coursework and take the final examination at the completion of the research or independent work. The University of Hawaii Graduate Division specifies that students failing any one of the general or 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 Graduate Division by the Department Chair providing a detailed degree plan and new limited timeline to completion of all degree requirements.

Upon completion of the program, students will have satisfied the ABET –EAC Engineering Criteria as well as the General Criteria for Advanced Level Programs outlined in the *Criteria for Accrediting Engineering Programs*. The Department Chair concludes the course of study of each student with an exit interview. The research advisor continues to monitor the progress of the student for at least three years after graduation to provide feedback data for the program. The Department continues to update the alumni with a newsletter generally published twice a year. The next Fall newsletter will come out in November, 2015. The newsletters are posted on the ORE website, emailed to alumni and sent in print format on request. The newsletter serves as an open forum for the faculty and alumni to exchange ideas and develops a sense of community and belonging of the Ocean and Resources Engineering program.

Table 5-1 shows the courses taught in the last two semesters along with descriptions of these courses. Beyond the core required courses in the department (411,601, 603, 607, 609, 792), each student takes selected electives according to one of three tracks –coastal (661, 664, 783B), offshore (612, 630, 783C), resources (677, 678, 783D). The collected curricular elements of the ORE program, those being the pre program requirements, core courses , selected track courses, the laboratory course, the capstone design project, the seminar course, the thesis project and final defense align well with the programs educational objectives. This is shown in Table 5-2. Table 5-3 shows the relationship between the program objectives and curricular elements The flowchart shows the way a student will progress through the program.

Table 5-1 OCEAN AND RESOURCES ENGINEERING

Year Semester	Course (Department, Number, Title)	Category (Credit Hours)			
		Math & Basic Sciences	Engineering Topics ✓ = *Significant Design*	General Education	Enrollment
2014-2015 Fall	ORE 330 Mineral & Energy Resources (3) -elective			3	12
2014-2015 Fall	ORE 411 Buoyancy & Stability (3) -required		*3*		18
2014-2015 Fall/Spring	ORE 500 Master's Plan B/C Studies (1)-elective		*1*✓		6
2014-2015 Fall	ORE 601-required Ocean & Resources Engineering Lab (3)		*3*✓		7
2014-2015 Fall	ORE 603-required Oceanography for Ocean Engineers (3)		*3*		14
2014-2015 Fall	ORE 607 Water Wave Mechanics (3)		*3*		13
2014-2015 Spring	ORE 608 Probability & Statistics for Ocean Engineers (3) -elective	3			2
2014-2015 Spring	ORE 609 -required Hydrodynamics of Ocean Structures (3)		*3*		10
2014-2015 Spring	ORE 612 –selected elective Dynamics of Ocean Structures (3)		*3*✓		7
2007-2008 Fall	ORE 630-selected elective Structural Analysis of Ocean Engineering (3)		*3*✓		n/a
2006-2007 Spring	ORE 641 -elective Environmental Fluid Dynamics (3)		*3*		3
2014-2015 Fall	ORE 654-elective Acoustics (3)		3		3
2014-2015 Spring	ORE 661 –selected elective Coastal and Harbor Engineering (3)		*3*✓		7
2014-2015 Spring	ORE 664-select elective Nearshore Processes & Sediment Transport (3		*3*✓		5
2014-2015 Fall	ORE 677-selected elective Marine Renewable Energy (3)		*3*✓		5
2014-2015 Spring	ORE 678 –selected elective Marine Mineral Resources Engineering (3)		*3*✓		5
2014-2015 Fall/Spring	ORE 695-selected elective Plan B Master's Project (3)		*3*✓		3
2014-2015	ORE 699 –selected elective				15

Fall/Spring	Directed Reading or Research (V)		*V✓*		
2014-2015 Fall/Spring	ORE 700 Thesis Research (V)- elective		*6✓*		1
2013	ORE 707-elective Non linear Wave Theories (3)		*3*		n/a
2014-2015 Spring	ORE 766 -elective Numerical Ocean Engineering (3)		3		12
2014-2015 Fall/Spring	ORE 783 (alpha)-elective Capstone Design Project (3) B) coastal engineering C) offshore engineering D) ocean resources engineering		*3✓*		B-4 D-1
Spring cancelled	ORE 791-elective Special Topics in Ocean & Resources Engineering (V)		*3✓*		n/a
2014-2015 Fall/spring	ORE 792-required Seminar in Ocean & Resources Eng. (1)		*1*		5
2014-2015 Fall/Spring	ORE 800 Dissertation Research (V)		*V✓*		2
Most ABET requirements met from Undergraduate studies					
OVERALL TOTAL FOR DEGREE	31 required credits for Masters				
PERCENT OF TOTAL For Masters in ORE			Normally 100%		
Totals must	Minimum semester credit hours undergrad	32 hrs	48 hrs		
satisfy one set	Minimum percentage	25%	37.5 %		

Note that instructional material and student work verifying course compliance with ABET criteria for the categories indicated above will be required during the campus visit.

Table 5-1 (Continued)- course descriptions

Ocean and Resources Engineering (ORE)

School of Ocean and Earth Science and Technology

ORE 202 Ocean Technology—Man in the Sea (3) Survey of human activities in the ocean, from the most traditional to the most innovative technical and engineering accomplishments.

ORE 330 Mineral and Energy Resources (3) Hard material and petroleum origins, exploration and exploitation. Renewable and non-renewable resources distribution. Political and scientific constraints. A-F only. Pre: 202 or OCN 201, or consent. (Cross-listed as OCN 330)

ORE 411 Buoyancy and Stability (3) Ship nomenclature and geometry, hydrostatic principles of surface ships and underwater vehicles in free-floating, partially waterborne, and damaged conditions. Subdivision of ships. Launching. Pre: CEE 270 or equivalent.

ORE 500 Master's Plan B/C Studies (1) Enrollment for degree completion. Pre: master's Plan B candidate and consent.

ORE 601 Ocean and Resources Engineering Laboratory (3) Design, construction, and evaluation of an engineering system. Laboratory and field experience and data analysis supplemented with appropriate theory. Pre: 603 and 607, or consent.

ORE 603 Oceanography for Ocean Engineers (3) Physical, chemical, biological, and geological ocean environments for ocean engineers. Introduction to ocean dynamical processes and general circulation. Ocean measurement techniques, theory of underwater acoustics. Sonar, swath bathymetry, and tomography applications. Pre: consent.

ORE 607 Water Wave Mechanics (3) Governing equations in free surface flow, deterministic and probabilistic wave theories, wave transformation, wave-induced coastal currents, tides, ocean engineering operational sea state, and design wave criteria. Pre: consent.

ORE 608 Probability and Statistics for Ocean Engineers (3) Probability and statistical analysis including distributions, multiple regression and correlation, autocovariance, cross-spectra, and practical applications in ocean engineering. Pre: 607 or consent.

ORE 609 Hydrodynamics of Fluid-Body Interaction (3) Hydrodynamics of ships, coastal and offshore structures. Wave forces by potential theory and by Morison's equation. Method of source distribution for potential flow problems. Flows with prescribed body motion, fixed and freely floating bodies. Pre: 607 or consent.

ORE 612 Dynamics of Ocean Structures (3) Response of floating platforms and vessels to wave action, spectral analysis in sea keeping. Frequency and time domain analyses of rigid body motions in six degrees of freedom. Pre: 411 or consent. Co-requisite: 609 or consent.

ORE 630 Structural Analysis in Ocean Engineering (3) Structural and finite element analyses and design of ocean structures to withstand hydrostatic and hydrodynamic loading of the sea. Considerations include material type, safety factor, stress concentration, and fatigue. Pre: consent. Co-requisite: 411.

ORE 641 Environmental Fluid Dynamics (3) Fluid dynamics for coastal and estuarine environments. Turbulent mixing processes in homogeneous and stratified fluids. Buoyancy driven flows, internal hydraulics, topographic effects and estuarine circulation. Spill and pollutant dispersal. Pre: 603 or consent.

ORE 642 Marine Environmental Remediation (3) Thermodynamics, chemistry and measurements of marine pollutants, biodegradation and biotransformation of pollutants, symbiosis and mass transfer in biofilms, bioremediation of oil spills, hazardous sediments, algae control, regulations on marine environment. Pre: consent.

ORE 654 Acoustics (3) Using sound to observe the ocean. Fundamentals of propagation, sources and receivers, radiated sound and scattering, bubbles, waveguides, scattering at rough surfaces, and bioacoustics. Topics include: marine mammals, fish and plankton imaging, navigation and communication, sound of seismics, ships, wind and rain, using sound to study ocean dynamics, flow imaging and measurement, mapping the seafloor and the combined forward/inverse problem.

ORE 661 Coastal and Harbor Engineering (3) Planning and design of seawalls, groins, jetties, breakwaters, and layout of ports. Design requirements for harbor entrances and channels. Littoral drift and sedimentation problems. Navigation and mooring requirements. Pre: 607 or consent.

ORE 664 Nearshore Processes and Sediment Transport (3) Sediment transport by waves and currents in coastal areas and its effect on morphological processes. Effect of man-made structures on littoral drift and shoreline. Pre: 607 or consent.

ORE 677 Marine Renewable Energy (3) Ocean thermal energy conversion (OTEC) systems: applicability, thermodynamics, design challenges; wave energy converters: floating devices, oscillating water column, optimal hydrodynamic performance; current, tidal and offshore wind power. Prerequisite: ORE 607; basic knowledge of thermodynamics desirable.

ORE 678 Marine Mineral Resources Engineering (3) Activities in marine minerals development are examined in a multidisciplinary systems approach involving engineering, Earth and environmental sciences and economics. Pre: consent.

ORE 695 Plan B Master's Project (3) Independent study for students working on a Plan B master's project. A grade of Satisfactory (S) is assigned when the project is satisfactorily completed. Pre: master's candidacy in ORE.

ORE 699 Directed Reading or Research (V) Pre: graduate standing and consent.

ORE 700 Thesis Research (V) Pre: candidacy for MS in ocean and resources engineering.

ORE 707 Nonlinear Water Wave Theories (3) Higher-order theories. Forced oscillations. Stoke's theory. Nonlinear shallow-water wave equations and hydraulic jumps; effects of rotation. Internal waves. Analytical techniques necessary will be developed as course progresses. Pre: consent.

ORE 766 Numerical Methods in Ocean Engineering (3) Formulation and application of numerical methods for simulating and solving ocean engineering problems. Mathematical and computational fundamentals; accuracy and stability; numerical interpolation, differentiation, and integration; boundary element, finite difference, and finite element methods. Pre: consent.

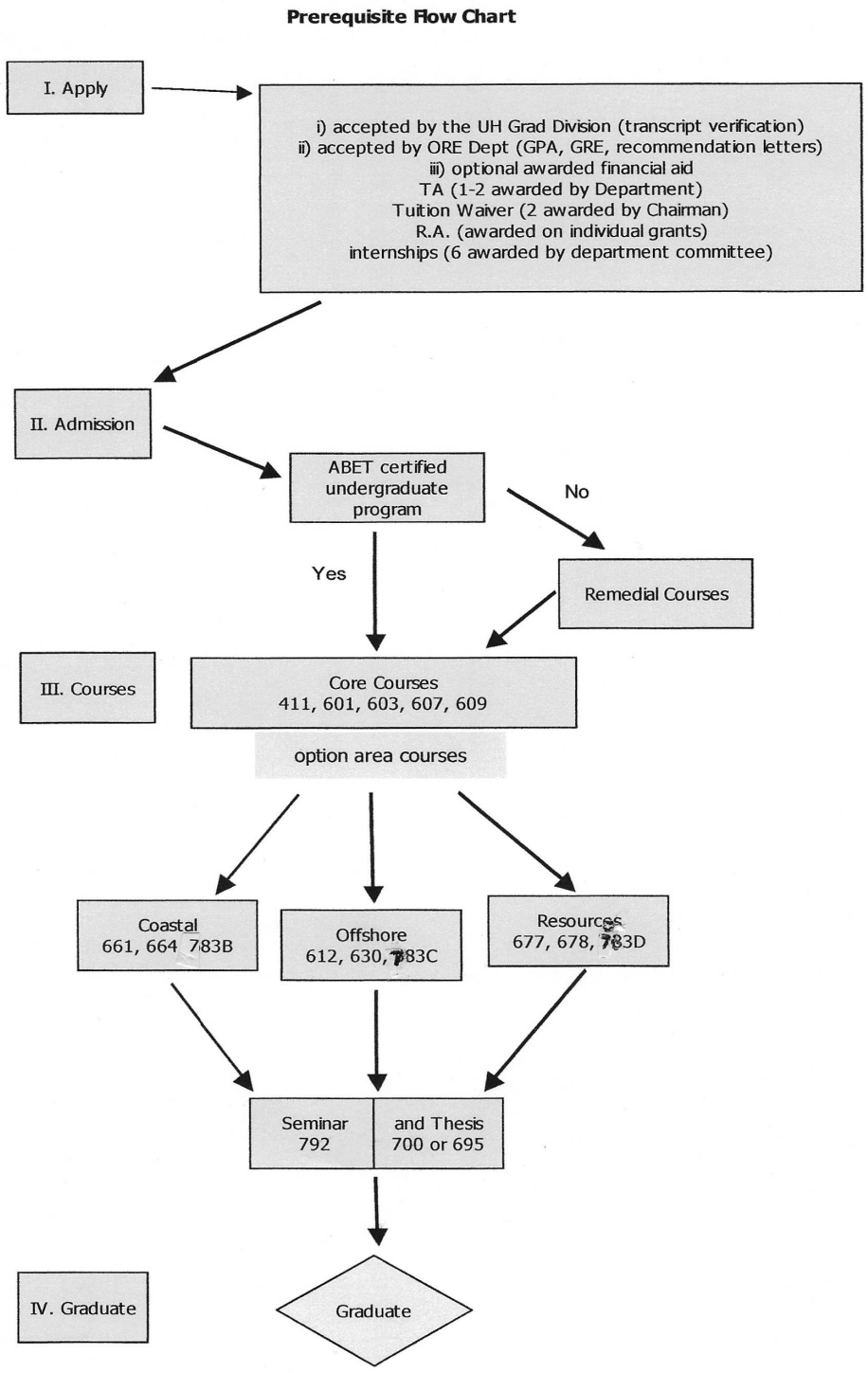
ORE 783 (Alpha) Capstone Design Project (3) Major design experience based on knowledge and skills acquired in earlier coursework and incorporating realistic constraints that include economic, environmental, ethical, social, and liability considerations. Emphasis is placed on teamwork and consultant-client relationship. (B) coastal engineering; (C) offshore engineering; (D) ocean resources engineering. Pre: 411, 601, 603, and 607; or consent.

ORE 791 Special Topics in Ocean and Resources Engineering (V) Content will reflect special interests of visiting and permanent faculty. Pre: consent.

ORE 792 Seminar in Ocean and Resources Engineering (1) Attendance at 15 approved seminars is required along with submission of notes.

ORE 800 Dissertation Research (V) Pre: candidacy for PhD in ocean and resources engineering.

A flow chart is attached above showing the prerequisite structure of the program's courses and



Prerequisite Flow Chart

the required 30 (usually 31) credit progression toward a master's in Ocean and Resources Engineering followed by the students.

Table 5-2. Relationship between Curricular Elements and ORE Educational Objectives

Curricular Elements	Educational Objectives					
	1	2	3	4	5	6
Pre-program & Gen. Exam	***					
Program core courses	**	***	**			
Option-area courses	*	**	***	*		
Laboratory course	*	***	**	*	*	
Capstone design project	*	**	***	**	**	*
Seminars				*	**	***
Thesis/independent project		*	**		**	***
Defense/final exam		*	**		***	*

*slightly, **moderately, ***highly relevant

Table 5-3. Course Outcome Matrix

Student Outcome	Program Coursework															
	411 **co**	601 **co**	603 **co**	607 **co**	608 **el**	609 **co**	612 **oe**	630 **oe**	641 **el**	642 **el**	661 **ce**	664 **ce**	677 **or**	678 **or**	783	792 **co**
1																
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
3	✓	✓	✓	✓		✓									✓	
4							✓	✓			✓		✓	✓	✓	
5	✓	✓	✓	✓	✓			✓	✓		✓	✓			✓	
6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
7								✓			✓		✓		✓	
8		✓													✓	
9	✓	✓						✓		✓	✓		✓	✓	✓	
10		✓													✓	✓
11																✓
12																✓

co – core, **oe** – offshore eng, **ce** – coastal eng, **or** – ocean resources, **el** – electives

The academic program consists of the core courses, the option-area courses, a capstone design course, seminars, and a thesis or an independent project. The core courses provide the students a basic understanding of the ocean and resources engineering disciplines that include hydrostatics,

oceanography, water waves, fluid-structure interaction, underwater acoustics, laboratory experiments, and at-sea experience. The option-area courses prepare students for specialization in coastal, offshore, and ocean resources engineering. Elective courses are also available, such as our specialty acoustics course ORE 654, to provide more in depth coverage in high demand areas. The coursework not only covers the subject matter, but also provides surveys of state-of-the-art technology in ocean and resources engineering.

The laboratory course connects materials covered in the classroom with observations and measurements made in the ocean. It is offered in the fall, in order to have sufficient boat-time to conduct measurements in the ocean. The experience offered the students includes coastal navigation, instrument usage, including deployment and retrieval, current measurements, sediment sampling and analysis, bathymetry survey, and wave measurements and analysis. The course also covers hydraulic scale-model experiments and ROV and submersible operations. Each student is required to submit a final report and give a presentation of the findings.

The capstone design project is team-taught by faculty members and practicing professional engineers. Its objective is to familiarize the students with the planning and design of a real-life engineering project in a consulting firm setting. Emphasis is placed on teamwork, risk management, decision making with insufficient information, consultant-client relation, ethics, and environmental and economic aspects of engineering design. The course is conducted as a series of meetings and informal presentations and culminates in a major presentation analogous to a public hearing at a department seminar attended by the faculty, students, and visitors from the local engineering community. In addition, students are required to read a number of engineering case studies and write a paper on issues related to ethics and professional practice.

All students in the program are required to attend 15 approved seminars. The seminars expose the students to the latest development and research related to ocean and resources engineering and instill an understanding in the students for the need to adapt to continuously changing technology. The students get an in-depth understanding in a subject area through the Plan A thesis or Plan B independent project. Both require a proposal outlining the subject, objectives, proposed methodology, sources of information, and anticipated results that must be approved by a committee composed of three faculty members, who supervise and evaluate the work. The research 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 the results at a final examination, which provides the faculty a final opportunity to test the student's understanding and ability to integrate their work at the MS level.

The core courses, along with the basic-level engineering courses in the pre-program, cover the subject matters essential to an ocean engineering program as outlined in the ABET Engineering Criteria. The option-area and elective courses allow students to specialize in an Ocean and Resources Engineering discipline. The capstone design project integrates the pre-program and the advanced-level program coursework into a major design experience and introduces students to non-technical issues commonly encountered by practicing engineers. The project simulates work in a consulting firm and prepares students for professional practice. The students gain research techniques and learn the latest technologies in an Ocean and Resources Engineering discipline through the thesis or independent project.

Cooperative Program and Internships

The Department does not provide a formal cooperative studies program. There are a number of internships at various local engineering companies . At the moment there are six of these. They provide tuition for the student and 20 hours a week of employment. The local engineering community is seeking more of these internships, so this is likely a program that will expand.

B. Course Syllabi

In Appendix A, a syllabus is included for each course showing how it satisfies the mathematics, science, and discipline-specific requirements required by Criterion 5 and the other applicable Program Criteria. The syllabi contain the following information:

- Department, course number, and title of course
- Designation as a Required or Elective course
- Course (catalog) description
- Prerequisites
- Textbook(s) and/or other required material
- ABET Course learning outcomes
- Topics covered
- Class/laboratory schedule, i.e., number of sessions each week and duration of each session
- Contribution of course to meeting the requirements of Criterion 5
- Relationship of course to Student Outcomes
- Person(s) who prepared this description and date of preparation

CRITERION 6. FACULTY

A. Faculty Qualifications

The Ocean and Resources Engineering program has eight state-funded positions in its faculty. These are augmented by 10 cooperating faculty appointments from other units at the University of Hawaii and four affiliate faculty members from local marine industry. Appendix B lists the current curriculum vitae of all the faculty. The departmental faculty members were hired through international searches following the rigorous selection procedure set by the University.

There are eight core faculty members in the Ocean and Resources Engineering Department. Of these eight faculty, six are tenured or tenure-track. All departmental faculty members are responsible for the instruction, research, and administration of the Ocean and Resources Engineering program:

- K.F. Cheung, PhD, PE, Professor of Ocean and Resources Engineering, Graduate Chairman of the Department – 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
- 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, Chair of the Department of Ocean and Resources Engineering – Ocean observation, glider technology, acoustics
- G.C. Nihous, PhD, Associate Professor Ocean and Resources Engineering, Project Manager, Pacific International Center for High Technology Research (PICHTR) – OTEC, offshore renewable energy
- E.-M. Nosal, PhD, Associate Professor of Ocean and Resources Engineering – Acoustics, applied mathematics
- Zhenhua Huang, PhD, Associate Professor of Ocean and Resources Engineering – Coastal mixing processes, fluid dynamics, sediment transport
- J.C. Wiltshire, PhD, Associate Chair of the Department of Ocean and Resources Engineering; Specialist and Director, Hawaii Undersea Research Laboratory – Submersibles, ROVs, deep-sea mining technology, ocean energy systems

The core faculty provide coverage of the three option areas in coastal, offshore engineering, and ocean resources engineering. Their research projects include laboratory and fieldwork, as well as computer simulation, and enrich the research component of the academic program.

The Ocean and Resources Engineering program has strong ties with the Hawaii Undersea Research Laboratory (HURL) at the University of Hawaii. The Director of HURL, John Wiltshire, has been first chair and now associate chair of Ocean and Resources Engineering since 2007. B.D. Greeson, PhD, US Navy Captain (Ret.), Certified Chief Engineer, is also the chief engineer of HURL.

These two faculty members who have joint positions with the Hawaii Undersea Research Laboratory bring in expertise in acoustics, marine engineering, marine mining technology, ship-ROV-submersible operations and have a wealth of at-sea experience. Most importantly, their involvement provides students access to the HURL facilities, including sea going vessels, submersibles, ROVs and a range of deep-sea equipment and test facilities, and active hands-on experience with oceanographic instrumentation.

The program has 10 additional cooperating faculty members from other research or academic units at the University of Hawaii. These include:

Cooperating Faculty
(Supporting Faculty from other Departments at the University of Hawai'i)

Janet M. Becker, PhD

Department of Geology and Geophysics
Nonlinear surface, internal waves,
general ocean circulation, hydrodynamic stability
E-mail: jbecker@soest.hawaii.edu

Brian Bingham, PhD
Department of Mechanical Engineering
autonomous robotics, navigation, dynamics and controls
E-mail: bsb@hawaii.edu

Monique Chyba, PhD
Department of Mathematics
Control theory, Optimal control, Trajectory design, Differential Geometry, Underwater Vehicle
E-mail: mchyba@math.hawaii.edu

Reza Ghorbani, PhD
Department of Mechanical Engineering
Director: Renewable Energy Design Laboratory
Email: rezag@hawaii.edu

Brian T. Glazer, PhD
Department of Oceanography
Subseafloor Biosphere, Coastal Benthic Boundary Layer, Instrumentation Development
E-mail: glazer@hawaii.edu

Stephen M. Masutani, PhD
Hawaii Natural Energy Institute
Ocean resources engineering
Email: masutan@wiliki.eng.hawaii.edu

Gary McMurtry, PhD
Department of Oceanography
Director Pacific GPS Facility Uranium-Series Disequilibrium, Marine Mineral Formation and Resources, Submarine Hydrothermal Systems, Magmatic Volatiles, Submarine Monitoring Technology, Mass spectrometry
Email: garym@soest.hawaii.edu

Mark A. Merrifield, PhD
Department of Oceanography
Coastal circulation, physical oceanography, ocean measurements and data analysis
E-mail: markm@soest.hawaii.edu

H. Ronald Riggs, PhD
Department of Civil and Environmental Engineering
Structural Engineering, Hydroelasticity
E-mail: riggs@hawaii.edu

John R. Smith, PhD
Hawaii Undersea Research Laboratory
Marine survey
Email: jrsmith@soest.hawaii.edu

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. Their involvement is critical in supporting students and rounding out thesis committee structure. Their research enlarges the research base of the education program and provides a more diversified selection of research projects for the students.

Four affiliate faculty members from local engineering and scientific communities are currently serving on the faculty:

Affiliate Graduate Faculty
(Supporting faculty from industry and external universities)

David Rezachek, PhD
PE, Rezachek & Associates, Honolulu, Hawaii.
Dayan Vithanage, PhD
PE, Vice President, Oceanit Laboratories, Inc., Honolulu, Hawaii.
Geno Pawlak, PhD
Assoc. Prof., Mechanical and Aerospace Engineering Dept., University of California, San Diego, California.
Joseph Van Ryzin, PhD
PE, Technical Director and President emeritus, Makai Ocean Engineering, Inc., Kailua, Hawaii.

These practicing professionals volunteer their time and bring in real-world engineering experience to the academic program. Most of them serve on student research committees and especially team-teach the capstone design project with the faculty. Their involvement is instrumental in preparing the students for the engineering profession.

The Ocean and Resources Engineering faculty members have served as officers in professional societies such as:

- American Society of Civil Engineers
- American Society for Engineering Education – Ocean and Marine Division
- Institute of Electrical and Electronic Engineers – Oceanic Engineering Society
- International Society of Offshore and Polar Engineering
- Marine Technology Society
- Society of Naval Architecture and Marine Engineering

They provide liaison between students and professional societies and assist students in organizing technical activities.

Table 6-1 shows the faculty experience. Most faculty members have research expertise in multiple disciplines, but only one is listed in Table 6-3 for programmatic reasons. The departmental faculty members cover all the core courses and most of the required courses in the three option areas. Faculty workload is shown in Table 6-2.

Table 6-1. Faculty Qualifications

Ocean & Resources Engineering Academic Year 2014-2015

Faculty Name	Highest Degree Earned- Field and Year	Rank [1]	Type of Academic Appointment[2] T, TT, NTT	FT or PT[3]	Years of Experience			Professional Registration / Certification	Level of Activity[4] H, M, or L		
					Govt./Ind. Practice	Teaching	This Institution		Professional Organizations	Professional Development	Consulting / summer work in industry
Cheung, Kwok Fai	Ph.D. – Civil Engineering, 1991	P	T	FT	2	22	22	PE Hawaii	M	M	M
Ertekin, R. Cengiz	Ph.D. – NAOE, 1984	P	T	FT	5	29	29	FASME, FSNAME	H	H	H
Greeson, Bernard D.	Ph.D. – Ocean Engineering 1997	P	NTT	PT	28	17	15	Navy/ USCG	M	M	M
Howe, Bruce M.	Ph.D. – Oceanography, 1986	P	T	FT	22	7	7	N/A	M	L	L
Zhenhua Huang	Ph.D. – Environmental Fluid Mechanics, 2004	ASC	TT	FT	0	10	1	N/A	M	M	L
Nihous, Gérard C.	Ph.D. – Ocean Engineering, 1983	ASC	T	FT	20	11	11	None	L	H	M
Eva-Marie Nosal	Ph.D. – Geophysics, 2007	ASC	T	FT	5	11	8	None	M	L	M
Wiltshire, John	Ph.D. – Oceanography, 1983	P	NTT	PT	7	30	30	None	H	M	M

Table 6-2. Faculty Workload Summary

Faculty Member (name)	PT or FT[1]	Classes Taught (Course No./Credit Hrs.) Term and Year[2]	Program Activity Distribution[3]			% of Time Devoted to the Program[5]
			Teaching	Research or Scholarship	Other[4]	
Cheung, Kwok Fai	FT	ORE 607/3, Fall 2014	30%	50%	20%	100%

		ORE 661/3, Spring 2015				
		ORE 695/3, Fall 2014 and Spring 2015				
		ORE 783B/3, Fall 2014				
Ertekin, R. Cengiz	FT	ORE 411/3, Fall 2014	30%	40%	30%	100%
		ORE 609/3, Spring 2015				
		ORE 695/3, Fall 2014 and Spring 2015				
Greeson, B. Dan	PT	None in Fall 2014/Spring 2015	0%	0%	100%	25%
Howe, Bruce	FT	ORE 500/3, Fall 2014 and Spring 2015	10%	60%	30%	100%
		ORE 654/3, Fall 2014				
Huang, Zhenhua	FT	ORE 601/3, Fall 2014	50%	50%	0%	100%
		ORE 664/3, Spring 2015				
		ORE 695/3, Fall 2014				
Nihous, Gérard C.	FT	ORE 677/3, Spring 2015	40%	40%	20%	100%
		ORE 695/3, Spring 2015				
		ORE 783D/3, Fall 2014				
		ORE792/1, Fall 2014 and Spring 2015				
Nosal, Eva-Marie	FT	ORE 603/3, Fall 2014	20%	20%	60%	100%
		On sabbatical, Spring 2015				
Wiltshire, John	PT	ORE 202/3, Spring 2015	50%	20%	30%	75%
		ORE 303/3, Fall 2014				
		ORE 678/3, Fall 2014 and Spring 2015				

1. FT = Full Time Faculty or PT = Part Time Faculty, at the institution
2. For the academic year for which the Self-Study Report is being prepared.
3. Program activity distribution should be in percent of effort in the program and should total 100%.
4. Indicate sabbatical leave, etc., under "Other."
5. 5. Out of the total time employed at the institution.

The cooperating faculty members provide additional electives and team teaching support (McMurtry and Merrifield). The affiliate faculty members team-teach the capstone design with the departmental faculty to integrate the coursework in a major design experience. Cooperating graduate faculty members can chair student research committees and their diverse backgrounds are instrumental to the graduate education program. Although the departmental faculty is relatively small and spread thin in the three option areas, the department provides a truly first rate education program with sufficient breath and depth by leveraging of resources within the university and from the local marine industry.

Table 6-3. Distribution of faculty in the three option areas and supporting disciplines

Discipline	Faculty		
	Departmental	Cooperating	Affiliate
Coastal Engineering	K.F. Cheung* Z. Huang*	M.A. Merrifield*	D. Vithanage* G. Pawlak

Ocean Resources Engineering	G.C. Nihous* J.C. Wiltshire*	S.H. Masutani	D. Rezachek*
Offshore Engineering	R.C. Ertekin* B.D. Greeson*	B.S. Bingham H.R. Riggs	J. Van Ryzin*
Oceanographic Engineering	B. Howe*	B.T. Glazer G.M. McMurtry* J.R. Smith	
Applied Mathematics	E.-M. Nosal*	J.M. Becker M. Chyba	

*Faculty members with teaching duties in the Department

B. Faculty Workload

The activities of each faculty member are summarized in Appendix B. An updated report for the current year will be provided at the time of the visit. Tables 6-2 and 6-4 above summarizes the faculty teaching load. The teaching load is lower compared to other engineering departments at the University of Hawaii because of the emphasis on research in the Ocean and Resources Engineering program. The full-time departmental faculty members teach between 3 and 6 credit hours per semester and cover the bulk of the coursework. Drs. Greeson and Wiltshire (the two HURL faculty members) and Dr. Bruce Howe on a research appointment, teach 3 credit hours per academic year consistent with their appointments. Two of the Ocean and Resources Engineering courses are cross-listed with courses in Mechanical Engineering and Oceanography. Drs. Rezachek, Van Ryzin, and Vithanage take turns team-teaching the capstone design with Prof. Cheung and Nihous.

Ocean and Resources Engineering is an advanced-level program. The faculty members spend a significant portion of their time advising students on their research work at the MS and PhD levels. The departmental faculty members are primarily responsible for academic advising and carry a major portion of the research advising duties by serving as research committee chairs. The cooperating faculty members are also actively involved in the students' research work. Many of them have chaired and served on research committees. They bring in research expertise not covered by the departmental faculty and provide additional research funding to support graduate students. Profs. Becker and Merrifield were formally Ocean and Resources Engineering faculty and continue to work closely with the Department. Several of the affiliate faculty members have also served on student research committees and provide insights from the perspective of the industry.

Table 6-4. Teaching Assignments from Fall 2013 – Spring 2015

Faculty	Number of Credits			
	Fall 2013	Spring 2014	Fall 2014	Spring 2015
K.F. Cheung	3	3	6	6
R.C. Ertekin	3	3	3	3
B.Howe	3	3	3	3
Z. Huang	na	na	6	3
E. Nosal	3	4	3	na

B.D. Greeson	0	3	0	0
J.C. Wiltshire	3	3	3	6
G. Nihous	3	3	4	7

*Team-taught with K.F. Cheung

C. Faculty Size

An analysis of the faculty is provided in the Appendix. The eight faculty are sufficient to deliver a strong program. Six of the departmental faculty members have education backgrounds in civil engineering, mechanical engineering, and naval architecture. These three distinctly different disciplines provide a broad coverage of the Ocean and Resources Engineering program. The faculty have a combined 123 years of experience at the University of Hawaii in addition to 89 years of government and industry experience. The prior industry experience includes oil companies, shipyards, and consulting firms specializing in coastal, offshore, harbor, and environmental engineering. Faculty were involved in a variety of engineering projects that range from preliminary design and feasibility assessment to detailed design and construction worldwide. One current and one emeritus faculty member are registered Professional Engineers in the state of Hawaii. Students have no trouble in finding willing faculty members to advise them and serve on their committees. The faculty are also involved with many service projects particularly to State agencies and professional societies in terms of bringing major conferences to Hawaii.

Research is one of the strengths of the Ocean and Resources Engineering program. During the period, the faculty members received over $10 million of research grants and contracts as University of Hawaii Principal Investigators . They published over 100 articles during the same period (see complete Departmental publication list in the Appendix). The articles were published in the best national and international journals of direct relevance to the Ocean and Resources Engineering program. These journals included:

- Engineering Analysis with Boundary Elements
- Fluid Dynamics Research
- Fluids and Structures
- Geophysical Research Letters
- IEEE Journal of Oceanic Engineering
- International Journal of Heat and Fluid Flow
- International Journal for Numerical Methods in Fluids
- International Journal of Offshore Mechanics and Polar Engineering
- Journal of the Acoustical Society of America
- Journal of Coastal Research
- Journal of Energy Resources Technology
- Journal of Engineering Mathematics
- Journal of Engineering Mechanics
- Journal of Fluid Mechanics
- Journal of Geophysical Research
- Journal of Hydraulic Engineering
- Journal of Hydraulic Research

- Journal of the Marine Acoustics Society
- Journal of Marine Environmental Engineering
- Journal of Offshore Mechanics and Arctic Engineering
- Journal of Physical Oceanography
- Journal of Waterway, Port, Coastal, and Ocean Engineering
- Marine Technology Society Journal
- Marine Georesources and Geotechnology
- Mechanical Engineering
- Ocean Engineering
- Wave Motion

Many of the publications were co-authored by students, who worked on their MS theses and PhD dissertations under the guidance of faculty members.

The faculty members are also actively interacting with community groups. They are members of national and international professional societies, including:

- Acoustical Society of America
- American Geophysical Union
- American Society of Engineering Education
- American Society of Civil Engineers
- American Society of Mechanical Engineers
- IEEE Oceanic Engineering Society
- International Ship Structure Congress
- International Society of Offshore and Polar Engineers
- Marine Technology Society
- Society of Naval Architects and Marine Engineers
- Society of Mining, Metallurgy and Exploration (formerly Society of Mining Engineers)
- The Oceanography Society

Some faculty members have served as officers of these organizations and organized international conferences, such as:

- International Conference on Offshore Mechanics and Arctic Engineering, Mexico, 2003
- International Conference on Offshore Mechanics and Arctic Engineering, Honolulu, Hawaii 2009
- IEEE/MTS Oceans Conference, Honolulu, 2001 and 2011(co-chaired)
- International Workshop on Very Large Floating Structures, Honolulu, Hawaii, 1999

The faculty members are also active in community service and serve on various advisory committees, including:

- Ala Wai Canal Improvement Advisory Committee, Department of Land and Natural Resources, State of Hawaii
- Coastal Erosion Advisory Group, Department of Business, Economic Development and Tourism, State of Hawaii
- Land Erosion Control Advisory Committee, City and County of Honolulu

- Multi-Hazards Science Advisory Committee, Department of Defense, State of Hawaii
- Tsunami Technical Review Committee, Department of Defense, State of Hawaii
- Water Quality Advisory Committee, Department of Health, State of Hawaii

Faculty members in professional fields of study, such as engineering, are better teachers and researchers, if they continue to practice and apply their knowledge in the real world. This is also the most direct way to interact with the professional communities. Recently the faculty members have been involved in engineering projects with:

- Applied Technology Corporation
- Bishop Museum
- Belt Collins Hawaii, Ltd.
- Booz Allen Hamilton
- Dept. of Business, Economic Development and Tourism, State of Hawaii
- Martin & Chock, Inc.
- Makai Ocean Engineering, Inc.
- Navatek Ltd.
- Ocean Engineering Consultants, Inc.
- Oceanit Laboratories, Inc.
- PACE Technologies
- Pacific Disaster Center
- Sea Engineering, Inc.
- SSFM International
- Trex Enterprises Corporation - Maui
- U.S. Army Corps of Engineers, Mississippi Valley Division

In addition, the faculty members have worked as visiting researchers or professors at various institutes worldwide, including:

- Toho University in Chiba, Japan
- Naval Surface Warfare Center Carderock Division, Maryland
- Department of Applied Physics, Christian Albrechts University, Kiel, Germany
- Department of Naval Architecture and Offshore Engineering, University of California, Berkeley, California
- Fluid Engineering Department, Universidad Carlos III de Madrid, Spain
- Royal Technical University, Stockholm, Sweden
- University of Washington, Applied Physics Laboratory

These research, scholarship, and professional activities are instrumental in maintaining the timeliness and diversity of the Ocean and Resources Engineering program. The cooperating and affiliate faculty members, who have backgrounds in biochemical engineering, civil engineering, geophysics, oceanography, ocean engineering, and mechanical engineering, and the same level of professional competency, add to the diversity of the program.

The eight faculty in the department provide abundant opportunity for interaction for the approximately 20 students (a 1:2.5 faculty to student ratio is unprecedented). Each student has an

advisor who interacts with them regularly to ensure they are making progress and are well counseled. The faculty are also actively involved in University service activities. Professor Ertekin has served on the Faculty Senate. Professors Howe and Wiltshire are part of the SOEST Executive Committee, advising the Dean on management of the School. Professor Nosal serves on the school curriculum review committee. Professor Howe serves on the research council and ship committee to name a few. The faculty are also very involved with the local engineering community having serve as officers in several of the societies noted above. Professor Ertekin is a Fellow of SNAME. Professor Wiltshire is a Fellow of the Marine Technology Society. The faculty actively work through these societies to interface with the local engineering community to provide opportunities and employment for students. Wiltshire is the advisor to the student MTS section which provides free membership to students (paid for with department funds).

D. Professional Development

The Department is most fortunate in that of its 8 faculty, five are at the highest rank. These faculty are very active with professional societies. They are reviewed every five years during a rigorous post tenure review process. The faculty are awarded sabbaticals every seven years to help sharpen their skills and better acquaint them with the modern engineering world and state of the art practices. They are encouraged to undertake consulting activities and interface closely with the tight-knit Hawaii ocean engineering community. The University Research Council provides travel funding to attend professional society meetings when grant monies are not available. All of the faculty regularly attend these professional society meetings (listed above) to maintain their edge on the latest research.

One faculty member, Dr. Zenhua Huang, was hired a year ago as a new assistant (now associate) professor. He will come up for tenure in three years. In order to help him progress he is being mentored by several senior faculty members. He is assigned classes and senior committee responsibility to challenge him and bring him into contact with senior university officials. Department members are also very active in several ocean engineering professional societies. He is strongly encouraged to actively participate in these societies.

Two other members of the department are at the associate professor level. Both are tenured (Nosal and Nihous). The same mentoring process is undertaken with them.

Dr. Cengiz Ertekin may retire from the ORE department in late 2015 after 30 years of service. His position will be advertised and replaced.

E. Authority and Responsibility of Faculty

As a whole the faculty create and modify courses (most recently majorly revising ORE 202-Ocean Technology). The faculty set program objectives and modify them in accordance with guidance received from the advisory committees. The faculty as a whole also decide on the student outcomes and assess the attainment of these outcomes through exercises and surveys. Decisions of the faculty on curriculum go to the curriculum committee for approval. Major program changes then go to the Dean for approval. An annual department assessment is done by the university's assessment office and the Associate Dean for academic affairs to ensure compliance and progress.

Courses are initially developed by qualified faculty members in response to an identified need or opportunity. The latest fully new (as opposed to majorly revised) course created in the Ocean and Resources Engineering Department is ORE 654, our acoustics course. This was created in response to a demand from our advisory panels, IEEE Oceanic Engineering Society guidelines and ABET advisors. It was given final approval by the University's Graduate Division.

Once created, the course is evaluated by a standing SOEST curriculum committee. The committee evaluates the course for level, excellence of the instructor, consistency and appropriateness for the program. ORE has one member on the curriculum committee (Prof. Nosal). All NEW courses and major course changes must be evaluated by the curriculum committee. The curriculum committee then makes a recommendation to the Dean's office, which forwards it to the Vice Chancellor for Academic Affaires and the Graduate Division. If the course is approved at all levels, it then goes in the University Course Catalog and becomes part of the ORE program.

Ongoing course evaluation is done by on-campus review teams reporting to the Vice Chancellor's Office. They periodically review all courses for appropriateness of level and content. All courses are required to be evaluated by students each semester they are taught. Poor student evaluations or complaints would trigger a departmental review, as well as overall university review immediately. The initial departmental review would entail evaluation of the syllabus, discussion with the instructor, remarking of assignments and sitting in the class by the chairman or other members of the ad hoc evaluation team.

The School of Ocean and Earth Science and Technology has committed to the expansion of the ORE Department. The faculty have gone from four active members in 2007 to eight in the last several years. Although the State's economic situation is making further expansion difficult, the long-term plan is to progress with more faculty, courses and student support. For a specialized, graduate only department such as ORE, this represents a solid commitment from the University Chancellor and Vice Chancellor for Research and a good sharing of responsibility for ocean engineering education with the faculty.

CRITERION 7. FACILITIES

A. Space

The Department of Ocean and Resources Engineering has access to the facilities needed to deliver the Student Outcomes and achieve the Program Educational Objectives. Students are provided hands-on experience that includes laboratory experiments, in-ocean measurements, ROV and AUV operations. The program requires extensive use of engineering tools and computers in the coursework. Some students are exposed to state-of-the-art computing infrastructure and high-fidelity simulation models through research work, depending on the research topic they focus on. The following sections outline the available facilities. These

facilities are available for a variety of instructional and research uses, depending on which classes a student takes and what topic they choose for their research.

Offices

Every faculty member has a well-appointed private office of a required minimum of 150 square feet. Offices are equipped with high-speed internet connections. Most faculty members provide computer equipment suited to their research, bought on their grants or start-up funds provided by the Dean's office. Should such funding not be available the Department will provide the necessary computers. Office and computer capability allows each faculty member to comfortably meet with advise and interact with students. Most of the faculty offices are in the departmental complex on the fourth floor of Holmes Hall. A few faculty offices are in adjoining SOEST buildings. Post Docs and technicians are normally housed two to the equivalent of one faculty office. There is also office space for all graduate students in the department. There are four large rooms and four smaller ones partitioned into individual graduate student space. The graduate student spaces are: Holmes 407 and 407A (12 students), 408 (10 students), POST 132 and 132A (12 students), HIG 321 and 322 (4 students) and MSB 318 (3 students). Each graduate student is assigned a desk and is provided a broadband Internet connection at no cost. Most of the rooms also have file cabinets, bookshelves, tables, general-purpose computers, and printers for student use. Clerical staff are assigned to the main office. The office is run by a secretary, administrative assistant and occasional student assistants. The office also contains the department files, reference books and office supplies cabinet. The space is adequate for a department of 8 faculty and 25 graduate students.

Classrooms

The department offers up to 8 courses per semester during the academic year. The enrollment in each course ranges from 2 to 13. The Department has a reserved 15-seat classroom in Holmes Hall, where the department is located. Additional classrooms can be assigned to the department. Each classroom in Holmes Hall has audio-video equipment, internet access as well as an overhead projector and at least one large blackboard. The facilities are adequate for instructional purposes. The capstone design class meets in the department conference room and occasionally at the off-campus offices of affiliate faculty members to simulate actual work environments.

Fluid Dynamics Laboratory

The Fluid Dynamics Laboratory focuses on the study of coastal and marine hydrodynamics including wave dynamics, wave-interaction with coastal structures, sediment transport, flow over rough boundaries, turbulent dispersal of pollutants and nutrients, and performance of hydrofoils. In addition, the laboratory is home to the Fluid Dynamics Education Laboratory, which serves as a center for teaching of fluids phenomena in support of courses within the Department and SOEST and is available to the general University community.

The laboratory houses a number of experiment tanks, which are used for both research and teaching demonstrations. These include a 10-meter long, 30 × 10 cm wave channel and a rotating table. The tanks allow demonstration of a range of fluid flow phenomena including wave breaking, wave reflection by coastal structures, down-slope currents, and internal waves in stratified fluids along with rotational effects such as spin-up, Ekman flow and geostrophy.

Laboratory instrumentation includes several sets of wave gauges for wave surface elevation measurements, a number of Acoustic Doppler Velocimeters (ADVs), which obtain high frequency, single point, 3-component velocity measurements, and a laser-based Particle Imaging Velocimetry (PIV) system, which obtains two-dimensional fluid velocity via laser imaging techniques. A pulsed YaG laser with digital still and video cameras is used for flow visualization and measurement.

KiloNalu Ocean Observatory, AUV and In-ocean Experiments

The Department maintains research facilities at Snug Harbor and offshore of Kewalo Basin for staging and in-ocean experiments. These facilities include field research equipment and instrumentation, a 25-ft motorboat (R/V *Kilo Kai*) and access to larger research vessels as well as machine shop support. The state-of-the-art Kilo Nalu 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 and has been used in numerous research projects focusing on water quality variability, benthic boundary layer physics and geochemistry, stratified turbulence, internal wave dynamics and sediment porewater processes. Research at the observatory involves collaborations with numerous units across UH (Oceanography, HIMB, HIGP, Mechanical Engineering), as well as outside the University (Stanford University, University of California, San Diego, Naval Postgraduate School, Oregon State University, NOAA CRED and NOAA PMEL) with funding from a range of agencies (National Science Foundation, NOAA Coastal Services Center, Office of Naval Research, UH Sea Grant Foundation, City and County of Honolulu). In addition, Kilo Nalu is a key component in the Hawaii Ocean Observing System (HIOOS) providing real-time observations for online access and for numerical model validation.

Kilo Nalu provides data and power connections to a suite of observational instruments. Baseline observations include water currents and temperature versus depth, directional wave spectra, salinity, acoustic backscatter, turbidity, dissolved oxygen, and chlorophyll fluorescence. Meteorological data is collected at the observatory's shore station. The 7-acre in-ocean test range off Kewalo Basin extends from 5 to 20 meters depth with test platforms equipped with shore-cabled power supply outlets and data connections. The Kilo Nalu equipment suite includes acoustic current profilers, current meters, wave gauges, thermistors, pressure sensors, conductivity-temperature-depth (CTD) sensors, anemometers, buoys, mooring equipment, and SCUBA diving gear.

The ORE field program operates a REMUS (Remote Environmental Monitoring UnitS: Hydroid, Inc.) autonomous underwater vehicle (AUV) in support of research and teaching programs. The AUV can operate at depths of up to 100 m (328 feet) and is equipped with two ADCPs (Acoustic

Doppler Current Profilers), one upward looking and one downward looking, and sidescan sonar. The UH REMUS is additionally outfitted with underwater modem communication, GPS navigation, a Seabird CTD, a Wetlabs ECO sensor, and Wi-Fi. Other sensors can be added as needed. Four batteries power the vehicle for maximum mission distances of approximately 55 km at 3 knots. The vehicle is small in comparison to most AUVs, with a weight of 90 lbs. REMUS can be deployed and recovered by two individuals from a small craft.

In addition, the ORE field program operates a Seabotix LBV150 remotely-operated vehicle (ROV). The LBV150 is equipped with two video cameras and a grabber arm and can operate to depths of 150 m from small vessels.

Aloha Cabled Observatory (ACO)

The ALOHA Cabled Observatory (ACO) is a general purpose "node" providing power, communications and timing connectivity for science use at Station ALOHA 100 km north of Oahu. Included are a suite of basic sensors making core measurements, some local and some sensing the water column. At 4728 m deep, it is the deepest scientific outpost on the planet with power and Internet.

The ACO was deployed in June 2011 to support innovative scientific research at Station ALOHA (Figure 1). Station ALOHA is the field site of the NSF-funded Hawaii Ocean Time-series (HOT) program that has investigated temporal dynamics in biology, physics, and chemistry since 1988, at a site that is representative of roughly 70% of the world ocean. Research cruises (~monthly since 1988) sample the ocean from top to bottom to monitor and study changes on scales of months to decades. The co-located Woods Hole mooring (WHOTS) provides meteorological and upper ocean physical data. Together, HOT, ACO and WHOTS provide a truly unique set of complementary in-situ observations of the ocean across all disciplines and regimes (deep sea, near surface, etc.).

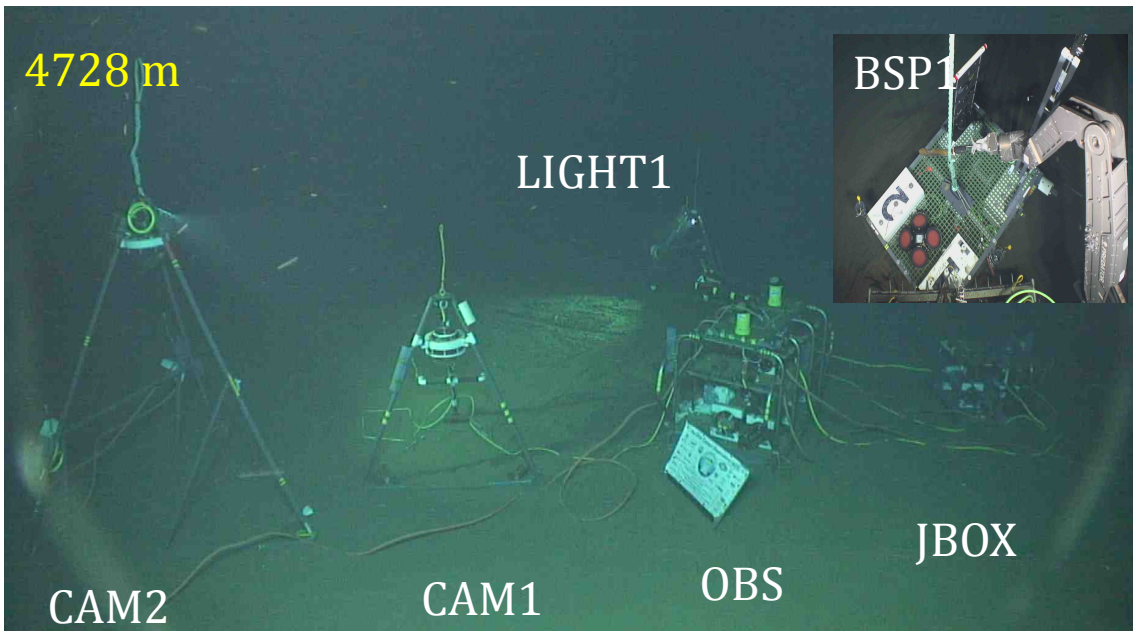


Figure. The current ACO configuration (November 2014). The BSP1 sits off to the right about 18 m; ROV *Jason* is just about to cut floats above free. A banner with contributors is by the OBS (photos by *Jason*).

The ACO system uses a retired AT&T telecommunications cable. In 2007 the cable was cut and one end moved slightly and a 'proof module' hydrophone attached. In June 2011, a general purpose 'node' was connected and the ACO has been providing power (1200 W), network communications (100 Mb/s) and timing (1 μs) to the seafloor node and instruments at 4728 m water depth since then. During a service cruise in November 2014, a camera system (CAM2 and LIGHT1) and a basic sensor package (BSP1) were added. Station ALOHA is unique in the world for the combination of long-term world-class ocean sampling coupled with multitudes of short to long term process studies and other research.

While supporting science research, the ACO provides many opportunities for ORE for teaching and research within classes, degree projects, and independent study, e.g., learning spectral analysis of ambient sound, analyzing the real time data (e.g., whale detection and real time reporting thereof, temperature variability, video and audio), software for displaying engineering and video/audio data, developing and preparing instrumentation and infrastructure for deployment, and participating in cruises with leading edge equipment. The SOEST 6000-m rated remotely operated vehicle (ROV) supports the latter. ACO is a topic in various classes: Seminar on Research (Honors 101), Ocean Technology (ORE 202), Earth System Science and Data (OCN 363), Ocean Acoustics (ORE 654), Ocean Engineering Laboratory (ORE 601), Oceanography for Engineers (ORE 603), and Numerical Methods (ORE 766).

Hawaii Undersea Research Laboratory

The Hawaii Undersea Research Laboratory (HURL) has facilities at Makai Pier. HURL operates two deep diving (2000 m) submersibles, the PISCES IV and PISCES V and a remotely operated vehicle. The ROV and submersibles operate off the 225-foot research vessel, *Ka'imikai-o-Kanaloa* (KOK), obtained for the University and largely supported by HURL. The submersibles,

ROV, and their mothership conduct a wide range of engineering and oceanographic 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 Ocean and Resources Engineering 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. The number of full research assistantships provided by HURL to ORE students has varied up to 2 per year. The HURL facilities, test site, pier and machine shop are available to the students of the department for a range of projects working or instrumentation beyond those directly funded by HURL. The machinists and technicians of HURL will be actively working on this grant. Many theses in the area of ocean energy resources will find support in this work. HURL and the Department of Ocean and Resources Engineering have a very close working relationship at all levels.

B. Computing Resources

Department Computing Facilities and Software

The Department and the faculty operate several clusters and six Linux systems and a network of Pentium-based PCs. All students are given computer accounts and email access on at least one of the Unix systems and the PC network. All PCs are installed with the current version of Windows and MS Office. All research assistants have assigned PCs. A number of software packages are available to the students for coursework and research. Software available for students include:

- Tecplot (versions 8.0, 9.0, 9.2, 10.0, 360)
- Fortran 95 Linux PRO v6.2, 95 Standard v5.7, C/C++
- Microsoft Office 2007, XP
- Microsoft Publisher 2007
- Aces 7b
- Dream Weaver 8
- Delft Ship Pro v7.14
- MATLAB 2013b, 2014a
- Adobe Acrobat 9 Pro Extended
- Mathematica 2.2

Software Used for Research

- Matlab
- Python
- WAMIT (a potential flow hydrodynamic wave-body flow solver, under academic license),
- OpenFOAM (an open source full Computational Fluid Dynamics solver) and
- MITgcm (an ocean general circulation model developed at MIT - open source)
- PGI Compiler
- Lahey Fortran
- Intel Fortran Compiler

- ArcGIS 10
- Google Earth Professional

AIX/Linux Computers

- 6 total Linux (2 Conghao, Florian, Troy, Prof. Cheung, Prof. Huang)

Computers Equipment Used for Research

- multicore GPU (Graphical Processing Unit) workstation with 448 NVIDIA Tesla GPU cores and 12 Intel Xeon CPU cores (Nosal)
- 16-node computer cluster with 128 CPUs maintained by SOEST (Nihous)
- 27-node computer cluster with 464 Intel Xeon CPUs and 123 TB RAIDs maintained by SOEST (Cheung)

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

University-Wide Computing Resources

Information Technology Services supports public computing labs for all currently affiliated University of Hawaii students, faculty and staff for University business and/or educational purposes. The computer labs are intended to provide a place to learn, study, and research. Labs are located at: Sinclair Library 1st floor (Wong Computer Lab) and Hamilton Library 1st floor (Hamilton CLIC). These facilities are quite comprehensive and are listed below.

Hamilton CLIC Lab

Computers Currently Available:
60 Dell Optiplex 9020
18 Dell Optiplex 980
1 Dell Optiplex 9020 ADA Station
Printing (requires a library copy card, 11 cents per page)
2 HP LaserJet 4515

Services:
Laptop Wireless Support
2 Scanning Stations

Software:
Microsoft Office 2010
Word, Excel, Powerpoint, etc.
Internet Explorer 11
Mozilla Firefox ESR 24
Google Chome
Acrobat Reader 11
SSH Secure Shell Client 3.2.9

McAfee VirusScan 8.8i
VLC Player
Stellarium
Aleks
Java
Quicktime
GIMP 2

Hardware:
Dell Optiplex 9020's:
Intel Core i5
500GB Hard Drive
8GB RAM
DVD/RW Combo Drive
21" Dell Flat Panel Display
Dell Optiplex 980's:
Intel Core i5
250GB Hard Drive
4GB RAM
DVD/RW Combo Drive
20" Dell Flat Panel Display

Sinclair Wong Computer Lab
Computers Currently Available:
36 Dell Optiplex 9020
2 Apple iMac 20"
1 Dell Optiplex 9020 ADA Station
Printing (requires a library copy card, 11 cents per page)
2 HP LaserJet 4515 Printers

Services:
UH Username Password Resets
You must provide a valid government issued photo ID (i.e. driver's license, state ID, or passport)
Laptop Wireless Support
1 Scanning Station

Software:
Microsoft Office 2010
Word, Excel, Powerpoint, etc.
Internet Explorer 11
Mozilla Firefox ESR 24
Google Chome
Acrobat Reader 11
SSH Secure Shell Client 3.2.9

McAfee VirusScan 8.8i
VLC Player
Stellarium
Aleks
Java
Quicktime
GIMP 2

Hardware:
Dell Optiplex 9020's:
Intel Core i5
500GB Hard Drive
8GB RAM
DVD/RW Combo Drive
21" Dell Flat Panel Display

Maui High Performance Computing Center

The Maui High Performance Computing Center (MHPCC) is an Air Force Research Laboratory Center. It is also a Distributed Center of the Department of Defense High Performance Computing Modernization Program and ranked as one of the top 20 supercomputer sites in the world. Its tera-scale, high-performing computing resources showcase a range of technologies, from IBM Power3 16-way configurations to the largest Linux Supercluster in the Department of Defense inventory. The Department of Ocean and Resources Engineering has a joint research project with MHPCC, which provides computer accounts, CPU time, and technical support to faculty members and research assistants working on the project.

In general, computer and laboratory equipment are adequate for most students to complete their Master's studies. A few students rely on equipment in other departments, especially Civil Engineering or at other universities through research exchange programs. Several students, for example, have in the past gone to the University of Oregon to use wave tank facilities.

The department employs one or two departmental Teaching Assistants who look after the department's computers and network connections. The network is also supported by the SOEST Research Computing Facility (RCF) and its several technicians who are paid solely to maintain all SOEST computer connections. These SOEST technicians are on call during business hours and are very efficient at solving most computer problems.

C. Guidance

Students are taught general lab principles in the Ocean Engineering Lab - ORE 601. Naturally, basic lab and engineering skills have been mastered during the student's undergraduate years. Each specialty research lab such as Kilo Nalu, the fluid dynamics lab, ACO or HURL maintains its own staff of technicians who train students in the use of materials pertinent to those labs. Training is part of the staff's function and because the numbers are small (28 graduates over a five year period) the training and supervision aspect of technician's work is something they take seriously and look forward to. Essentially these labs run apprentice programs in the use of their

facilities.

The lab staffs particularly focus on safety instruction for the students, as this is the highest of University priorities. Students are taught the safety features of each piece of gear and its safe utilization. The labs are continuously inspected by the University's Office of Environmental Health and Safety who review safety programs, documentation and inspection.

D. Maintenance and Upgrading of Facilities

Maintenance and upgrade of facilities associated with ORE is dependent on grants received by the Principle Investigators. Most investigators are eager to maintain state of the art facilities. Only very basic computer access is supported by departmental funds and upgrades in software and hardware are done at the teaching assistants at the start of the year.

As ORE is a graduate department with a small number of students doing highly specialized research in focused labs, the acquisition of laboratory equipment is not a departmental process but is focused on the individual lab. Each of these labs has its own plan and acquires equipment in relation to the number of grants coming in and the progress of these grants. Most labs have technicians and lab engineers on the grants carrying out maintenance and upgrades. This is certainly true of Kilo Nalu, the Fluid Dynamics Lab, the Aloha Cabled Observatory and HURL. This has proved adequate for the needs of most research. The Department also has on staff Jim Jolly, a half time technician, to help with a number of specialized programs in particular ACO and the gliders.

SOEST also has an engineering support facility of half a dozen, machinists, electrical and mechanical engineers who can be engaged at cost to provide support services of all types on short notice or for a longer term.

E. Library Services

<u>Collections and Access</u>

The University of Hawaii at Mānoa Library has acquisition plans and collection policies to ensure that the engineering collections that serve the Civil, Computer, Electrical, and Mechanical Engineering programs in the College of Engineering, the Biological Engineering program in CTAHR and the Ocean and Resources Engineering program in SOEST are continuously updated and maintained. When possible the library selects online formats over print to provide immediate access to faculty and students.

The library subscribes to major article databases in engineering, such as the *ASTM Standards and Engineering Digital Library*, *ASCE Civil Engineering Database*, *Compendex*, *IEEE Xplore*, and to general research article databases such as *Web of Science* and *ScienceDirect*. In addition, the UHM Library provides a robust interlibrary loan program for print and online resources that is free to faculty, staff, and students.

The library provides course reserves in print and as e-reserves through the online catalog Hawaii Voyager. ScholarSpace, a repository for digital dissertations and theses and faculty research,

provides open access to research by UH Manoa scholars, see [http://scholarspace.manoa.hawaii.edu/].

Librarians who are assigned as liaisons to the engineering departments provide course-related instruction when requested by faculty and instructors. This is a particularly useful service that new ORE faculty have been encouraged to use.

The Science and Technology Reference Department is the department that serves the engineering departments and is located in Hamilton Library, see [http://www.hawaii.edu/sciref]. (Sara Rutter, Science Librarian: srutter@hawaii.edu)

Library Facilities

The UH Manoa Library (Hamilton Library and Sinclair Library) houses two computer labs maintained by UH ITS. The library provides 13 group study rooms, and 2 presentation rooms that students may reserve.

Library Data

The UH Mānoa Library has a staff of 46 FTE library faculty, 89 FTE support and professional staff and 46 FTE student assistants. The collections total 3.1 million volumes, and include 132,000 electronic books, 237 active databases, and 49,391 e-journal subscriptions.

F. Overall Comments on Facilities

In general the ORE does not maintain Departmental Laboratories so this is not a wide issue. Each research laboratory meets university standards and is routinely inspected for safety compliance by University inspectors from the Office of Environmental Health and Safety. ORE takes guidance from the College of Engineering Safety Committee. ORE acts to disseminate safety information it receives to each of tis faculty members so they may bring their labs up to the highest standards.

CRITERION 8. SUPPORT

A. Leadership

The program is lead by the Departmental Chairman. Since 2010, this has been Dr. Bruce Howe. In ORE, Dr. Howe is responsible for supervising the faculty, including assigning faculty teaching and committee responsibilities, as well as overseeing that University polices and regulations are complied with in an efficient manner. Dr. Howe is assisted by associate chair, Dr. Wiltshire, and graduate chair Dr. Fai Cheung. Dr. Wiltshire is a professionally trained manager currently also serving as Director of the Hawaii Undersea Research Laboratory. After his PhD, Dr. Wiltshire was trained in public administration and served as the State of Hawaii's Ocean Resources Manager. Dr. Kwok Fai Cheung, P.E was Departmental Chairman from 2001-2007. Dr. Cheung turned the department around in the early 2000's and is responsible for most of the innovative change that has allowed the department to meet ABET-EAC requirements and move forward.

The Department Chair is nominated by the departmental faculty and then selected by vote. The final selection is approved by the Dean of the School of Ocean and Earth Science and Technology and the appointment made for 3 years. The Chair is closely assisted by the Associate Chair and the Graduate Chair who are appointed. These appointments, made by the Dean are also for 3 years. This group of three handles day to day administration of the department. Major policy decisions are handled at monthly faculty meetings and decided by vote. As the department is small, this system has successfully insured both quality and continuity. The department also has a series of standing subcommittees (admissions for instance) which report back periodically to the faculty as a whole. With only 8 faculty this helps to divide the work load. The small number of students ensures that any problem can be handled quickly and efficiently and that there are adequate, well trained people in charge to ensure the program quality is maintained.

B. Program Budget Process and Financial Support

The University of Hawaii provides State of Hawaii General Funds (GF) from the State legislature along with Tuition Special Funds (TSF) to support the salaries and operation of the School of Ocean and Earth Science and Technology (SOEST). General Funds are used to pay for most of the tenure track faculty and permanent staff salaries while the tuition monies are used to pay the balance of tenure track faculty and permanent staff salaries, temporary staff and operational expenses such as phone rentals, supplies, maintenance of equipment, and so forth. Funding for the School by the University has been historically based until now, and so the base has not changed substantially for many years except for budget reductions at the University level and union approved faculty and staff salary adjustments.

These sources of funding, along with contributions made to the UH Foundation for ORE, have been adequate to support the School's financial needs including expenses for new faculty, with the University assisting with faculty start-up needs. In 2008 - 2009 substantial budget reductions took place as recorded in the last ABET-EAC review, but the School was able to accommodate the budget reductions. Starting in FY13 new rounds of budget reductions have taken place and the long-term outlook is more problematic.

The vast majority of the funds in the non-research budget is in faculty and office staff salaries. Faculty salaries are negotiated at the time of hire by the Dean's office. Although the Department recommends to the Dean's office to hire a candidate or not, the Department is not part of the salary negotiation process. Further adjustments to salary are largely by contract negotiations between the faculty union and university. In times of more abundant financial resources, small merit increases were possible. Faculty involvement was sought for such increases. Departmental office staff are also hired on a salary scale fixed by the school's business manager. Once negotiated and fixed, salaries are simply added into the department's budget allocation. Supplies are bought on an as needed basis. A small budget is established for this on the basis of past expenditures.

Institutional Support

The institutional funding for the Ocean and Resources Engineering program has three categories: state general fund, tuition special fund, and research and training revolving fund. The state general fund contribution is calculated based on the number and rank of full-time equivalent positions in the Department. The state general fund and tuition special fund, in principle, cover the salaries of the faculty, staff, and teaching assistants as well as the operations of the Department. The research and training revolving fund derives from the indirect cost generated by extramural research projects in the Department. The revolving fund varies year to year depending on the amount generated by the faculty and the amounts retained by the University and SOEST administrations. Currently most projects have a 41% overhead, half of which is returned to the Dean's Office. Half of the Dean's share is typically returned to the department, which in fiscally abundant times, returned all of this share to the principal investigator and in the present fiscally challenging times returns half. This portion of the revolving fund overhead return is very important to the principal investigators as it supports research-related activities not covered by grants or contracts.

Tables in Appendix D summarize the support expenditures of the Department. The tuition special fund, supplemented by state general fund and research and training revolving fund, is the main source of this budget. Unlike other academic units with high undergraduate teaching load and high tuition revenue, the Department does not have a regular budget for faculty travel as most faculty travel is supported on individual grants. The department's operational expenditures decreased dramatically in the late 1990s due to the closing of the off campus Look Laboratory of Ocean Engineering. Subsequently, the Department has a new on-campus laboratory, which is covered by the regular university maintenance budget at no cost to the Department. Most new equipment is purchased on grants. When a grant is not available, the allotment for equipment purchase will vary depending on the amount of funds left at the end of each fiscal year. In general meets the needs of the Department are met through one of these two modes of purchase. The Department has been supporting one-to-two graduate teaching assistants. The department budget covers a portion of the cost of part-time office assistants and the reminder is supported by research projects.

Research Funding

A significant source of funding for graduate education and research training is extramural. The funded research projects awarded to the departmental faculty members as principal investigators during the last five academic years or since they joined the department are listed below (Table 8-1).

Table 8-1. Recent Funding

Agency	Proposal Title	Award Amount
HI State Civil Defense (DOD pass through)	Tsunami Inundation Map for Hawaii 2010 - 2014	$792,981
Defense Dept. – Army	Modeling of Hurricane Surge and Waves for Hawaii 2010 - 2011	224,883

Defense Dept. – Navy	Response of Marine Vehicles Advancing in a Seaway and in the Surf Zone 2010 - 2011	149,916
Woods Hole Oceanographic Institute	Shoreline Evolution and Coastal Resiliency at Two Military Installations: Modeling of Hurricane Surge, Waves, and Overwash 2010-2013	227,446
Defense – Navy ONR	Coupling of Coastal Wave Transformation and Computational Fluid Dynamics Models for Seakeeping Analysis 2012 - 2014	114,302
National Science Foundation	Collaborative Research: RAPID: Post-Disaster Structural Data Collection Following the Tohoku Tsunami	28,835
Homeland Security, Dept. American Samoa	Tsunami Inundation Mapping for American Samoa 2013	150,000
Healy Tibbits Builders, Inc.	Ocean Engineering Internship 2010-2011	86,610
Oceanit Laboratories, Inc.	Ocean Engineering Internship 2010-2011	86,610
Makai Ocean Engineering, Inc.	Ocean Engineering Internship 2010-2011	60,451
Sea Engineering, Inc.	Ocean Engineering Internship 2010-2011 and 2015	79,429
Navatek, Inc.	Ocean Engineering Internship 2011 – 2012, 2015	92,443
Energy, Dept –Colorado (LOC)	Marine Energy Center in Hawaii - Cheung (2010 – 2015)	414,282
Commerce, Dept-NOAA	PACIOOS Wave Modeling –Cheung 2012 - 2015	240,400
Cheung, Fai	**TOTAL**	**$2,748,588**

Agency	Proposal Title	Award Amount
Trex Enterprises Corp	Modeling and Simulation of WEC Device	$218,236
Hawaii – Transportation Dept.	Coastal Bridge and Port Vulnerability to Tsunami and Storm Surge	505,000
University of Hawaii Foundation	Offshore Mechanics and Arctic Engineering Resch	38,892
ERTEKIN, R. Cengiz	**Total**	**$825,128**

Agency	Proposal Title	Award Amount
University of Washington	HOT Profiler: Supporting Activities at the University of Hawaii	$37,345
University of Washington	Coastal Margin Observation and Prediction: Supporting Activities at the University of Hawaii	31,500
National Science Foundation	ALOHA Cabled Observatory: Installation and Operation 2010 - 2012	905,310
National Science Foundation	ALOHA Cabled Observatory: Operation and Maintenance 2012, 2013, 2014	1,223,115
National Oceanic & Atmosc. Admin., Dept. of Commerce	Advancing Remote Marine Mammal Stock Assessment with Passive Acoustic Gliders 2010 - 2012	160,000
Office of Naval Research	Acoustic Seaglider: Philippine Sea Experiment 2010 -2013	682,782
Axis Engineering Technologies Inc.	Autonomous Gateway Wave Glider supporting Acoustic Tracking and Communication for a Portable Underwater Tracking Range	247,053
Ocean Acoustical Services & Instrumentation Systems	Simultaneously Improving Position Estimates and Ocean State Forecasts	155,103
Office of Naval Research	Acoustic Seaglider: PhilSea10 Data Analysis 2013 - 2014	341,076
NASA	From Space to the Deep Seafloor: Using "Green" Submarine Cable Systems in the Ocean Observing System - 2015	80,000
Howe, Bruce	**TOTAL**	$3,863,284

Agency	Proposal Title	Award Amount
Texas A & M University 2012-2015	Subtasks for TAMU Proposal Submitted to The Gulf pf Mexico research Institute	$338,220
Lockheed Martin Corp	Study of OTEC Environmental Interactions	149,392

Dept. of Energy	Marine Energy Center in Hawaii -	679,382
Nihous, Gerard	**Total**	**1,166,994**

Agency	Proposal Title	Award Amount
Office of Naval Research	Passive Acoustic tracking of Minke Whales	$10,709
Office of Naval Research	Acoustic Seaglider: Philippine Sea Experiment	682,782
Office of Naval Research	Accoustic Seaglider: PhilSea Analysis	341,076
National Science Foundation	CIF: Small: signal Processing Methods for Passive Acoustic Monitoring of Marine Mammels	397,054
Office of Naval Research	Improvements to Passive Acoustic Tracking Methods for Marine Mammal Monitoring	147,391
Homeland Security	CIMES Acoustic Passive System	634,600
Dept of Energy - Colorado	Marine Energy Center in Hawaii	383,858
NOSAL, Eva-Marie	**Total**	**2,597,470**

Agency	Proposal Title	Award Amount
Office of Naval Research	Hydrodynamics and Roughness of Irregular Boundaries	$444,910
PAWLAK, Eugene	Total	$444,910

Agency	Proposal Title	Award Amount
National Oceanic & Atmosc. Admin., Dept. of Commerce	HURL Annual Funding - 2010	$2,946,455
National Oceanic & Atmosc. Admin., Dept. of Commerce	HURL Annual Funding – 2011	3,495,349
National Oceanic & Atmosc. Admin., Dept. of Commerce	HURL Annual Funding - 2012	2,052,290

National Oceanic & Atmosc. Admin., Dept. of Commerce	HURL Annual Funding - 2013	1,453,000
National Oceanic & Atmosc. Admin., Dept. of Commerce	Coral Reef Research Grant Program for Hawaii and the Western Pacific	215,013
Western Pacific Regional Fishery Mgmt Council	Ecological Impacts of *Carijoa Riisei* on Black Coral Habitat in the 'Au'au Channel	86,796
Western Pacific Regional Fishery Mgmt Council	Ecological Impacts of Carijoa Riisei on Black Coral Habitat and Eradication Efforts in waters off Kauai	29,063
National Oceanic & Atmosc. Admin., Dept. of Commerce	Submersible Support for Meso-Photic Coral Reef Survey in the Main Hawaiian Islands	210,000
Honolulu Seawater Air Conditioning LLC	Survey of the Proposed Honolulu Seawater Air Conditioning Pipe Route	39,568
National Geographic Television	Marine Investigation of Lo'ihi Seamount and Deep Sea Precious Corals	334,989
Sea Engineering, Inc.	Submersible Support for Marine Inspection of the Sand Island Outfall	35,338
Business, Econ Dev & Tour- Nat Energy Lab (NELH)	Deep Seawater Pipeline Inspection and Survey 2012	152,795
National Oceanic & Atmosc. Admin., Dept. of Commerce	Central Pacific Deep-sea Exploration & Research Projects: A Compendium of Multi-disciplinary Expeditions to be Accomplished by the University of HI (2014)	800,000
Planning Solutions, Inc.	Catalog and Analyze Seafloor Manganese Nodule Data (2014)	18,771
WILTSHIRE, JOHN C.	**TOTAL**	**$11,869,427**

Table 8-1 shows that in the last five years, the department has brought in over $11 million of research funding (not counting the Hawaii Undersea Research Lab which if counted gives a total of $23 million) . One of the most significant aspects of this research funding is the research assistantships it provides for ORE students. The research projects also acquired laboratory equipment and computers that have been used, in turn, by graduate students working on their theses and research projects. The funding also provided support for the faculty to attend conferences and meetings. Although state general funds are limited, the research funding base obtained by the ORE faculty represents a key financial resource that vastly enriches the graduate program.

Being a graduate education program that emphasizes research, the funding structure for Ocean and Resources Engineering is different from many other undergraduate engineering programs at the University of Hawaii. ORE is heavily focused on the large number of grants brought in by faculty who have been particularly successful in their grant applications over the last several years. While more funding is always desired and can be profitably spent, the current funding is adequate to meet the basic teaching needs of the department. Research funding is sufficient and serves the needs of the various research projects. One of the areas where funding is not currently adequate is in the providing of student assistantships. The reduction is student assistantships because of the reduction in grants and general fiscal problems has caused the number of graduate to decrease.

Support of Facilities and Equipment

The School of Ocean and Earth Science and Technology maintains four groups dedicated to facilities support. These include: The Research Computing Facility, the Ocean Technology Group, the Engineering Support Facility, and the Physical Plant Support Facility of SOEST. Each of these groups deals with a certain aspect of facilities support.

The Research Computing Facility (RCF) supports the schools 1,100 computers and network connections. RCF staff are responsible for repair, upgrade and reestablishing computer connections, upgrading systems, and are generally available within an hour's notice to assist with all network hardware problems.

The Ocean Technology Group (OTG) maintains all of the school's seagoing equipment and will operate it, if requested, as well as handle maintenance and repair of systems assigned to them. OTG are available for consultation.

The Engineering Support Facility (ESF) will design and machine unique components for many applications. They maintain a skilled staff of mechanical and electrical engineers. ESF also maintains contacts worldwide to undertake any projects beyond their skill. This group is currently being reorganized and may be reduced in the current economic downturn.

On the other end of the scale is the Physical Plant Support Facility (PPSF). They handle room maintenance issues from burned out lights to broken doors and leaking plumbing. They repaint and upgrade rooms and lab areas. They will also provide or build office and lab furniture.

Quality staff are available to provide the services sought. All of the above services are provided free or at-cost, depending on the nature of the request. If there is a cost, it comes out of the department or laboratory budget of the requesting unit. Services provided at no cost are essentially paid for by the Dean's office from general school funds to support facilities and equipment.

C. Staffing

The support personnel and institutional services are adequate to meet all of the ORE Department's needs. The teaching staff is excellent and covers all of the key departmental areas as noted in the section on faculty. The department has a secretary and administrative helper who are adequate although more office help could be used if funds were available. Technical staff are

invariably project staff hired on a project to project basis. Most of these people are highly qualified and do an excellent job. Their hiring, training and continuation is up to the Principal Investigator of the project. Nonetheless, issues of cost do arise. Outside of project grants, ORE is essentially assigned a budget by the school through a range of institutional processes, including collective bargaining, formula allocation of tuition funds and return of overhead funds on research grants. This budget is adequate to maintain all critical functions. There are times when the department would like to upgrade facilities beyond what the assigned funds would provide. There is no easy way for the department to obtain funds to do this, although we have been getting an increasing level of tax free donations from local engineering companies, alumni and others, which can be applied to facilities through the use of the support groups described above. The department currently has $9,000 in its donation account (held at the University of Hawaii Foundation) and hopes to engage in another fund raising drive in the winter of 2016 in hopes of raising another $10,000. Most donations are small, in the range of $50-$500, largely from University of Hawaii alumni.

The office staff is stable under the very able guidance of Ms. Natalie Nagai who has over 20 years of university experience and has efficiently taken on the task of revamping the department's records and filing procedures. She is periodically assisted by student helpers and more senior office personnel. The department has stabilized its personnel changes and is well positioned for positive growth.

D. Faculty Hiring and Retention

Faculty hiring is approved by the Chancellor after recommendation by the Dean. Normally hiring is approved after the retirement or departure of an existing faculty member. In the current tight fiscal situation new positions (beyond retirement replacements) are not being approved. ORE did receive an unprecedented 3 new positions 7 years ago and is noted as a further growth area should better fiscal times return. Once a position is released, a national advertising campaign is undertaken and the top three candidates selected. The top three candidates are recommended by the search committee to the Dean who approves travel to Hawaii and interviews. Each faculty member meets with the candidate and the faculty as a whole then make a hiring recommendation to the Dean. The Dean negotiates the salary and makes the final offer to the candidate. The entire process typically takes six months to a year.

To fill any gaps in faculty expertise members of other departments are sought after as cooperating faculty members. Outside engineering experts are sought as affiliate faculty. All cooperating and affiliate faculty members, prior to their appointments to the Department, must demonstrate their communication skills by giving a presentation in the department seminar series. They must also demonstrate their enthusiasm and willingness to contribute to the Ocean and Resources Engineering program through an interview conducted by the departmental faculty.

Retention of faculty is also important. In general ORE has been good at this. In the last eight years one faculty member (Pawlak) left for an exceptional position on the mainland and was replaced by a highly qualified candidate from Singapore (Huang). To help younger faculty the department offers informal mentoring by senior faculty as well as more organized faculty development seminars from the Instructional Resources Center. The university provides

counseling and training in a host of issues from time management and financial planning to teaching instruction and evaluation. The university has an active sabbatical system and provides travel money for faculty to attend conferences. Most faculty find the support network to be quite good.

The University also has a number of avenues open to honor and retain distinguished faculty members. These include establishing distinguished professorships, offering merit salary increases, and meeting salary offers provided by other institutions. In general the University is fairly good at retaining its top faculty through these measures.

E. Support of Faculty Professional Development

The school provides funding for faculty members to take a fully paid six-month sabbatical every seven years. This is paid out of school funds. Faculty members submit a plan for the sabbatical which is approved by the Department Chair and Dean, assuming it describes adequately how the faculty member and department will benefit from this development period. Normally faculty members take advantage of the offer and conduct their sabbatical at another institution every seven years.

Since the emphasis of the Department is graduate education and research, the faculty members have lighter teaching loads compared to their peers and spend more time working on extramurally funded research projects, which in turn provide support for faculty travel. In addition, the University Research Council provides travel grants to faculty. Most ORE faculty regularly attend one to three professional conferences or workshops each year. Generally, attendance costs for these conferences is written into their grants. However, in the absence of a relevant grant, University Research Council funding is relatively easy to apply for to attend relevant conferences once per year, particularly if a paper is being presented.

The University has a superb training and teaching center to help faculty develop their teaching skills. They also lend a great deal of assistance in the way of teaching technologies and methodologies. The center staff will work one on one with an individual faculty member to improve teaching delivery style. Campus support staff also provide seminars and counseling on everything from time management to dealing with harassment. These offerings are continuous, effective and well utilized by the campus community

PROGRAM CRITERIA - Ocean Engineering

While the University of Hawaii has the only Ocean and Resources Engineering Department in the U.S., there are 8 other programs that fall under the general ocean engineering description. There are two specific program criteria for programs carrying the designator of Ocean Engineering and related programs. These are:

1. Curriculum

   The program must demonstrate that graduates have: 1) Knowledge and the skills to apply the principles of fluid and solid mechanics, dynamics, hydrostatics, probability and

applied statistics, oceanography, water waves, and underwater acoustics to engineering problems; and 2) the ability to work in groups to perform engineering design at the system level, integrating multiple technical areas and addressing design optimization.

2. Faculty
   Program faculty must have responsibility and sufficient authority to define, revise, implement, and achieve the program objectives.

Curriculum

For the curriculum, many of these requirements are met by pre-program undergraduate requirements. Specifically, fluid and solid mechanics, dynamics and probability and statistics are covered in ABET-EAC approved undergraduate programs or, if missing, are part of the make-up courses assigned to a student at the beginning of the Master's program. The Department Chair and Department ABET committee verifies completion of these requirements. Hydrostatics is covered in core course ORE 411 (Buoyancy and Stability), oceanography in core course ORE 603 (Oceanography for Ocean Engineers), waves in core course ORE 607 (Water Wave Mechanics), acoustics in core course ORE 601 (Ocean Engineering Lab) and ORE 603, as well as elective course ORE 654 (Acoustics). Work in groups, design and design optimization are covered in ORE 783, the Capstone Design class. A design element is further incorporated into student theses. All of these requirements are documented as completed by each student on the student progress form (copy in the appendix). The curriculum is fully described in Criterion 5 and the appendix.

Faculty

At the University of Hawaii the faculty have a great deal of independence in setting objectives and tailoring the program to suit the changing needs of students and the greater engineering community. This right is preserved by contract in the collective bargaining agreement between the University of Hawaii and the Faculty Union. This contract is available on line at http://www.uhpa.org/uhpa-bor-contract. The program and its objectives are reviewed every few years by the faculty in conjunction with both the Department's local and national/international advisory committees. The faculty has full authority to revise the objectives. If the objectives involve redesigning courses, the School of Ocean and Earth Science curriculum committee must approve the change in the courses. This is a standing faculty committee that meets every few months to review all courses and proposed course changes in the school. If the changes involve course selection for completing the graduate program, then the university's graduate division approval must be sought. In general, the Graduate Division always approves program changes requested by the department, after a due process of deliberation has been followed. The rubrics used to measure achievement of program objectives and outcomes are solely selected at the discretion of the department.

CRITERIA FOR MASTERS LEVEL PROGRAMS

Master's level programs must develop, publish, and periodically review, educational objectives and student outcomes. The criteria for masters level programs are fulfillment of the baccalaureate level general criteria, fulfillment of program criteria appropriate to the masters level specialization area, and one academic year of study beyond the baccalaureate level. The program must demonstrate that graduates have an ability to apply masters level knowledge in a specialized area of engineering related to the program area.

A. Satisfaction of Criteria

Great effort is placed on insuring that all undergraduate ABET–EAC requirements are fulfilled, even though these courses are not taught by the ORE Department. The undergraduate's transcripts are closely scrutinized by the Chairman and one other senior Professor (Dr. Kwok Fai Cheung) for adherence to ABET criteria. Clearly, this is easier if the student has graduated from an ABET-EAC approved engineering program. Transcript review is done as soon as the student is admitted. The student is informed even before acceptance that there are pre program requirements that need to be fulfilled before the formal Master's program can start. The exact requirements of the pre-program are published on the Department's website. Any pre-program deficiencies are noted on the student progress form. These must be resolved before the student can proceed to the formal Master's program.

The Master's program requirements are clearly spelled out in Criterion 5. These are noted on the student progress form and checked by the chairman as well as the department's administrative assistant. Before a student can graduate, the University's Graduate Division verifies all of the Master's requirements. The chairman must sign a form that all degree requirements have been completed. The student progress form is also completed as a second check.

B. Advanced Level Knowledge in a Specialized Area

The department offers specialized knowledge in Ocean and Resources Engineering. This specialty is further broken down into offshore, coastal and resources tracks. The students demonstrate that they have this advanced knowledge by passing the core courses and Master's qualifying exam. The students demonstrate that they have the ability to apply this knowledge by formally applying it to their Master's level capstone design project and thesis.

Typically, the capstone design class will involve a real world project, for example, a pier design for the major harbor on Maui to accommodate Hawaii's new Superferry or the design of a seawater air-conditioning system for downtown Honolulu. These design projects are overseen by practicing engineers who serve on our adjunct faculty. The students are held to a standard expected from a professional engineer. Without passing the capstone design project they cannot graduate.

The second demonstration of the ability to apply advanced knowledge is the thesis. Each student writes a thesis (plan A) or major project (plan B) involving original and significant work. This is

the second clear demonstration of the ability to put together many of the aspects of what was learned in the courses.

The specialized areas of engineering mastered by our students include: Buoyancy and stability, hydrodynamics, acoustics, water wave mechanics, coastal engineering, offshore energy systems engineering, deep sea resources engineering, and the efficient use of standard ocean engineering measuring tools. The students have a professional level of attainment in these fields such that they could undertake a typical project coming to an ocean engineering company relying on knowledge of the specialty field. The confidence of our many ocean engineering company supporters is a testament to this attainment by our students.

APPENDIX A

COURSE SYLLABI

1. Course Number and Name
   ORE 202, Ocean Technology - Man in the Sea

2. Credits and Contact Hours
   Two 1.25-hour sessions per week. Course is 3 credits. It can fulfill the undergraduate diversification requirements for a physical science course and is an effort to offer more undergraduate introductory ocean engineering courses

3. Course Coordinator's Name
   John C. Wiltshire; course is co-taught by Drs. Wiltshire and Howe

4. Textbooks and/or Other Reading Material
   Textbook: Garrison, T., *Oceanography-An invitation to Marine Science,* Brooks/Cole, 2002.
   Reference:
   a. *National Geographic Atlas of the World,* latest edition
   b. Supplemental materials and readings are posted on the class website

5. Specific course information
   a. The course is a survey of human activities in the ocean from the most traditional to the most innovative technical and engineering accomplishments. The course builds on a basic mastery of oceanographic principles and then goes on to apply these principles to ship and floating structure design, submersibles and seafloor instrumentation, acoustics, coastal engineering problems, offshore energy and mineral deposits. The course ends with speculation on where this growing body of marine technology may lead human civilization.
   b. prerequisites and co-requisites: None- This is an introductory course
   c. course is an elective, not specifically part of the ORE Master's program

6. Specific goals for the course
   a. To understand the geological, biological, physical and chemical oceanographic principles underlying marine technology. To gain an understanding of the major components of ocean engineering including coastal, offshore resources and acoustical engineering and instrumentation. To master the ability to articulate the engineering, environmental, economic and energy issues involved in ocean technology development and hence man's role and future in the sea.
   b. The specific student outcomes addressed by this course include:
      1. Student Outcome 1: Broad Education
      11. Student Outcome 2: Basic science, mathematics, & engineering
      111. Student Outcome 6: Problem formulation & solution
      1v. Student Outcome 9: Professional issues
      v. Student Outcome 11: Research & contemporary issues

7. <u>Topics Covered</u>

a. Geological oceanography.
b. Physical oceanography.
c. Chemical oceanography.
d. Biological oceanography.
e. Offshore engineering and naval architecture.
f. Acoustics.
g. Coastal engineering.
h. Marine mineral deposits and mining.
1. Offshore energy.
J. Future developments in marine technology.

1. Course Number and Name
   ORE 330, Mineral & Energy Resources ofthe Sea

2. Credits and contact hours
   Two 1.25-hour sessions per week. Course is 3 credits.
   It can fulfill the undergraduate diversification requirements for a physical science course.

3. Course Coordinator's Name
   John C. Wiltshire; course is co-taught by Drs. Wiltshire and McMurtry

4. Textbooks and/or Other Reading Material
   a. *Cronan, D.S. (1999). Handbook of Marine Mineral Deposits. CRC Press*
   b. *Cronan, D.S. (1980). Underwater Minerals. London: Academic Press*

5. Specific Course Information
   a. Hard material and petroleum origins, exploration and exploitation. Renewable and non-renewable resource distribution. Political and scientific constraints. This course looks at the large range of energy and mineral resources in the sea and the engineering challenges to fully developing them for critical future human needs.
   b. Prerequisites: ORE 202 or OCN 201, or consent. (Cross-listed as OCN 330)
   c. Designation: Course is an elective not specifically part of the ORE Master's program.

6. Specific Goals for the Course
   a. Upon successful completion of ORE 330, the student should be able to:
      1. Understand the various types of marine minerals, their mode of formation and their importance geologically and economically.
      n. Understand the various options for deriving energy from the ocean and the potential advantages and disadvantages of each.
      111. Understand the legal, envirorunental, economic and technical difficulties in extracting minerals and energy from the ocean.
   b. The specific student outcomes addressed by this course include:
      1. Student Outcome 1: Broad Education
      n. Student Outcome 2: Basic science, mathematics, & engineering
      111. Student Outcome 6: Problem formulation & solution
      IV. Student Outcome 9: Professional issues
      v. Student Outcome 10: Communication skills
      v1. Student Outcome 11: Research & contemporary issues
      vii. Student Outcome 12: Life-long learning

7. Topics Covered
   a. The coming problem of peak resource utilization, Parts I (Population & Fossil Fuels) & II (Minerals)
   b. Mid-ocean ridges, basins and trenches, their basic features
   c. Overview of submarine hydrothermal systems

d. Origins of high and low-temperature hydrothermal deposits
e. Recycling of ocean crust and the 'Geostill Concept'
f. Chemistry of hydrothermal vents and polymetallic sulfides
g. Introduction to Ocean Energy
h. Oil and gas deposits; Future oil provinces
1. Oil and Gas: Resources & politics of oil & gas, oil spills & oil spill recovery
J. Methane hydrates as future natural gas resources
k. OTEC (Ocean thermal energy conversion)
1. Wind power
m. Wave power
n. Current and tidal power
o. Energy futures, hydrogen, fuel cells
p. Placer deposits
q. Fresh water and desalination
r. Geology of ferromanganese crusts and nodules
s. Chemistry of crusts and chemical variability with age
t. Platinum and phosphorite-rich layers: Seawater vs. extraterrestrial sources
u. Phosphorite deposits, their formation and mining potential
v. Mining technology for manganese nodules, crusts and sulfides
w. Marine minerals development - Legal and environmental issues
x. Marine minerals as possible economic deposits, world metal markets

I. Course Number and Name
ORE 411 Buoyancy and Stability

2. Credits and Contact hours
Two 1.25-hour sessions per week.

3. Instructor
R. Cengiz Ertekin

4. Textbooks
Textbook: Lecture Notes by R.C. Ertekin
Reference books
1. Rawson, K.J. and Tupper, E.C., "Basic Ship Theory", Vol. I, Longman Scientific and
2. Technical, 1983.
3. Papanikolaou, A. "Buoyancy and Stability", J.K.K. Look Lab., Rep. No. 52, 1981.
4. Benford, H. "Naval Architecture for Non-Naval Architects, 1991.
5. D'Arcangelo, A.M., "Ship Design and Construction," SNAME, 1969.
6. Semyonov-Tyan-Shansky, V. "Statics and Dynamics of the Ship," Peace Publishers,
7. Moscow.
8. Lester, A.R., "Merchant Ship Stability," Butterworths, 1985.
9. "Principles ofNaval Architecture," Soc. ofNaval Arc. and Marine Engr., Vol. 1, 1988

5. Course Information
a. Course Content: Buoyancy and Stability (3) Ship nomenclature and geometry, hydrostatic principles of surface ships and underwater vehicles in free-floating, partially water-borne and damaged conditions. Subdivision of ships. Launching.
b. Prerequisites
i.Calculus
ii.Applied Mechanics
c. Designation: Required Core course

6. Course Goals
a. Program Outcomes
1. Understand the mathematical principles of buoyancy and stability of floating and submerged bodies,
n. Understand the design principles of intact or damaged ships, offshore platforms, or submersibles to overcome external forces that can overturn them, and
iii. Understand the safety of vessels during dry docking and grounding, and their longitudinal strength in calm waters.

7. Topics Covered
- Introduction
- Irregular Shapes and Numerical Methods
- Buoyancy and Stability
- List and Ballast Free-Surface and Density Effects
- Stability at Large Angles of Inclination

- Longitudinal Stability, trim and Hydrostatic Curves
- Dry Docking and Grounding
- Stability in Damages Condition (or Bilging)

1. Course Number and Name
   ORE 601 -Ocean and Resources Engineering Laboratory

2. Credit and Hours
   3 credits, two 3-hour sessions per week

3. Instructor
   Zhenhua Huang

4. Textbooks
   Textbook: None
   Reference book: Coastal Engineering Manual, Army Corps of Engineers, 2002

5. Course Information
   a. Course content: Design, construction and evaluation of an engineering system. Laboratory and field experience and data analysis supplemented with appropriate theory.
   b. Prerequisite: ORE 603- Oceanography for Ocean Engineers; ORE 607- Water Waves Mechanics
   c.· Designation as required or elective course: Ocean Resources Engineering required course

6. Course Goals
   This course aims to provide ocean and resources engineering students with the fundamentals necessary for carrying out field and laboratory observations along with analysis of observational and experimental data in support of engineering endeavors.
   b. Program Outcomes:
      1. Program Outcome 2: Basic science, mathematics, & engineering
      11. Program Outcome 3: Ocean engineering core
      111. Program Outcome 5: Use of latest tools in ocean engineering
      tv. Program Outcome 6: Problem formulation & solution
      v. Program Outcome 8: Independent & teamwork
      vi. Program Outcome 9: Professional issues
      v11. Program Outcome 10: Communication skills

7. Topics covered
   a. Ocean Engineering Instrumentation
   b. Experimental Design
   c. Data Collection/Sampling
   d. Spectral Analysis

1. Course Number and Name
   ORE 603- Oceanography for Ocean Engineers

2. Credit and Hours
   3 credits, two 1.25-hour sessions per week.

3. Instructor
   Eva-Marie Nosal

4. Textbooks
   Textbooks:
   a. R.H. Stewart (2007), An introduction to physical oceanography.
   Reference books:
   b. T. Garrison (2002), Oceanography: An Invitation to Marine Science, Brooks/Cole.
   c. G.L. Pickard and W.J. Emery (1990), Descriptive Physical Oceanography: An Introduction, Butterworth- Heinemann.
   d. S. Pond and G.L. Pickard (1993), Introductory Dynamical Oceanography, Butterworth-Heinemann.
   e. R.J. Urich (1983), Principles of underwater sound, 3rd ed., Peninsula Publishing.

5. Course Information
   a. Physical, chemical, biological and geological ocean environments for ocean engineers. Introduction to ocean dynamical processes and general circulation. Ocean measurement techniques, theory of underwater acoustics. Sonar, swath bathymetry, and tomography applications. Pre: consent.
   b. Prerequisites: Differential equations Fluid mechanics
   c. Designation: Core Course

6. Course Goals
   a. To provide the ocean engineering student with an understanding of the ocean environment. The course will provide an overview of the physical, chemical, biological and geological processes that determine the state of the ocean and its dynamics. Topics of discussion will include description of the world's oceans and dynamic processes, introduction to analytical description, circulation and ocean measurement techniques. Theory of underwater acoustics will be examined along with sonar, swath bathymetry and tomography applications.
      1. Program Outcome 2: Basic science, mathematics, & engineering
      11. Program Outcome 3: Ocean engineering core Program Outcome 6: Problem formulation & solution Program Outcome 10: Communication skills
      111. Program Outcome 11: Research & contemporary issues
   b. Upon successful completion of ORE 603, students will be able to:
      1. Identify, describe, and relate the physical processes and dynamics processes associated with surface and deep ocean circulation
      11. Describe and relate sea-water chemistry, salinity, temperature, pressure, and density
      iii. Summarize the basic principles and implications of plate tectonics and marine sedimentation

IV. Demonstrate a basic understanding of biological processes and production in the ocean
v. Explain the key elements associated with air-sea interaction
v1. Balance oceanic water, heat, and salt budgets
vn. Demonstrate a basic understanding of sound propagation in the ocean
vn1. Formulate and communicate (in writing and orally) a critical review of a research paper

7. Topics Covered
   a. Ocean Basins and Margins
   b. Properties of Water / Sea Water Chemistry
   c. Water, Salt and Heat Balance
   d. Physical Laws and Equations of Motion
   e. Effects of Rotation
   f. Atmospheric Circulation
   g. Ocean Circulation
   h. Coastal Oceanography
   1. Biological Oceanography
   J. Instruments and Methods
   k. Underwater Acoustics

I. Course number and name
ORE 607 Water Wave Mechanics

2. Credits and contact hours
Two 1.25-hour sessions per week.

3. Instructor's or course coordinator's name
Kwok Fai Cheung

4. Textbooks
Textbooks: None
Reference books:
   a. Coastal Engineering Manual- Part II, US Army Corps of Engineers, 2006 (PDF version on http://chl.erdc.usace.army.mil).
   b. *Water Wave Mechanics for Engineers and Scientists*, by R.G. Dean and R.A. Dalrymple, World Scientific Publishing Company, 1991.
   c. Ocean Surface Waves: Their Physics and Prediction, by S.R. Massel, World Scientific Publishing Company, 1996.

5. Specific course information
   a. Course context: Governing equations in free surface flow, deterministic and probabilistic wave theories, wave transformation, wave-induced coastal currents, tides, ocean engineering operational sea state, and design wave criteria. Pre. Consent.
   b. Prerequisite:
      i. Differential equations
      ii. Fluid mechanics
   c. Designation:

6. Specific goals for the course
   a. Learning Outcomes:
      The course familiarizes students with water wave mechanics for ocean structure design and the use of measured and synthesized data to define operating and design wave conditions. Specific learning outcomes include:
      1. Ability to apply knowledge.of mathematics and mechanics to formulate and solve water wave problems.
      n. Understanding of kinematics, dynamics, propagation, transformation, and statistical properties of water waves.
      111. Ability to apply water wave theories in engineering design.

7. Brief list of topics to be covered
   a. Wave Theories. Linear, Stokes second-order, first and second-order cnoidal, solitary, and stream-function wave theories.
   b. Wave Transformation. Shoaling, refraction, diffraction, reflection, breaking, and runup on beaches.
   c. Random Seas. Uni-directional and directional wave spectra, Rayleigh distribution, scatter diagram, normal and extremal distributions.

d. Operational and Design Criteria. Winds, wave hindcasting and forecasting, tides, hurricane waves, storm surge, wave setup, design wave conditions and water level.
e. Wave Induced Coastal Currents. Radiation stress, harbor oscillation, cross-shore and long-shore currents.

I. Course number and name
ORE 608 Probability and Statistics for Ocean Engineers

2. Credits and contact hours
3 credits, Two 1.25-hour sessions per week

3. Instructor's or course coordinator's name
Eva-Marie Nosal

4. Textbooks:
Textbooks: None
Reference books:
   a. C Moler, *Numerical Computing with MATLAB*, Society for Industrial Mathematics, 2004
   b. C Moler, *Experiments with MATLAB*, Society for Industrial Mathematics, 2011
   c. S.M. Kay, *Intuitive Probability and Random Processes using MATLAB*, Springer, 2006
   d. Emery & Thomson, *Data Analysis Methods in Physical Oceanography*, 2004

5. Specific course information
   a. Probability and statistical analysis including distributions, multiple regression and correlation, autocovariance, cross-spectra, and practical applications in ocean engineering.
   b. Prerequisite:
      1. Calculus
      u. Probability and statistics
      111. Water wave mechanics
      iv. 607 or consent
   c. Designation: Elective Course

6. Specific goals for the course
The objective of this course is to provide students with the background and skills required to conduct statistical analyses of data in ocean engineering. This will be a hands-on class with theory accompanied by practical implementation in MATLAB. After a review of programming in MATLAB and fundamentals of probability and statistics, topics including data exploration, descriptive statistics, linear and non-linear models, hypothesis testing, multivariate statistics, time series analysis, and spectral analysis will be covered. Emphasis will be placed on application to ocean engineering problems such as water waves, ocean structures, and ocean acoustics.
   a. Program Outcome 2: Basic science, mathematics, & engineering
   b. Program Outcome 5: Use of latest tools in ocean engineering
   c. Program Outcome 6: Problem formulation & solution

7. Brief list of topics to be covered
   a. MATLAB Review
   b. Fundamentals of probability and statistics Data exploration and visualization Descriptive statistics
   c. Linear models

d. Nonlinear regression models Hypothesis testing Multivariate statistics
e. Time series analysis
f. Spectral analysis

1. Course Number and Name
   ORE 609 -Hydrodynamics of Fluid-Body Interaction

2. Credit and Hours
3. Two 1.25-hour sessions per week.

4. Instructor
   R.C. Ertekin

5. Textbooks:
   Textbooks: Lecture Notes by R.C. Ertekin
   Reference books:
   a. Sarpkaya and Isaacson: Mechanics of Wave Forces on Offshore Structures
   b. Newman: Marine Hydrodynamics
   c. Currie: Fundamental Mechanics of Fluids
   d. Ippen: Estuary and Coastline Hydrodynamics
   e. Mei: The Applied Dynamics of Ocean Surface Waves
   f. Abramowitz and Stegun: Handbook of Mathematical Functions
   g. Gradshteyn and Ryzhik: Table of Integrals, Series and Products
   h. Chakrabarti: Hydrodynamics of Offshore Structures
   1. Mase: Continuum Mechanics

6. Course Information
   a. Course content: Hydrodynamics of ships, coastal and offshore structures. Wave forces by potential theory and by Morison's equation. Method of source distribution for potential flow problems. Flows with prescribed body motion, fixed and freely floating bodies.
   b. Prerequisites:
      i. Water-Wave Theories (ORE 607) Basic Fluid Mechanics
      ii. Complex Variables Vector Calculus
   c. Designation: Required Core course

7. Course Goals
   a. This course is designed to give ocean engineering students a basic background for the assessment of hydrodynamic loads acting on fixed and floating bodies and their motions in regular and irregular waves.
      1. Program Outcome 2: Basic science, mathematics, & engineering Program Outcome 3: Ocean engineering core
      ii. Program Outcome 6: Problem formulation & solution
   b. Student Learning Outcomes:
      1. Understand the theoretical and experimental principles of fluid-body interaction problems in the oceans
      11. Understand the principles of viscous and ideal flow and be able to apply the principles to problem solving that involves rigid body movements in the oceans, and
      111. Understand the diffraction, radiation and motions of floating and submerged bodies in deterministic and irregular wave

8. <u>Topics Covered</u>
    a. Introduction:
    b. Dimensional Analysis
    c. Viscous-Fluid Flow
    d. Ideal-Fluid Flow
    e. Water waves
        i. The purpose is for clarification of notation and to introduce perturbation expansion
    f. Wave Diffraction and Forces
    g. Flows with prescribed body motion and freely-floating bodies
    h. Irregular-sea analysis
        i. The purpose is to apply the force and motion transfer functions in random waves

1. Course Number and Name
   ORE-612 Dynamics of Ocean Structures

2. Credit and Hours
   Credits, two 3-hour sessions per week

3. Instructor
   Bernard D. Greeson, Ph.D

4. Textbooks
   Textbooks: None
   References:
   a. Bhattacharyya, R., Dynamics of Marine Vehicles, John Wiley & Sons, 1978
   b. Chakrabarti, S.K., Hydrodynamics of Offshore Structures, Springer, 1987
   c. Faltinsen, O.M., Sea Loads on Ships and Offshore Structures, Cambridge University Press, 1990
   d. Jackson, Leland B., Signals. Systems. and Transforms, Addison-Wesley, 1991
   e. Jacobson, Lydik S. and Ayre, Robert S., Engineering Vibrations, McGraw-Hill, 1958
   f. Newman, J.N., Marine Hydrodynamics, MIT Press, 1977
   g. Wilson, J.F., Dynamics of Offshore Structures, John Wiley & Sons, 2003

5. Course Information
   a. Course content: Response of floating platforms and vessels to wave action, spectral analysis in sea keeping. Frequency and time domain analyses of rigid body motions in six degrees of freedom.
   b. Prerequisite:
      i. ORE 411 or consent.
      ii. Co-requisite ORE 609 or consent.
   c. Designation as required or elective course: Offshore Option in ORE

6. Course Goal
   Upon satisfactory completion of the course, the student should:
   a. Understand the wave forces which act on offshore structures
   b. Be able to calculate these forces for various situations
   c. Have a sound background in the mathematical tools involved
   d. Have a basic understanding of offshore structure kinematics

7. Topics covered
   a. Linear Oscillator – One Degree of Freedom
   b. Free Vibration with Linear Damping
      i. Motion of a Floating Body in Quiescent Water
   c. Forced Vibration-Steady State Oscillation (Part I)
      i. Motion of a Floating Body in Regular Waves
   d. Forced Vibration-Transient and Nonperiodic Vibrations
      i. Review of Laplace Transform

ii. Unit Step Function-Indicia!Response
iii. Unit Impulse Function-Impulsive Response
iv. Pulsed Sinusoidal Excitation
v. Arbitrary Excitation

e. Forced Vibration-Steady State Oscillation (Part II)
i. Review of Fourier Transforms
ii. Impulsive Response and Complex Frequency Operator
f. Time Domain Solutions
g. Time Domain Solution of Equations of Motion Containing
1. Frequency Dependent Coefficients
a. Connection between Frequency Domain and Time Domain
b. Time Domain Description-Linear Equations of Motion
c. Hydrodynamic Force on Body Making Arbitrary Oscillations in
1. Originally Calm Water

Motion of Floating Bodies
1. Kinematics of Rigid Bodies
a. Linear Momentum of a Rigid Body
b. Angular Momentum
c. Dynamics of a Rigid Body
11. Linear Motions
111. Rotational Motions
tv. The General Six Scalar Equations of Motion
v. The Linearized Equations of Motion for a Body with a Plane of Symmetry

Hydrodynamic Coefficients and Wave Excitation-3D Source Distribution
i. Review of Ideal Fluid Theory
ii. Green's Theorem and Distribution of Singularities
iii. Hydrodynamic Pressure Forces
iv. Force on a Moving Body in an Unbounded Fluid
v. General Properties of Added Mass Coefficients
vi. The Body-Mass Force
vii. Linear Diffraction Theory Equations of Motions

Non Linear Equations of Motion-Frequency Domain
i. Non Linear Restoration Function-Ritz-Galerkin Method
ii. Forced Oscillation with Non Linear Damping and Non Linear Restoration
iii. General Types of Non Linear Damping and Linear Restoration

Two Moving Body Interaction Problem
i. Van Oortmerssen (1979)
ii. Cummins (1962)
iii. Greeson (1997)

i. Ship Motions in Irregular Seas: St. Denis, et al (1950)

1. Course Number and Name
   ORE 654 - Applications of Ocean Acoustics

2. Credit and Hours
   Two 1.25-hour sessions per week

3. Instructor
   Bruce Howe

4. Textbook(s)
   Textbooks:
   a. *Sound in the Sea,* Medwin, Cambridge University Press, 2005
   Reference Books
   b. *Fundamentals of Acoustical Oceanography,* Medwin and Clay, Associated Press, 1998
   c. *Acoustical Oceanography,* Clay and Medwin, John Wiley & Sons, 1977
   d. *Underwater Acoustic Systems,* Coates, John Wiley & Sons, 1989
   e. *Oceanography and Acoustics: Prediction and Propagation Models,* Robinson and Lee, American Institute of Physics, 1994
   f. *Inverse Problems in Underwater Acoustics,* Taroudakis and Makrakis, Springer, 2001
   g. *Sound transmission through a fluctuating ocean,* Flatte, Cambridge University Press, 1979
   h. *Ocean Acoustic Tomography,* Munk, Worcester, and Wunsch, Cambridge University Press, 1995
   1. *The Sonar of Dolphins,* Au, Springer-Verlag, 1993
   J. *Principles of Underwater Sound,* Urick, McGraw-Hill, 1975

5. Course Information
   a. Course content: Using sound to observe the ocean. Fundamentals of propagation, sources and receivers, radiated sound and scattering, bubbles, waveguides, scattering at rough surfaces, and bioacoustics. Topics include: marine mammals, fish and plankton imaging, navigation and communication, sound of seismics, ships, wind and rain, using sound to study ocean dynamics, flow imaging and measurement, mapping the seafloor and the combined forward/inverse problem.
   b. Prerequisites: Consent of instructor
   c. Designation: Elective

6. Course Goal
   a. The objective of this course is to provide the ocean engineering student an understanding of how sound propagates through the ocean environment and how to use that information to observe the ocean. The course will provide an overview of the fundamentals of sound propagation, sound of seismics, ships, wind and rain, bioacoustics, using sound to study ocean dynamics, and imaging and mapping the seafloor. At the outcome, students will be able to formulate the combined forward/inverse problem, from tracing rays and estimating sound levels to solving for rainfall or current velocity, for example.
   b. Program Outcomes
      i. Program Outcome 2: Basic science, mathematics, & engineering

11. Program Outcome 4: Ocean engineering specialization Program Outcome 5: Use of latest tools in ocean engineering Program Outcome 6: Problem formulation & solution Program Outcome 9: Professional issues
111. Program Outcome 10: Communication skills
IV. Program Outcome 11: Research & contemporary issues

7. Topics Covered
   a. Fundamentals: Simple propagation, rays, sources and receivers, radiated sound, bioacoustics, waveguides, scattering by bubbles, interior fluctuations, and rough surfaces
   b. The near surface ocean: upper ocean boundary layer and rain
   c. Bioacoustics: sensing of plankton and nekton; passive acoustics and marine animals, marine mammals
   d. Ocean Dynamics: tomography, time reversal, turbulence
   e. Ocean Bottom: imaging hydrothermal vents, large scale mapping

. Course number and name

ORE 661- Coastal and Harbor Engineering

2. Credits and contact hours

3 credits, two 1.25-hour sessions per week

3. Instructor's or course coordinator's name

Kwok Fai Cheung

4. Textbooks

Textbooks: None

Reference books:

a. Coastal Engineering Manual- Part II, US Army Corps of Engineers, 2006 (PDF version on http://chl.erdc.usace.army.mil).
b. NAVFAC DM 26.1, 26.2, and 26.3
c. *Handbook of Coastal and Ocean Engineering,* Vol. I, II, and III, Edited by John Herbich, Gulf Publishing Company, 1990.
d. *Port Engineering,* Vol. I and II, Edited by Per Bruun, Gulf Publishing Company, 1990.
e. Design of Marine Facilities for the Berthing, Mooring, and Repair of Vessels, J.W. Gaythwaite, ASCE Press, 2004.

5. Specific course information

a. Course context: Planning and design of seawalls, groins, jetties, breakwaters, and layout of ports. Design requirements for harbor entrances and channels. Littoral drift and sedimentation problems. Navigation and mooring requirements. Pre. 607 or consent.
b. Prerequisites by Topics:
   1. Applied mechanics
   11. Engineering economics
   111. Fluid mechanics
   tv. Hydraulics
   v. Probability and Statistics
   vt. Soil Mechanics
   vii. Wave mechanics
c. Designation: ORE required course

6. Specific goals for the course

a. Learning Outcomes:

   The course familiarizes students with the planning, design, and maintenance of coastal and harbor structures. Specific learning outcomes include:
   1. Ability to identify, formulate, and solve coastal and harbor engineering problems
   11. Ability to provide optimal designs of coastal structures and harbor facilities
   111. Appreciation of professional and non-technical issues

7. Brief list of topics to be covered

a. Planning and Design. Problem definition, site characterization and data, alternative evaluation.

b. Breakwaters. Rubble mound structures (conventional and berm design), caissons, scour protection, and geotechnical consideration.

c. Revetments and Seawalls. Rubble mound structures, caissons, lateral earth pressure, seismic consideration.
d. Harbor. Navigational requirements, channels and turning basins, sedimentation and maintenance dredging.
e. Engineering practice issues. Design process, economics, construction, and risk.

1. Course Number and Name
   ORE 664- Nearshore Processes and Sediment Transport

2. Credit and Hours
   3 credits, two 1.25-hour sessions per week

3. Instructor
   Zhenhua Huang

4. Textbooks
   Textbook: None
   Reference books:
   1. Coastal Processes with Engineering Applications, Robert G. Dean and Robert A. Dalrymple, Cambridge University Press, 2004.
   2. Coastal Bottom Boundary Layers and Sediment Transport, Advanced Series on Ocean Engineering, Vol. 4, P. Nielsen, World Scientific, 1992
   3. Coastal Engineering Manual, Army Corps of Engineers, 2002; online at http://chl.erdc.usace.army.n1il/cem

5. Course Information
   a. Course content: Review of nearshore hydrodynamics. Sediment transport by waves and currents in coastal areas and its effect on morphological processes. Effect of man-made structures on littoral drift and shoreline. Pre: 607 or consent.
   b. Prerequisite:
      i. Differential equations
      ii. Fluid mechanics
      iii. Wave mechanics
   c. Designation as required or elective course: Coastal Engineering Required Course

6. Course Goal
   The aim of the course is to provide engineers working in the coastal environment with the understanding of nearshore wave, current and sediment processes and their effects on the morphology of beaches and coastlines. The dynamics of the nearshore environment will be explored in detail, including nearshore currents, consideration of wave boundary layer processes and sediment particle dynamics and examine how these can be considered using engineering models.
   a. Program Outcomes
      1. Program Outcome 2: Basic science, mathematics, & engineering
      11. Program Outcome 5: Use of latest tools in ocean engineering
      111. Program Outcome 6: Problem formulation & solution
      IV. Program Outcome 8: Independent & teamwork
      v. Program Outcome 10: Communication skills

7. Topics covered
   - Review of Fluid Dynamics and Wave Theory
   - Nearshore Currents

- Boundary Layer Dynamics
- Sediment Dynamics
- Cross-shore Transport
- Longshore Transport
- Sediment Transport Models
- Nearshore Morphodynamics

1. Course Number and Name
   ORE 677, Marine Renewable Energy

2. Credits and Hours
   3 credits, two 1.25-hour sessions per week

3. Instructor
   Gerard C. Nihous

4. Textbooks
   Textbook: none
   Reference books:
   a. Renewable Energy from the Ocean-a Guide to OTEC, W.H. Avery and C. Wu, Oxford University Press, 1994.
   b. Ocean Wave Energy-Current Status and Future Perspectives, J. Cruz (ed.), Springer, 2008.
   c. Wind Energy Explained-Theory, Design and Application, J.F. Manwell, J.G. McGowan, A.l. Rogers, Wiley & Sons, 2004.
   d. Sustainable Energy-without the hot air, D.J.C. MacKay, http://www.withouthotair.com, 2008.

5. Course Information
   a. Course contents: Ocean thermal energy conversion (OTEC) systems: applicability, thermodynamics, design challenges; wave energy converters: floating devices, oscillating water column, optimal hydrodynamic performance; current, tidal and offshore wind power.
   b. Prerequisite: Water Waves Mechanics; knowledge of Thermodynamics desirable
   c. Designation as a required or elective course: Ocean Resources Engineering required course

6. Course Goals
   a. Instruction Outcomes:
      1. An understanding of the principles and applicability of OTEC systems.
      11. An understanding of the design principles and engineering criteria to develop functional and efficient electrical power generation from wave, wind, current and tidal resources.
      iii. An understanding of the role of ocean renewable energy within the current worldwide framework of energy production.
   b. Program Outcomes:
      i. Program Outcome 1: Broad education
      11. Program Outcome 2: Basic science, mathematics, & engineering
      iii. Program Outcome 4: Ocean resources engineering specialization
      tv. Program Outcome 5: Use of latest tools in ocean engineering
      v. Program Outcome 6: Problem formulation & solution
      vt. Program Outcome 7: Design & optimization in ocean engineering

vu. Program Outcome 9: Professional & ethical issues
v1u. Program Outcome 11: Research & contemporary issues

7. Topics Covered
   a. Economic, social and political context of energy production.
   b. Estimation of the OTEC resource.
   c. Thermodynamics of basic OTEC cycles.
   d. Design of pipes, pumps, heat exchangers, turbines, generators.
   e. Floating wave energy converters and oscillating water columns.
   f. Optimal hydrodynamic performance.
   g. Design principles and constraints.
   h. Current, tidal and wind power production.

1. Course Number and Name
   ORE 678, Marine Mineral Resources Engineering

2. Credits and Contact Hours
   Two 1.25-hour sessions per week. Course is 3 credits.

3. Course Coordinator's Name
   Course is taught by Dr. John C.Wiltshire

4. Textbooks and/or Other Reading Material
   a. Cronan, D.S. (1999). *Handbook of Marine Mineral Deposits.* CRC Press
   b. Cronan, D.S. (1980). *Underwater Minerals.* London: Academic Press
   c. Herbich, J.B. (1992). *Handbook of Dredging Engineering.* New York: McGraw-Hill
   d. Other readings are passed out as needed and posted on the class website

a. Specific course information
   a. Activities in marine minerals development are examined in a multidisciplinary systems approach involving engineering, earth and environmental sciences and economics. Students give 3 seminars during the course to demonstrate their knowledge of the engineering issues surrounding the extraction of the vast but difficult to recover mineral resources found in the ocean.
   b. Prerequisites and co-requisites: applied mechanics, engineering economics, graduate standing
   c. Course is a selected elective, it is required to complete the resources track of the ORE Master's program

6. Specific goals for the course
   a. The course familiarizes students with the mineral resources of the ocean and the engineering challenges faced to exploit them. Specific course learning outcomes include:
      1. The ability to formulate the design issues involved in underwatr mining equipment.
      u. An understanding of the range and type of ocean mineral deposits.
      111. The ability to articulate the environmental, economic and energy issues involved 1n ocean mineral development

   b. The specific student outcomes addressed by this course include:
      1. Student Outcome 1: Broad Education
      ii. Student Outcome 2: Basic science, mathematics, & engineering
      iii. Student Outcome 4: Ocean engineering specialization
      tv. Student Outcome 5: Use of latest tools in ocean engineering
      v. Student Outcome 6: Problem formulation & solution
      VI. Student Outcome 9: Professional issues
      vu. Student Outcome 10: Communication skills
      v1u. Student Outcome 11: Research & contemporary issues

7. Topics Covered

a. Introduction to Marine Minerals
b. The Problem of Peak Resources - Running out of Commodities
c. Manganese Nodules and the History of Deep Sea Mining
d. Deep Sea Mining Technology
e. Minerals Processing
f. Offshore Oil and Gas
g. Oil and Gas Technology, Future Oil Sources and Issues
h. Economics of Marine Minerals
1. World Metal Markets
J. Formation Processes of Polymetallic Sulfides (PMS) on the Ocean Floor: Geology of the Smoker and PMS- Nautilus Minerals Co.
k. Chemistry of Hydrothermal Vents and Polymetallic Sulfides - exploration technology
1. PMS Deposits: From Smoker to an Ore Body- cutter technology
m. Case Studies on the Ocean Floor: The Red Sea - suction mining
n. Ferromanganese Crusts, Methane Hydrates, Placers and Relevant Dredging Technology

1. <u>Course number and name</u>
   ORE 766- Numerical Methods in Ocean Engineering

2. <u>Credits and contact hours</u>
   Two 1.25-hour sessions per week. 50% lecture, 50% computer lab.

3. <u>Instructor's or course coordinator's name</u>
   Eva-Marie Nosal

4. Textbooks
   a. Textbooks:
      i. C. Moler (2004), Numerical computing with MATALB, Society for Industrial Mathematics.
   b. Reference books:
      1. RL Burden *eta/., Numerical Analysis,* Brooks Cole, 2000
      11. A Iserles, *A First Course in the 1Vumerical Analysis of Differential Equations,* Cambridge University Press, 1996
      111. Y Kwon, H Bang, *The Finite Element Method using MATLAB,* CRC Press, Inc., 2000
      IV. CA Brebbia *eta/., Boundary Element Techniques,* Springer-Verlag, 1984
      v. P Lin, *Numerical Modeling of Water Waves,* Taylor & Francis, 2008

5. <u>Specific course information</u>
   a. Course content:
      Formulation and application of numerical methods for simulating and solving ocean engineering problems. Topics include: Mathematical and computational fundamentals with implications for accuracy and stability; numerical interpolation, differentiation, and integration; boundary element, finite difference, and finite element methods. Pre: consent.
   b. Prerequisites:
      i. Computer programming language
      ii. Differential equations Basic numerical methods Fluid mechanics
      iii. Water wave theory
   c. Designation: Elective Course

6. <u>Specific goals for the course</u>
   a. Learning Outcomes:
      The objective of this course is to provide students with the background and skills required to numerically simulate and solve Ocean Engineering problems. This will be a hands-on class with theory accompanied by practical implementation in MATLAB. After a review of programming in MATLAB and basic numerical methods (linear equations, interpolation, numerical differentiation, integration), methods to solve various ordinary and partial differential equations will be covered. Emphasis will be placed on application to Ocean Engineering problems such as potential flow, water waves, ocean structures, and ocean acoustics.
      1. Program Outcome 2: Basic science, mathematics, & engineering
      11. Program Outcome 5: Use of latest tools in ocean engineering
      111. Program Outcome 6: Problem formulation & solution

tv. Program Outcome 10: Communication skills

b. Upon successful completion of ORE 766, students will be able to:
   1. Demonstrate an understanding of the fundamental principles of digital computing, including number representation and arithmetic operations.
   11. Develop and implement stable and accurate numerical methods to solve linear systems of equations and find roots of linear and non-linear equations.
   111. Perform numerical interpolation, curve fitting, integration, and differentiation.
   tv. Develop and·implement stable algorithms to solve ordinary differential equations and simple partial differential equations.

7. <u>Brief list of topics to be covered</u>
   a. MATLAB review
   b. Fundamental of Numerical Analysis
   c. Solving linear systems
   d. Curve fitting and interpolation
   e. Numerical differentiation and integration
   f. Numerical ordinary differential equations
   g. Single-step methods Multistep methods Stability, stiffness, errors
   h. Numerical partial differential equations
   1. Finite difference method
   J. Boundary element method
   k. Finite element method

I. Course number and name
ORE 783 (Alpha) Capstone Design Project

2. Credits and contact hours
3 credits. The course is conducted as a series of meetings and informal presentations and culminates in a major presentation analogous to a public hearing at a department seminar attended by the faculty, students, and visitors from the local engineering community.

3. Instructor's or course coordinator's name
Kwok Fai Cheung

4. Textbooks
Textbooks: None
Reference books: Applicable design manuals

5. Specific course information
   a. Course content: Major design experience based on knowledge and skills acquired in earlier coursework incorporating realistic constraints that include economic, environmental, ethical, social, and liability considerations. Emphasis is placed on teamwork and consultant-client relationship. (B) coastal engineering; (C) offshore engineering; (D) ocean resources engineering. Repeatable one time
   b. Prerequisites by Topics:
      1. All students: hydrostatics, at-sea experience, oceanography, water wave mechanics, wave-structure interaction, and engineering economics.
      11. Coastal engineering students: coastal and harbor structures, coastal processes, and sedin1ent transport.
      111. Offshore engineering students: structural analysis and dynamics of floating structures.
      iv. Ocean resources engineering students: OTEC system and marine mineral resources.
   c. Designation:
      1. Coastal Engineering Required Course (B)
      11. Offshore Engineering Required Course (C)
      111. Ocean Resources Engineering Required Course (D)

6. Specific goals for the course
   a. Learning Outcomes:
      The course familiarizes the students with the planning and design of a real-life engineering project in a consulting firm setting. Emphasis is placed on teamwork, risk management, decision making with insufficient information, consultant-client relation, ethics, and environmental and economic aspects of engineering design. Specific learning outcomes include
      1. Appreciation of professional and ethical responsibilities
      11. Ability to work independently and function on multi-disciplinary teams
      111. Ability to design and optimize ocean and resources engineering systems
      1v. Ability to use techniques, tools, and data necessary for ocean engineering practice
      v. Ability to communicate effectively to technical and non-technical audiences

7. Brief list of topics to be covered

The topic varies every semester and reflects the latest engineering projects in Hawaii. ORE 783B has been team taught with practicing professional engineers from Oceanit Inc. and Sea Engineering Inc., Hawaii. Healy Tibbitts Builders Inc., a major marine contractor in Hawaii, has been supporting the capstone design class by providing feedback to student designs and up-to-date cost and construction data.

APPENDIX B

FACULTY VITAE

DEPARTMENTAL, COOPERATING AND AFFILIATE

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1) Name: Kwok Fai Cheung, PhD, PE

2) Education
PhD, Civil Engineering, University of British Columbia, 1991.
MASc, Civil Engineering, University of British Columbia, 1987.
BASe, Civil Engineering, University of Ottawa, 1985.

3) Academic Experience: 22 years
Assistant Professor (1993- 1998); Associate Professor (1998 -2001), Professor (2001 -Present), Department and Graduate Chair (2001 – 2007), Graduate Chair (2012 -present).

4) Non-Academic Related Experience
Visiting Researcher, Naval Surface Warfare Center Carderock Division, West Bethesda, Maryland, 2004.
Visiting Researcher, National Institute for Coastal and Marine Management, The Hague, The Netherlands, 2001.
Visiting Researcher, Danish Hydraulic Institute, H0rsholm, Denmark, 1996, 1997.
Coastal Engineer, Sandwell Engineering, Inc., Vancouver, British Columbia, 1991 – 1993.

Consulting
AECOM, British Columbia; Ausenco Ltd., British Columbia; Martin and Chock, Inc., Hawaii; Maui Electric Company Ltd., Hawaii; Marc Siah and Associates, Inc., Hawaii; Ocean Engineering Consultants, Inc., Hawaii; Oceanit Inc., Hawaii; Oregon State University; Pacific Disaster Center, Hawaii; Sandwell Engineering, Inc., British Columbia; Sea Engineering, Inc., Hawaii; Shell Offshore Inc., Texas; Sound and Sea Technology, Washington; The Glosten Associates, Inc., Washington.

5) Professional Registration
Professional Engineer (Civil), License No. 9791, Hawaii.
Professional Engineer (Civil), License No. 20667, British Columbia (inactive).

6) Membership of Scientific and Professional Societies
American Geophysical Union

7) Honors and Awards
Resource Conservation and Climate Change Project-of-the-Year Award (co-recipient with Robert Evans of WHOI), Strategic Environmental Research and Development Program, Department of Defense, 2014.
Award of Merit (co-recipient with Mike Brady of AECOM), Association of Consulting Engineering Companies, British Columbia, 2014.
Dr. Gaylord R. Miller Award for Excellence in Tsunami Preparedness, Hawaii Emergency Managen1ent Agency, State of Hawaii, 2014.
Commendation, Mayor of the City and County of Honolulu, 20I0.
Scientific Application and Public Contribution Award, Department of Emergency Management, City and County of Honolulu, 2010.
Senior Faculty Research Fellow, Office of Naval Research, 2004.

Research Initiation Award, National Science Foundation, 1994.

8) Institutional and Professional Service in Last Five Years (10% time commitment)
Hawaii Weather and Impact Advisory Committee, 2015-Present.
Hawaii Earthquake and Tsunami Advisory Committee, 2014-Present.
Coordination Committee, National Tsunami Hazard Mitigation Program, 2007 – Present.
Design Code C<;>mmittee on Tsunamis, American Society of Civil Engineers, 2011 – 13.

9) Representative Publications of Last Five Years (6 of 43 in refereed journals)
Bai, Y. and Cheung, K.F. (2013). Dispersion and nonlinearity of multi-layer non-hydrostatic free-surface flow. *Journal of Fluid Mechanics,* 726, 226-260.
Das, S. and Cheung, K.F. (2012). Hydroelasticity of marine vessels advancing in a seaway. *Journal of Fluids and Structures,* 34, 271-290.
Ge, L. and Cheung, K.F. (2011). Spectral sampling method for uncertainty propagation in long-wave runup modeling. *Journal of Hydraulic Engineering,* 137(3), 277-288.
Roeber, V. and Cheung, K.F. (2012). Boussinesq-type model for energetic breaking waves in fringing reef environment. *Coastal Engineering,* 70, 1-20.
Stopa, J.E. and Cheung, K.F. (2014). Periodicity and pattern of ocean wind and wave climate. *Journal ofGeophysical Research: Oceans,* 119(8), 5563-5584.
Yamazaki, Y., Cheung, K.F., and Kowalik, Z. (2011). Depth-integrated, non-hydrostatic model with grid nesting for tsunami generation, propagation, and run-up. *International Journal for Numerical Methods in Fluids,* 67(12), 2081-2107.

10) Research or Scholarly Activities (50o/o time commitment)
Published 86 papers in refereed journals: Applied Ocean Research; Canadian Journal of Civil Engineering, Coastal Engineering; Earth and Planetary Science Letters; Earthquake Spectra; Engineering Analysis with Boundary Elements; Geophysical Research Letters; International Journal for Numerical Methods in Fluids; International Journal of Offshore and Polar Engineering; Journal of Atmospheric and Oceanic Technology; Journal of Coastal Research; Journal of Engineering Mathematics; Journal of Engineering Mechanics; Journal of Fluids and Structures; Journal of Fluid Mechanics; Journal of Geophysical Research; Journal of Hydraulic Engineering; Journal of Hydraulic Research; Journal of Offshore Mechanics and Arctic Engineering; Journal of Structural Engineering; Journal of Waterway, Port, Coastal and Ocean Engineering; Marine Technology; Marine Structures; Natural Hazards; Numerical Algorithms, Ocean Engineering; Ocean Modelling; Renewable Energy; Sedimentology; Tectonophysics; Wave Motion.
Raised $12M of grants and contracts as the Principal Investigator from American Samoa Department of Homeland Security, Federal Emergency Management Agency, Office of Naval Research, National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, National Science Foundation, National Tsunami Hazard Mitigation Program, US Army Corps of Engineers, Hawaii State Civil Defense, and other agencies and organizations since 1994.
Participated in five major projects (over $1M each) funded by the Department of Energy, Department of Defense, National Oceanic and Atmospheric Administration, and National Science Foundation as a co-Principal Investigator or co-Investigator.

1. Name
   R. Cengiz Ertekin, Professor, full-time, tenured

2. Education
   M.S. and Ph.D. in Naval Architecture and Offshore Engng., University of California at Berkeley, 1980, 1984
   B.S. in Naval Architecture and Marine Engineering, Technical University of Istanbul, 1977

3. Service on the Faculty
   Years of Service: 29 (by 2015); Original appointment: 1986; Tenured: 1990; Promoted to Full Professor: 1994.

4. Related Experience
   2014- Present: Guest Professor, College of Shipbuilding Engineering, Harbin Engineering University, China.
   1998 - Present: Global Environmental Science, B.S. Degree Program, Univ. of Hawaii, Grad. Faculty.
   1997- Present: Department of Civil & Environmental Engng., Univ. of Hawaii, Cooperating Grad. Faculty.
   1985- 1986: Shell Development Co., Bellaire Research Center, Houston, TX. Associate Research Engineer.
   1984- 1985: Department of Naval Arch.& Offshore Engng, Univ. of Calif., Berkeley, Post-doctoral Fellow.
   1981- 1982: Standard Oil Company of California, Chevron, San Francisco, CA. Design Engineer.
   1977- 1978: Shipbuilding Inst. of the Technical Univ. of Istanbul, Model Test Engineer.

   Consulting & Patents
   2009- U.S. Patent (w/ R. Carter) Induced Surface Flow Wave Energy Converter, U.S.Patent No. 8,084,873
   1996- Present: *Of!Coast, Inc.*, Honolulu, Hawaii, An R&D firm specializing in offshore and coastal engineering consulting and software development, Vice-President.

5. Professional Registration None

6. Scientific and Professional Societies
   Society of Naval Architects and Marine Engineers, SNAME (Fellow, member since '80), American Society of Mechanical Engineers, ASME (Fellow, member since '85), American Society of Civil Engineers, ASCE (M '90}, Marine Technology Society, MTS (M '90)

7. Honors and Awards
   - ReCipient of the National Science Foundation's Presidential Young Investigator Award
   - American Society of Mechanical Engineers, Offshore Mech. & Arctic Engrg. Division, Achievement Award 1993, Special Service Award, 1998, Special Service Award, 2002 for dedication and leadership as Chair of OOAE, 2001-2002, and for contributions to organizing OMAE Conferences.
   - Elected to the Fellow of American Society of Mechanical Engineers International, ASME, and Society of Naval Architects and Marine Engineers, SNAME.

8. Institutional and Professional Service in the Last Five Years
   - ASME International Conference Co-Chair ofOMAE 2009.
   - Society ofNaval Architects and Marine Engineers & MTS.Hawaii Student Section Advisor, 1991-present.

- Serves on the organizing committees ofOMAE, RENEW, IMAM, Hydroelasticity in Marine Technology, ICHD conferences.
- Founding Editor-in-Chief, *Journal of Ocean Engineering and Marine Energy,* Springer, 2013-Present and currently serves on the editorial boards of *Journal of Marine Science and Technology, Springer; Journal of Engineering/or the Maritime Environment,* IMechM; *Journal of Waterway, Port, Coastal and Ocean Engineering, ASCE; Marine Structures,* Elsevier; *Ships and Offshore Structures, Taylor & Francis.*
- Served in or currently serving in UHM faculty Senate representing SOEST as the Senator 2012-Present: SOEST faculty Senator, Ph.D. Qualifying Exam Committee member, ORE Personnel Committee member and chair, ORE Outstanding Student Award Committee member and chair, Served as Acting Chairman on various occasions, Coordinator for International Professional Advisory Panel, Coordinator for CAFE implementation at the ORE Department, ORE Faculty Search Committee and chair, among others.

9. <u>Some Publications in the Last Five Years</u>

Kim, J.W., Ertekin, R.C. and Bai, K.J. (201 0), "Linear and Nonlinear Wave Models based on Hamilton's Principle and Stream Function Theory: CMSE and IGN," *J. Offshore Mechanics and Arctic Engineering,* Trans. of ASME, Vol. 132, May, pp. 021102-1 - 021102-6.

Padmanabhan, B. and Ertekin, R.C. (2011) "Interaction of Waves with a Steady Intake/Discharge Flow Emanating from a 3-D Body," *J. Offshore Mechanics and Arctic Engineering,* Trans. of ASME, Vol.133, No.4, November, pp. 041101-1 to 041101-10.

Nolte, J., Ertekin, R.C., Davis, E.P. (2013), "In-Ocean experiments of a wave energy conversion device moored to an anchor and to a drogue," *J. Ocean Technology,* March, Vol. 8, No.I, pp. 72-85.

Korde, U. A. and Ertekin, R.C. (2014) "On wave energy focusing and conversion in open water," *Renewable Energy,* Vol. 62, February, pp. 84-99.

Zhao, B.B., Duan, W.Y. and Ertekin, R.C. (2014), "Application of Higher-Level GN Theory to some Wave Transformation Problems," *Coastal Engineering,* Vol. 83, January, pp. 177-189.

Ertekin, R.C. and Xia, D. (2014), "Hydroelastic response of a floating runway to cnoidal waves," *Physics of Fluids,* AlP, Vol., 26, No.2, February, pp. 027101-1 to 0127101-16.

Nolte, J. and Ertekin, R.C. (2014), "Wave Power Calculations for a Wave Energy Conversion Device Connected to a Drogue," *J. Renewable and Sustainable Energy,* AlP, Vol. 6, No. 1, pp. 013117-1 to 013117-21

Seiffert, B., Hayatdavoodi, M. and Ertekin, R.C. (2014), "Experiments and Computations of Solitary-Wave Forces on a Coastal-Bridge Deck. Part 1: Flat Plate," *Coastal Engineering,* Vol. 88, June, pp. 194-209.

Hayatdavoodi, M., Seiffert, B. and Ertekin, R.C. (2014), "Experiments and Computations of Solitary-Wave Forces on a Coastal-Bridge Deck. Part II: Plate with Girders," *Coastal Engineering,* Vol. 88, June, pp. 21 0-226.

Ertekin, R.C., Hayatdavoodi, M. and Kim, J.W. (2014) "On Some Solitary and Cnoidal Wave Diffraction Solutions of the Green-Naghdi Equations," *Applied Ocean Research,* Vol. 47, August, pp. 125-137.

Carter, R.W. and Ertekin, R.C. (2014), "Focusing of Wave-Induced Flow through a Submerged Disk with a Tubular Opening," *Applied Ocean Research,* Vol. 47, August, pp. 110-124.

Zhao, 8.8., Ertekin, R.C., Duan, W.Y. and Hayatdavoodi, M. (2014). "On the steady solitary-wave solution ofthe Green-Naghdi equations of different levels," *Wave Motion,* Vol. 51, No.8, December, Elsevier, DOl: 10.1016/j.wavemoti.2014.08.009

Zhao, B.B., E1tekin, R.C., Duan, W.Y. and Kim, J.W. (2014) "Particle Trajectory Calculations under a Solitary Wave by High-level IGN Equations," *J. Waterway, Port, Coastal and Ocean Engineering,* ASCE, DOl: 10.1061/(ASCE)WW.l943-5460.0000283

I. Nan1e and Academic Rank
Bernard Dandridge Greeson, Specialist

2. Education
B.S., Naval Science, Mathematics (Minor), United States Naval Academy, 1964
M.Eng., Ocean Engineering, Texas A& M University, 1976
Ph.D., Ocean Engineering, University of Hawaii at Manoa, 1997

3. Service on the Faculty
Texas A&M University, Associate Professor, Naval Science, Full Time 1974-1976.
University of Hawaii at Manoa, Specialist, Part Time, 1998- present

4. Related Experience
Military: Graduate of Naval Submarine School and Naval Nuclear Propulsion Training
Served in the United States Navy nuclear submarine force from I964 until I992.
I966-I967: USS Bonefish (SS-582)
I967-I970: USS Scamp (SSN-588)
I970-I974: Engineer Officer, Submarine NR-1
I977-I979: Executive Officer, USS Theodore Roosevelt (SSBN-600)
1979-1980: Executive Officer, USS Hawkbill (SSN-666)
1980-I 980: Commanding Officer, USS Thomas Jefferson (SSBN-618)
I980-I983: Commanding Officer, USS Robert E. Lee (SSBN-60 I)
1983-I984: Commanding Officer, USS Puffer (SSN-652)
I984-I985: Acting Commanding Officer, USS Guardfish (SSN-612)
I985-1987: Deputy Commander, COMSUBRU 9
I987-1989: Commanding Officer, USS Michigan (SSBN-727)
I990-1992: Fleet Operations Officer, CINCPACFLT and Deputy Commander, CTF-12
Retired from military in 1992 as Captain, United States Navy

Civilian: Served as Chief Engineer, Hawaii Undersea Research Laboratory, operator of deep diving research submersibles, Pisces VI and Pisces V, at the University of Hawaii, I998-2014

Consulting & Patents
Licensed by United States Coast Guard for service on Merchant Marine vessels as Chief Engineer, Unlimited Horsepower (Steam); Second Mate, Unlimited Tonnage (Oceans), and Master, I600GT (Oceans).

5. Professional Registration
Sigma Xi Scientific Research Society
American Society of Civil Engineers (Life Member)
Society ofNaval Architects and Marine Engineers
Marine Technology Society
U.S. Naval Institute
U.S. Submarine Veterans International (Life Member)
Naval Submarine League (Life Member)

Deep Submersible Pilots Association (Life Member)

6. Membership

7. Honors and Awards
   Military: Legion of Merit (two awards), Meritorious Service Medal (three awards), Navy Commendation Medal (two awards). Qualified in Submarines and as a Deep Submersible Vehicle Operator. Qualified for Command ofNuclear Submarines.

   Academic: Phi Kappa Phi Honor Society (1976). Outstanding Graduate Student Department of Ocean Engineering, University of Hawaii at Manoa (1994).

8. Service Activities
   American Legion, 1995- present.
   Serve on the Admissions Committee, ORE Department, 2010-present

9. Publications

10. Professional Development Activities

1. Name
Bruce M. Howe, Researcher

2. Education
Ph.D. Oceanography, Ocean Acoustic Tomography, 1986, University of California, San Diego
M.Sc. Engineering Science, Fluid Dynamics, 1978, Stanford University
B.Sc. Mechanical Engineering, Fluid Mechanics, 1978, Stanford University

3. Academic Experience
University of Hawaii
Ocean and Resources Engineering Department, School of Ocean and Earth Science and Technology
2010 – Chair of Department 2008 – Research Professor
University of Washington
Applied Physics Laboratory, College of Ocean and Fishery Sciences
1998 – 2008 Principal Oceanographer; 1992 Senior Oceanographer; 1987 Oceanographer
School of Oceanography, College of Ocean and Fishery Sciences
1994 – 2008 Research Associate Professor; 1988 Research Assistant Professor
Department of Electrical Engineering, College of Engineering
2005-2008 Adjunct Research Associate Professor
University of California, San Diego
1986-1987 Postgraduate Researcher, Institute of Geophysics and Planetary Physics
1981 – 1986 Research Assistant, Scripps Institution of Oceanography UniversiUit
Karlsruhe: 1979-1981 Research Associate, Institut fiir Hydromechanik
Stanford University: 1976-1979 Research Assistant, Department of Civil Engineering

4. Non-Academic Experience

5. Professional Registration
Acoustical Society of America
American Assoc. Advancement of Science
American Geophysical Union
American Meteorological Society
IEEE Oceanic Engineering Society
Marine Technology Society
The Oceanography Society (charter life member)

6. Memberships

7. Honors and Awards
Sigma Xi

8. Service Activities
2014- Acoustical Society of America, Honolulu 2016 Meeting, Technical Chair
2014- ITU/WMO/IOC Joint Task Force, SMART subsea cable systems for ocean and climate monitoring and disaster warning, Engineering Committee, Chair
2011 – International Science Advisory Board, Ocean Networks Canada, Member
2010 Expert Review of CTBTO Hydroacoustic Station Crozet Island, Member
1997-2008 NEPTUNE and ORION/OOI planning and technical activities

Reviewer for numerous journals:

Bulletin of the Am. Meteorological Society
Continental Shelf Research
Eos – Trans. Am. Geophys. Union
Geophysical Research Letters
Journal of Geophysical Research
Journal of Marine Research
Journal of Physical Oceanography
Journal of the Acoustical Society of America
Journal of the IEEE Oceanic Eng. Society
Marine Technology Society Journal
Measurement Science and Technology Ocean Engineering
Oceanography

Reviewer for marine related divisions of NSF and NASA, NOAA Ocean Exploration, Gulf of Mexico Research Initiative, The Oceanography Society Munk Award, Schmidt Ocean Institute

9. Publications (selected)

Chen, Y., B. M. Ho,ve, and C. Yang, Actively Controllable Switching for Tree Topology Seafloor Observation Networks, IEEE J. Oceanic Engineering, 10.1109/JOE.2014.2362830, 2014

B. M. Howe, A Deep Cabled Observatory: Biology and Physics in the Abyss, *Eos, Trans. AGU,* 95(47), 429-430,2014. DOl: 10.1002/2014E0470001

Song, H. C., B. M. Howe, M.G. Brown, and R. K. Andrew, Diversity-based acoustic communication with a glider in deep water, J. Acoust. Soc. Am. Express Letters, 135, 1023-1026, (2014), DOI:http:/ldx.doi.org/10.1121/1.4864299

Ardhuin, F., T. Lavanant, M. Obrebski, L. Marie, J. Y. Royer, J. F. d'Eu, B. M. Ho,ve, R. Lukas, and J. Aucan, A numerical model for ocean ultra low frequency (UFL) noise: wave-generated acoustic-gravity and Rayleigh modes, *J Acoust. Soc. Am.,134,* 3242-3259 (2013), DOI:http://dx.doi.org/10.1121/1.4818840.

Van Uffelen, L. J., E. M. Nosal, B. M. Howe, and G. S. Carter, P. F. Worcester, M.A. Dzieciuch, K. D. Heaney, R. L. Campbell, and P. S. Cross, Estimating uncertainty in subsurface glider position using transmissions from fixed acoustic tomography sources, *J Acoust. Soc. Am.,*134, 3260-3271 (2013), DOI:http:l/dx.doi.org/10.1121/1.4818841.

Howe, B. M., F. K. Duennebier, R. Butler, R. B. Lukas, Scientific uses of submarine cables: Evolutionary development leading to the ALOHA Cabled Observatory, Mains'l Haul, *1 Pacific Maritime History,* 48, 100-119,2012.

Bingham, B., N. Kraus, B. M. Howe, L. Freitag, K. Ball, P. Koski, and E. Gallimore, Passive and active acoustics using an autonomous wave glider, *J of Field Robotics,* DOl: 10.1002/rob.21424, 2012. Andrew, R.K., Howe, B. M., Mercer, J.A., Long-time trends in ship traffic noise for four sites off the North American West Coast, J. Acoust. Soc. Am., 129 (2), 642-651' 2011.

Howe, B. M., Y. Chao, P. Arabshahi, S. Roy, Tim McGinnis and A. Gray, A Smart Sensor Web for Ocean Observation: Fixed and Mobile Platforms, Integrated Acoustics, Satellites and Predictive Modeling, *IEEE J. Selected Topics in Earth Observations and Remote Sensing,* 3, 507-521, 20I0.

Howe, B. M., and T. Chereskin, Oceanographic Measurements, Springer Handbook of Experimental Measurements, Springer Berlin Heidelberg, Chapter 18, pp 1179-I2I7, DOl I0.1007/978-3-540-30299-5_18, 2007

10. <u>Professional Development Activities</u>

1.Name
Zhenhua Huang, Associate Professor

2.Education
Ph.D. in Environmental Fluid Mechanics, Massachusetts Institute of Technology, USA. 2004
M.E. in Environmental Fluid Mechanics, Tsinghua University, Beijing, China. 1991
B.S. in Applied Mechanics, Tsinghua University, Beijing, China. 1988

3.Academic Experience
Assistant Professor, Department of Ocean and Resources Engineering, School of Ocean and Earth Science and Technology, University of Hawaii at Manoa, January 2014-present.
Principal Investigator, Earth Observatory of Singapore (EOS). 2009-2014.
Assistant Professor, School of Civil and Environmental Engineering, Nanyang Technological University (NTU), Singapore, 2007-2014.
Visiting Assistant Professor, Hong Kong University of Science and Technology, Hong Kong, 2004-2007.

4.Non-Academic Experience

5.Professional Registrations

6.Membership in professional organizations
American Geophysical Union
American Coast and Education Society (CERF)
ITIC (International Tsunami Information Center) Tsunami Bulletin Board

7.Honors and Awards

8. Service Activities
Within the organization:
Member of the Undergraduate Research Opportunities Council, UH Manoa. 2014-2015.
Member of Curriculum Committee, School of Ocean and Earth Science and Technology, UH Manoa, 2014-present.
Member of Education and Outreach Committee, School of Ocean and Earth Science and Technology, UH Manoa, 2014-present.
Outside of the organization
Editorial Board member: Journal of Earthquake and Tsunami. January 2014-present.
Editorial Board member: China Ocean Engineering. January 2014-present.
International steering committee: Asian and Pacific Coasts (APAC), 2007-present

9. Publications
Fang He and Zhenhua Huang (2014). Hydrodynamic performance of pile-supported OWC-type structures as breakwaters: An experimental study. *Ocean Engineering.* Vol. 88, pp. 618-626.
Zhengzhi Deng, Zhenhua Huang and Adrian W.K Law (2014). Wave power extraction from a bottom-mounted oscillating water column converter with a V-shaped channel. *Proceedings of the Royal Society A.* Vol. 470 (2167). Article No. 20140074.

Jie Chen, Zhenhua Huang, Changbo Jiang, Bin Deng, Yuannan Long (2013). Tsunami scours at coastal roadways: a laboratory study. *Natural Hazards.* Vol. 69(1), pp. 655-674.

Zhengzhi Deng, Zhenhua Huang and Adrian W.K Law, 2013. Wave power extraction by an oscillating water column device supported by a semi-circular structure. *Applied Ocean Research.* Vol. 42, pp.ll4-123.

Zhenhua Huang, Tso-Ren Wu, Tzu-Yu Chen and Shawn Y. Sim and Yao Yao (2013). A possible mechanism of destruction of coastal trees by tsunamis: A hydrodynamic study on effects of coastal steep hills. *Journal of Hydro-Environment Research.* Vol. 7(2), pp. 113-123.

Binbin Li, Zhenhua Huang, Ying-Min Low and Jinping Ou (2013), Experimental and numerical study of the effects of heave plates on the motion responses of a new type of deep-draft multi-spar platform. *Journal of Marine Science and Technology.* Vol. 18(2), 229-246.

Fang He, Zhenhua Huang and Adrian Wing-Keung Law (2013). An experimental study of floating breakwater with asymmetric pneumatic chambers for wave energy extraction. *Applied Energy.* Vol. 106, pp. 222-231.

Erell-Isis Garniner, Zhenhua Huang, Chiang C. Mei (2012). Nonlinear long waves over a muddy beach. *Journal of Fluid Mechanics.* Vol. 718, pp 371-397.

Yu Yao, Zhenhua Huang, Stephen G. Monismith, and Edmond, Y. M. Lo, 2013. A laboratory study of characteristics of breaking waves over fringing reefs. *Journal of Coastal Research.* Vol. 29(1), pp.9-12.

Fang He, Zhenhua Huang, and Adrian Wing-Keung Law (2012). Hydrodynamic performance of a rectangular floating breakwater with and without pneumatic chambers: an experimental study. *Ocean Engineering.* 51, pp.l6-27.

Emma M. Hill, Jose C. Borrero, Zhenhua Huang, Qiang Qiu, Paramesh Banerjee, Danny H. Natawidjaja, Pedro Elosegui, Hermann M. Fritz, Ignatius Ryan, Linlin Lin, Kenneth A. Macpherson, Vassilis Skanavis, Costas E. Synolakis, and Kerry Sieh (2012). Very near-trench source ofthe October 2010 Mentawi tsunami earthquake. *Journal ofGeophysical Research.* Vol. 117. Article number B06402.

Yu Yao, Zhenhua Huang, Stephen G. Monismith and Edmond Y.M., Lo (2012). IDH Boussinesq modeling of wave transformation over fringing reefs. *Ocean Engineering.* Vol. 47, pp.30-42.

Chiang C. Mei, 1-Chi Chan, Philip L. F. Liu, Zhenhua Huang, and Wenbin Zhang (2011). Long waves through emergent coastal vegetation. *Journal of Fluid Mechanics.* Vol. 687, pp.461-491.

Zhenhua Huang, Yu Yao, Shawn Y. Sim and Yao Yao (2011). Interaction of solitary waves with emergent, rigid vegetation. *Ocean Engineering.* Vol. 38, Issue I0, pp. 1080-1088.

Zhenhua Huang*, Yucheng Li, Yong Liu, 2011. Hydraulic performance and wave loadings of perforated/slotted coastal structures: A review. *Ocean Engineering.* Vol. 38, Issue 10, pp. 1031-1053.

Zhenhua Huang and Zhida Yuan (2010). Transmission of solitary waves through slotted barriers: A laboratory study with analysis by a long wave approximation. *Journal of Hydro-Environment Research.* Vol. 3, pp.l79-185.

Chiang C. Mei, Mikhael Krotov, Zhenhua Huang, and Huhe Aode (2010). Short and long waves over a muddy seabed. *Journal of Fluid Mechanics.* Vol. 643, pp.33-58.

10. <u>Professional development activities</u>

Workshops: Faculty Mentoring Series, University of Hawaii at Manoa. 2014.

1. Name
Gerard C. Nihous, Associate Professor

2. Education
PhD. Ocean Engineering, University of California, Berkeley, 1983
M.S. Ocean Engineering, University of California, Berkeley, 1980
Diplome d'Ingenieur. Ocean Engineering, Ecole Centrale de Paris, 1979

3. Academic Experience

2009	Associate Professor, ORE, University of Hawaii
2004 - 2009	Associate Researcher, HNEI, University of Hawaii
2004- 2009	Cooperating Graduate Faculty, ORE, University of Hawaii
1993 - 2004	Affiliate Graduate Faculty, ORE, University of Hawaii
1996-1997	Visiting Professor, IDEC, Hiroshima University (Japan)
1980- 1983	Research Assistant, Dept. of Naval Architecture, UC Berkeley

4. Non-Academic Experience

1987-2003	Researcher and Program Manager, Pacific International Center for High Technology Research (PICHTR), Honolulu, Hawaii (1996-1997: on leave)
1983 - 1987	Researcher, Vega & Associates, Berkeley, California

5. Professional Registration

6. Professional Organizations
Marine Technology Society
American Society of Mechanical Engineers

7. Honors and Awards

8. Service Activities
ORE Committee Chair (Personnel, 2014; Responsible Conduct of Research; M.S. General Examination; Ph.D. Qualifying Examination; Outstanding Graduate Student Award; Web Page); ORE Committee Member (Faculty Search, 2012-2013); SOEST Committee Member (SOEST Young Investigator).
Reviewer for a dozen journals *(Nature Geoscience, Ocean Engineering, JOMAE, JGR, MTS Journal* etc.); Associate Editor for the *Journal of Ocean Engineering and Marine Energy* (2014); OMAE Conference Session Organizer (2010-2012 and 2014).

9. Publication
Nihous, G.C., "The Method of Imbedded Lagrangian Element to estimate wave power absorption by some submerged devices," *Journal of Marine Science and Application,* 13, 134-142,2014.
Nihous, G.C., "Maximum wave power absorption by slender bodies of arbitrary cross sections in oblique seas," *Applied Ocean Research,* 47, 17-27, 2014.

Rajagopalan, K. and G.C. Nihous, "Predictions of water-column properties under widespread artificial upwelling scenarios in the North Pacific Subtropical Gyre using an Ocean General Circulation Model," *Journal of Marine Environmental Engineering*, 9, 285-304, 2014.

Rajagopalan, K. and G.C. Nihous, "An Assessment of global Ocean Thermal Energy Conversion Resources under broad geographical constraints," *Journal of Renewable and Sustainable Energy*, 5, 063124, 11 p., 2013.

Nihous, G.C., "Maximum wave power absorption by flexible line attenuators," *Applied Ocean Research*, 43, 68-70, 2013.

Rajagopalan, K. and G.C. Nihous, "An assessment of Global Ocean Thermal Energy Conversion (OTEC) resources with a high-resolution Ocean General Circulation Model," *Journal of Energy Resources Technology*, 135, 041202, 9 p., 2013.

Rajagopalan, K. and G.C. Nihous, "Estimates of global Ocean Thermal Energy Conversion (OTEC) resources using an Ocean General Circulation Model," *Renewable Energy*, 50, 532-540, 2013.

Nihous, G.C.: Chapter 16: OTEC in "Handbook of Energy," World Scientific Publishing Company, G.M. Crawley ed., 359-372, 2013.

Jia, Y., G.C. Nihous and K.J. Richards, "Effects of Ocean Thermal Energy Conversion systems on near and far field seawater properties- A case study for Hawaii," *Journal of Renewable and Sustainable Energy*, 4, 063104, doi: 10.1063/1.4766820, 13 p., 2012.

Nihous, G.C., "Wave power extraction by arbitrary arrays of non-diffracting oscillating water columns," *Ocean Engineering*, 51, 94-105, 2012.

Nihous, G.C. and M. Gauthier: Chapter 12: Ocean Thermal Energy Conversion: a historical perspective: in "Marine Renewable Energy Handbook," B. Multon ed., ISTE, John Wiley & Sons, ISBN: 9781848213326,367-401,2011.

Nihous, G.C., "Gulf of Mexico aftermath," *Nature Geoscience*, 4, 141-142,2011.

Nihous, G.C., "A discussion of endoreversible engines at maximum output," *Fundamental Journal of Thermal Science and Engineering* 1(2), 73-81, 2011.

Nihous, G.C., "Assessment of the evolution of water-column stratification following the hypothetical implementation of widespread controlled upwelling in the North Pacific Subtropical Gyre," *Journal of Marine Environmental Engineering*, 9(3), 175-189, 2011.

Nihous, G.C., "Mapping available Ocean Thermal Energy Conversion resources around the main Hawaiian Islands with state-of-the-art tools," *Journal of Renewable and Sustainable Energy* 2, 043104, doi:10.1063/1.3463051, 9 pp., 2010.

Nihous, G.C., K. Kuroda, J.R. Lobos-Gonzalez, R.J. Kurasaki, and S.M. Masutani, "An analysis of gas hydrate dissociation in the presence of thermodynamic inhibitors," *Chemical Engineering Science* 65, 1748-1761, 2010.

10. Professional Development Activities

- Participation in the establishment of the U.S. Department of Energy's Hawaii National Marine Renewable Energy Center (Principal Investigator for subaward grants totaling $0.7M over 5 years)
- Collaboration in British Petroleum's Gulf of Mexico Research Initiative (Principal Investigator for sub-award grants totaling $0.1Mover 3 years)
- Active research on the environmental aspects of Ocean Thermal Energy Conversion (OTEC), with a $0.15M grant from Lockheed Martin Corporation

1. Name
   Eva-Marie Nosal, Associate Professor

2. Education
   PhD 2007 Geology and Geophysics, University ofHawai'i at Manoa (SOESTIUH)
   MSc 2003 Applied Mathematics, University of British Columbia (UBC)
   BSc 2000 Pure Mathematics (first class honors) University of Calgary (UofC)
   BSc 2000 Applied Mathematics (first class honors), UofC
   BMus 2000 Piano Performance (with distinction), UofC

3. Academic experience:
   2014 - pres. Associate Professor with tenure, Ocean & Resources Eng., University of Hawaii
   2008- 2014 Assistant Professor, Ocean & Resources Eng., University of Hawaii
   2008/01-07 Assistant Researcher, Geology & Geophysics, University of Hawaii
   2004 Teaching Assistant, Geology & Geophysics, University of Hawaii
   2003-2007 Research Assistant, Geology & Geophysics, University of Hawaii
   2001-2002 Research Assistant, Mechanical Engineering, University of British Columbia
   2000 Teaching Assistant, Math & Stats, University of British Columbia
   1998-2000 Teaching Assistant, Math & Stats, University of British Columbia
   1998-2000 Research Assistant, Math & Stats, University of Calgary

4. Non-academic experience
   2010 - pres. President and Senior Scientist, Abakai International LLC
   1995-2002 Analyst, Modeler, Programmer, STATSCON Statistical Consulting
   1993-2005 Private tutor, University math and physics, piano performance, and composition

5. Certifications or professional registration
   ACUC Openwater SCUBA (1990); NAUI CPR &First Aid, Master Diver, Rescue Diver, NITROX Diver (2010); DAN Oxygen Administrator (2010); UH Scientific Diver (2010)

6. Membership in professional organizations
   Acoustical Society of America, Institute of Electrical and Electronics Engineers, Society for Marine Mammalogy, Marine Technology Society

8. Service activities
   Reviewer for: Applied Acoustics, Acoustics Australia, IEEE Journal of Ocean Engineering, IEEE Transactions on Audio, Speech and Language Processing, Journal of the Acoustical Society of America, Marine Technology Society Journal. Ocean Engineering, National Oceanographic Partnership Program, WHOI Seagrant, Marine Georesources & Geotechnology.
   Expert advice given: NSF Alaska Region Research Vessel, ARRV (2008)
   UH committees served (S=Spring, F=Fall): ORE faculty search (S12, co-Chair); ORE student admissions (S10- S12 as member, F12-pres. as Chair); SOEST curriculum (F08-pres.); ORE PhD qualifying exam (F09-pres.); SOEST open house (Fl1); SOEST Research Computing (S10); UH Manoa Green Days (F09); ORE ABET accreditation (S09, S15); ORE

secretary search (S08); ORE faculty search (F08); SOEST young investigator search (F08); GO curriculum (F07); GO relations and honors (F06-S07).

Other committees served: Acoustical Oceanography Local Organizing Committee, Acoustical Society of America (2011-pres.)

Outreach: Underwater acoustics demos at SOEST Open House (biennially, 2005-pres.). HEAR lab high school student volunteer program (2010-pres.). MATE Hawaii Underwater Robot Challenge, Judge (2011- pres.).

9. Publications (last 5 years, refereed journal paper unless otherwise indicated, *denotes student)

Gemba* K, Nosal E-M, Reed T (2014). Partial dereverberation used to characterize open circuit scuba diver signatures. JASA 136(2), 623-633.

Nosal E-M (2013). Chapter 8: Model-based marine mammal localization methods. In: Eds. **O** Adam and F Samaran, Detection Classification and Localization of Marine Mammal using Passive Acoustics-10 years of progress. Dirac NGO, Paris (Invited book chapter)

VanUffelen L, Nosal E-M, Howe B, Carter G (2013). Estimating uncertainty in subsurface glider position using transmissions from fixed acoustic tomography sources. JASA 134(4) Pt.2, 3260-3271

Nosal E-M (2013). Methods for tracking multiple marine mammals with wide-baseline passive acoustic arrays. JASA 134(3), 2383-2392.

Young* J, Host-Madsen A, Nosal E-M (2013). Impulsive source separation with application to sperm whale clicks, Proceedings of the 2013 IEEE Digital Signal Processing workshop, Napa California (peer-reviewed conference paper)

Stimpert AK, Mattila D, Nosal E-M, Au WWL (2012). Tagging young humpback whale calves: Methodology, dive behavior, and acoustics. Endangered Species Res. 19, 11-17.

Duennebier F, Lukas R, Nosal E-M, Aucan J, Weller R (2012). Wind, waves, and acoustic background levels at Station ALOHA. Journal of Geophysical Research. 117, 21 pages, C03017, doi:I0.1029/2011JC007267

Fedenczuk T, Nosal E-M (2011). Hawaii experimental acoustics range (HEAR) for shallow water applications. Journal of the Marine Technology Society 45(3), 69-76.

I0. Professional development activities

2015/01-06 Sabbatical

1. Name
John C. Wiltshire, Specialist

2. Education
Ph.D. Geological Oceanography, University of Hawaii, 1983
B.Sc. Geology, Carleton University, Ottawa, Canada, 1976

3. Academic Experience

2010-present	Associate Chairman, ORE, University of Hawaii
2002 - present	Director, Hawaii Undersea Research Lab, University of Hawaii
2007-2010	Chairman, ORE, University of Hawaii
1999-2007	Associate Professor, ORE, University of Hawaii
1990-2002	Associate Director, Hawaii Undersea Research Lab (HURL)
1986 - 1990	Senior Researcher, HURL, University of Hawaii

4. Non-Academic Experience

1973-1978	Mining Geologist working field seasons for major oil and mining companies (Noranda, Union, Chevron, Mclntryre)
1983-1986	Ocean Resources Manager, State of Hawaii
1993-2013	Engineering Consultant (PT)- TCI Hawaii -mine tailings

5. Certifications
1985 - Certificate in public management from Hawaii Institute of Management and Analysis in Government (HIMAG) for courses given to senior State Government Managers

6. Professional Organizations
- Marine Technology Society
- International Marine Minerals Society (IMMS)
- Society of Mining, Metallurgy and Exploration (SME)
- Offshore Technology Conference Program Committee (OTC)
- Pacific Congress on Marine Science and Technology (PACON)

7. Honors
President's Citation Award -Society for Mining, Metallurgy and Exploration, 2011
Elected Fellow of the Marine Technology Society and PACON

8. Service Activities
School of Ocean Earth Science and Technology Executive Committee Member; ORE Committee Member (ABET Committee Chair 2007-2016, ORE Executive Committee); SOEST Ship Committee Member, Board of Directors ofiMMS and PACON, MTS Council, Advisor MTS UH student section, Chair SME Marine Mining and OTC Committees, OTC Program Committee
Reviewer for a half dozen journals *(MTS, Ocean Engineering, Geological Society of America OTC.* etc.)

9. Publications

1. Bai, Z., Z. Wen and J.C. Wiltshire, 2008, Marine mineral tailings use in anticorrosive coatings, *Proceedings of the OCEANS 2008 MTSIIEEE QUEBEC Conference*, 15-18 September 2008, Quebec City, Canada.
2. Lay, G.F.T., M.C. Rockwell and J.C. Wiltshire, 2009, Investigation of the Properties of a Borosilicate Glass From Recycled Manganese Crust Tailings, *Journal of Characterization and Development of Novel Materials*, v.l, n.3, p.225-240.
3. Wiltshire, John C., 2010, OCEANS '11 MTS/IEEE Kona: Oceans of Opportunity: International Cooperation and Partnerships Across the Pacific, *Marine Technology Society Journal*, v.44, n.4, p.6-7.
4. Bai, Z., Z. Wen and J.C. Wiltshire, 2015, Anticorrosive coatings prepared using the tailings of cobalt-rich manganese crusts: Preparation and properties, *Marine Georesources and Geotechnology*, (in review).
5. Fan, Wei, Chen Y., Liu, Clark and J.C. Wiltshire, 2015, Hydrodynamic design of deep ocean water effluent discharge for the creation of a nutrient-rich plume in the South China Sea, *Journal of Atmospheric and Oceanic Technology* (in press).
6. Wiltshire J.C., 2016, Special Issue on Marine Mineral Developments with guest editorial, *Marine Georesources and Geotechnology*.

10. <u>Professional Development Activities</u>

1. International Marine Minerals Society (IMMS) - Member of the Executive Board and Treasurer.
2. Marine Technology Society (MTS)- Chairman, Mineral Resources Professional Committee; Society Fellow.
3. OCEANS Conference- General Chairman for *OCEANS '11 MTSIIEEE Kona*, the international conference on the Big Island of Hawaii in Sept 2011 with an attendance of 1500. Conference highlighted the latest technical developments in the ocean industry and research.
4. Society for Mining, Metallurgy and Exploration (SME) - Chairman, Special Committee for Offshore Technology (OTC), which provides organizational input to the annual Offshore Technology Conference (the world's largest offshore technology conference held annually in Houston) for which I am also on the program committee, 2005-present; founding member U.S. Energy Policy Coalition sponsored by SME, head of SME marine mining committee,
5. Pacific Congress on Marine Science and Technology and PACON International - 1984- present; Founding member, Treasurer, Chairman of PACON '99 Moscow, Board of Directors, elected Society Fellow in 2006.
6. Organizer and Instructor, Toho University (Chiba, Japan) Environmental Field Program in conjunction with Outreach College, University of Hawaii- held annually 2008-

2014. The program also involves a week of lectures in Japan where I serve as Adjunct Professor.

7. Editor-in-Chief, *Marine Georesources and Geotechnology* (international journal), selected in 2015 by publisher Taylor and Francis for a major publicity campaign as one of its most improved journals.
8. Deep Submergence Science Committee (DESSC) of UNOLS - Member since 2011, examines needs for U.S. deep submergence.

APPENDIX B: COOPERATING FACULTY

1. Name and Academic Rank
Janet M. Becker, Associate Professor

2. Education
Ph.D. University of California, San Diego, Scripps Institution of Oceanography, 1989
B.S., University of California, San Diego, Physics (summa cum laude), 1983

3. Academic experience
15 years; Original appointment: 1994; Tenured: 2001
Assistant Professor, Department of Geology and Geophysics, University of Hawaii, 1997 – 2001.
Assistant Research Oceanographer, Scripps Institution of Oceanography, University of California, San Diego, 1993.
Lecturer, Department of Applied Mechanics and Engineering Science, University of California, San Diego, 1992-1993.
Postdoctoral Fellow, Scripps Institute of Oceanography, University of California, San Diego, 1991 – 1993.
Research Associate, Department of Mathematics, University ofNew South Wales, Australia, 1989-1991.

4. Non-academic Experience: none

5. Certification or professional registration: none

6. Membership of Scientific and Professional Societies
American Physical Society -DFD
American Geophysical Union

7. Honors and Awards
National Science Foundation Mathematical Science Postdoctoral Research Fellowship, 1991-1993
Geophysical Fluid Dynamics Fellowship, WHOI, 1985
National Science Foundation Graduate Fellowship, 1984-1987
Outstanding Physics Major, Revelle College, 1983

8. Service Activities
Undergraduate thesis advisor:
Hyang Yoon, GES Senior Thesis, "Low Frequency modes on two fringing reefs: Observations and dynamics", May 2013 (now at UPenn for PhD).
Graduate thesis/dissertation advisor:
Svetlana Natarov, PhD student, GG, 2012-present.

Anne Christine Pequignet, PhD student, Oceanography, PhD, 7/2012
"Transformation of wave energy across the fringing reef of Ipan, Guam"
(postdoc at UWA).
Selected Student Committee Service:
Geology and Geophysics: Svetlana Port (PhD), Arjun Aryal (PhD, 2013)
Civil Engineering: Nathan Shimabuku (MS, 2012), Hongqiang Zhou (PhD, 2008)
Mechanical Engineering: Tyler Hee Wai (MS, 2014) Oceanography:
Saulo Soares (PhD, 2015), Adam Jenkins (MS, 2014. ORE: Austin
Barnes (MS 2013)
Selected University Committee Service
ORE: DPC, 2008,2010
ME: DPC, 2008 (4 faculty evaluated for promotion and/or tenure)
GG: 2010-11: Departmental Committee (Chair), Bullard Fellowship Committee (Chair)
2011-12: Graduate Admissions (Chair), Bullard Fellowship Committee (Chair)
2012-2013, Graduate Admissions (Chair), Bullard Fellowship Committee
2013-2014, Graduate Admissions (Chair), Bullard Fellowship Committee
2014-present, Graduate Admissions (Chair), Bullard Fellowship Committee, GT Division head.
UH Manoa: TPRC chair, 2012.
National Service: NSF Panel Member (2009,2010,2011,2012,2013, 2015), Referee for NSF-DMS, NSF-OCE, Referee for Nonlinear Dynamics, JGR, Physics of Fluids, International Journal of Solids and Structures, Coastal Engineering Journal.
International: Referee for CUP (2014), Referee for FONDECYT (2012)

9. Publications of Last Five Years

Merrifield, M.A., J. M. Becker, M. Ford, andY. Yao (2014), Observations and estimates of wave-driven water level extremes at the Marshall Islands, Geophys. Res. Lett., 41, 7245-7253, doi:10.1002/2014GL061 005.
Pequignet, A.-C. N., J. M. Becker, and M.A. Merrifield (2014), Energy transfer between wind waves and low-frequency oscillations on a fringing reef, Ipan, Guam, J. Geophys. Res. Oceans, 119,6709-6724, doi:10.1002/2014JC010179.
Becker, J. M., M.A. Merrifield, and M. Ford (2014), Water level effects on breaking wave setup for Pacific Island fringing reefs, J. Geophys. Res. Oceans, 119, 914-932, doi:10.1002/2013JC009373.
Ford, M, J.M. Becker, M.A. Merrifield, and Y.T. Song, Marshall Islands Fringing Reef and Atoll Lagoon Observations of the Tohoku Tsunami, 2013, PAGEOPH, 1-13.
Ford, M.R., J.M. Becker and M.A. Merrifield, Reply to: Payo, A. and Munoz-Perez, JJ, 2013, Discussion of Ford, MR; Becker, JM, and Merrifield, MA, 2013, Reef Flat Wave Processes and Excavation Pits: Observations and Implications for Majuro Atoll, Marshall Islands, J. of Coastal Research, 29(3):545-554, J. Coastal Res, 29(5) 1241-1246.
Ford, MR, J.M. Becker, and M.A. Merrifield, Reef flat wave processes and excavation pits: Observations and implications for Majuro Atoll, Marshall Islands, 2012, J. Coastal Res., 29(3):545-554. (2nd author with postdoc 1st author).

10. Institutional and Professional Service in the Last 5 Years

1. Name
   Brian S Bingham

2. Education – degree, discipline, institution, year

Ph.D.	ME, Massachusetts Institute of Technology	2003
M.S.	ME, Massachusetts Institute of Technology	1998
B.S.	ME, Massachusetts Institute of Technology	1996

3. Academic experience

• University of Hawaii at Manoa	Associate Professor	2013- Present	Full time
• University of Hawaii at Manoa	Assistant Professor	2009-2013	Full time
• Franklin W. Olin College of Engineering	Assistant Professor	2005-2008	Full time

4. Non-academic experience

• Axis Engineering Technologies	Vice President	2007-2012	Part time

5. Certifications or professional registrations: None

6. Current membership in professional organizations
- IEEE, Marie Technology Society.

7. Honors and awards
- Northrop Grumman Excellence in Teaching Award 2011-2012.
- Hi Chang Chai Excellence in Teaching Award, University of Hawaii, College of Engineering, 2010 and 2013.
- Selected by the National Academy of Engineering as one of nation's top fifty three most innovative young engineering educators to participate in the Frontiers of Engineering Education Symposium, Dec. 13-16,2010.
- Outstanding Young Alumni Award, Greenwood Laboratory School, 2011.

8. Service activities (within and outside of the institution)
- College Committees: Research, Curriculum, ABET, Faculty search
- SAE, SAMPE, and SAME FacEditor, Marine Technology Society (MTS) Journal 2010-2011.
- Editorial Board Member, Marine Technology Society (MTS) Joumal2011-2014.
- Guest Editor, IEEE/AMSE Transactions on Mechatronics, Special Issue on Marine Mechatronic Systems, February, 2012.
- Local Organizing Committee, Website Chair, MTS/IEEE OCEANS Conference, Kona, HI, 2011.
- Session Chair, MTS/IEEE OCEANS Conference (2011, 2009, 2008) and IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) (2009).
- Publication Reviewer: IEEE International Conference on Robotics and Automation, IEEE Journal of Oceanic Engineering, IEEE Robotics and Automation Magazine, IEEE/RSJ

International Conference on Intelligent Robots and Systems, IEEE Journal of Mechatronics, Ocean Dynamics Journal and Journal of Field Robotics.

- Proposal Reviewer: NSF, Ocean Technology and Interdisciplinary Coordination; NSF, National Robotics Initiative; NOAA, Office of Ocean Exploration; and NOAA, National Sea Grant Office.ulty Advisors; ASME Faculty Advisor (1992-2012)

9. Briefly list the most important publications/presentation last 5 years

- J. Chen, W. Fan, B.Bingham, Y. Chen, L. Gu and S. Li, "A long gravity-piston corer developed for seafloor gas hydrate coring utilizing an in situ pressure-retaining method," Energies, vol. 6, no. 7, pp. 3353-3372, 2013.
- B. Bingham, N. Kraus, B. Howe, L. Freitag, K. Ball, P. Koski and E. Gallimore, "Passive and active acoustics using an autonomous wave glider," Journal of Field Robotics, 29(6), 911-923, 2012.
- B. Bingham, J. M. Walls, R. M. Eustice, "Development of a flexible command and control software architecture for marine robotic applications", Marine Technology Society (MTS) Journal, vol. 45, no. 3, pp. 25-36, 2011.
- B. Bingham, "Estimating system-level uncertainty for underwater navigation incorporating acoustic ranging and dead reckoning," Journal of Ocean Technology, vol. 6, no. 2, 2011.
- B. Bingham, B. P. Foley, H. Singh, R. Camilli, K. Delaporta, R. Eustice, A. Mallios, D. Mindell, C. Roman, D. Sakellariou, "Robotic Tools for Deep Water Archaeology: Surveying an Ancient Shipwreck with an Autonomous Underwater Vehicle", Journal of Field Robotics, vol. 27, no 6, pp. 702-717, 2010.
- A. Sylvester, J. Delmerico, A. Trimble and B. Bingham, "Variable Buoyancy Control for a Bottom Skimming Autonomous Underwater Vehicle," Proceedings of the MTS/IEEE Oceans Conference, 2014.
- S. Li, Y. Guo and B. Bingham, "Multi-robot Cooperative Control for Monitoring and Tracking Dynamic Plumes," IEEE International Conference on Robotics and Automation (ICRA), May 31 -June 5, 2014.
- V. Howard, J. Mefford, L. Arnold, B. Bingham and R. Camilli, "The unmanned port security vessel: an autonomous platform for monitoring ports and harbors," Proceedings of the MTS/IEEE Oceans Conference, 2011.
- N. Kraus and B. Bingham, "Estimation of wave glider dynamics for precise positioning," Proceedings of the MTS/IEEE Oceans Conference, 2011.
- M. Cai, B. Bingham, "Passive acoustic detection of a small remotely operated vehicle", Proceedings of the IEEE Oceans Conference, 2011.
- M. Cai, I. Sou, C. Layman, B. Bingham and J. Allen, "Characterization of the acoustic signature of a small remotely operated vehicle for detection," Proceedings of the MTS/IEEE Oceans Conference, Sept. 2010.

10. Briefly list the most recent professional development activities: none

1. Name and Academic Rank

Monique Chyba, Full Professor

2. Degrees with fields, institution, and date

1997, Ph.D., University of Geneva, Switzerland
1993, M.S., University of Geneva, Switzerland
1989, B.S., Technicum of Geneva, Switzerland

3. Academic Experience:

2002-	University of Hawai'i, Honolulu	Full Professor (12-) Associate Professor (06-11) Assistant Professor (02-06)
2000-2002	University of California, Santa Cruz	Visiting AssistantProfessor
1999-2000	Princeton University	Research Assistant
1999	INRIA French Institute	Research Visitor
1998	Harvard University	Research Visitor
1997	University of Paris VI (France)	Research Fellow

4. Non-academic experience: company name, position, describe position

None

5. Certification or professional registrations

None

6. Current membership in professional organizations

7. Honors and awards

1. Recipient of the Science and Lectureship Award from Chiba University in December 2014 for contributions to applied mathematics.
2. NSF, Grant #1109937, Division ofMathematical Sciences, $199,984.2011 -2015.
3. NSF, Grant #0841223, Division of Graduate Education, $2,841,335. 2009- 2015.
4. Regents' Medal for Excellence in Teaching, UH Manoa 2008. Nominated in 2012 (but past recipients are not eligible a second time).
5. NSF, Grant #0608583, Division of Mathematical Sciences, $155,157. 2006-2009.
6. NSF, Grant #0306141, Division of Mathematical Sciences, $248,441. 2003 –2007.
7. Diversity and Equity Initiative, UH-Manoa (each award amount around $2,000) Oct. 2007, Oct. 2008, Oct. 2009, Oct. 2010, Jan. 2011, Oct. 2013.

8. Service activities (within and outside of the institution)

- Member of the editorial board for Ocean Engineering. Associate Editor for Acta Applicandae Mathematicae and Pacific Journal of Mathematics for Industry. Reviewer for many journals in Mathematics and in Engineering.

- Head of Outreach educational programs: Robo-Nemo and Stomp-Hawaii. Director of the School and University Partnership for Educational Renewal in Mathematics program.
- Member of several committees with the math department (Graduate Committee, Advisory committee, etc.). Member of a several TPRC panel sat UH.

9) Principal publications ofthe last five years: 2010-2015

1. (With G. Patterson, G. Picot, M. Granvik, R. Jedicke, J. Vaubaillon), Designing Rendez-vous Missions with Mini-Moons using Geometric Optimal Control, Journal of Industrial and Management Optimization, Volume 10, Issue 2, pp. 477-501 (2014).
2. (With B. Bannard, A. Jacquemard, J. Marriott) Algebraic geometric classification of the singular flow in the contrast imaging problem in nuclear magnetic resonance. Mathematical Control and Related Fields-AIMS, Special issue in the honor of Bernard Bannard. Part II., Vol 3(4), pp. 397-432 (2013).
3. (With B. Bannard, J. Marriott) Singular Trajectories and the Contrast Imaging Problem in Nuclear Magnetic Resonance. SIAM J. Control Optim., 51(2), pp. 1325-1349 (2012).
4. (With M. Kobayashi, F. Mercier, J. Rader, A. Tamura-Sato, G. Telleschi, Y. Kwon) A new Approach to Modeling Morphogenesis Using Control Theory, Special volume of the Sao Paulo Journal of Mathematical Sciences in honor of Prof. Waldyr Oliva, pp. (2012).
5. (With A. Sanyal, N. Nordkvist) An almost global tracking control scheme for maneuverable autonomous vehicles and its discretization, IEEE Transactions on Automatic Control, vol. 56(2), pp. 457-462 (2011).

10) Most recent professional development activities

Guest Editor, Special Issues: 1. Control and Observation ofNonlinear Control Systems with Application to Medicine, Acta Applicandae Mathematicae. In press 2014. 2. 60th Birthday of Bernard Bannard, Mathematical Control and Related Fields-AIMS, Volume 3. September 2013. Co-organizer: Forum "Math-for-Industry" 2011 "TSUNAMI- Mathematical Modeling" Using Mathematics Natural Disaster Prediction, Recovery and Provision for the Future (with Japan Ministry of Education, Science and Culture, Global COE Program "Education and Research Hub for Mathematics-for-Industry") East-West center 2011. Co-organizer: Workshop for 60th Birthday of Bernard Bannard, University ofDijon, June 2012. Organizer: Workshop on Control and Observation ofNonlinear Control Systems with Application to Medicine, 2013, University ofHawai'i at Manoa, Department of Mathematics.

1. Name
   Reza Ghorbani

2. Education-degree, discipline, institution, year

Ph.D.	Mech. Eng.,	University of Manitoba, Winnipeg, Canada	5/2008
M.S.	Mech. Eng.	Sharif University of Technology, Tehran, Iran	8/2002
B.S.	Mech. Eng.	Sharif University ofTechnology, Tehran, Iran	8/2000

3. Academic experience-institution, rank, title (chair, coordinator, etc. if appropriate), when (ex. 1990-1995), full time or part time

• University of Hawaii at Manoa	Associate Professor	Jul2014- Present	Full time
• University of Hawaii at Manoa	Assistant Professor	Aug 2008- Jul2014	Full time

4. Non-academic experience-company or entity, title, brief description of position, when (ex. 1993-1999), full time or part time

• President, SmartGrid Corporation	1/2015 – Present	Part time

5. Certifications or professional registrations: None

6. Current membership in professional organizations None

7. Honors and a\vards
   - National Science Foundation, AIS: Collaborative Research: A Novel Intelligent Grid Optimization Architecture Using Hierarchical Multi-Agent Framework for Modem Sustainable Power Grid, PI, $315,508, 2013-2016.
   - Electric Vehicle Transportation Center, US Department 0f Transportation, Co-PI, $1,950,000, 2013-2017. http://evtc.fsec.ucf.edu/about/index.html
   - Grid Engineering for Accelerated Renewable Energy Deployment, Department of Energy, Co-PI, $60,000,2013-2014.
   - National Science Foundation, Workshop on Fundamental Research and Technology in Wave and Hydrokinetics Power Systems, PI, 20 II, $33,160.
   - Travel Support for Student Program at Oceans 2011 Conference, Office of Naval Research, PI, 20II, $51,450.
   - UHM sustainability program award, Co-PI, 2010-2012,$1.0 Million.
   - Fuel Cell Testing, HNEI-Office of Naval Research, Co-Investigator 2009-20 II, $55,688.
   - Heet Initiative Phase II, HNEI-Office ofNaval Research, Co-Investigator 2009-2013, $62,950.
   - NSERC Postdoctoral Fellowship, 2008-2010, $80,000.
   - Donald M. Stephen's Memorial Award in Power Systems, 2008, $8000.
   - NSERC/JSPS Postdoctoral Fellowship, 2007-2009, $80,000.
   - University of Manitoba Graduate Fellowship, 2004-2007, $48,000.
   - Edward Toporeck Engineering Fellowship, 2006, $4000.
   - World Champion (together with the University of Manitoba Team) in the International Unmanned Aerial Vehicle Competition, Maryland, USA, 2006.
   - Edward Toporeck Engineering Fellowship, 2004, $4000.
   - Winner of the Best Engineering Challenge Award (together with Sharif CE Team), Soccer Player Robot Competitions, Seattle, 2001.
   - yd place in the International Middle Size Soccer Player Robot Competitions (together with Sharif CE Team), Melbourne, 2000.
   - Europe Champion in the European Middle Size Soccer Player Robot Competitions (together with SharifCE Team), Amsterdam, 1999, SI0,000 EUR.
   - Award of Research Excellence, The Minister of Education and Training, IRAN, 1999.
   - Award of Research Excellence, The Minister oflndustries, IRAN, 1999.
   - Award of Research Excellence, The Chancellor of Sharif University of Technology, 1999.

- World Champion in the International Middle Size Soccer Player Robot Competitions (together with SharifCE Team), Stockholm, 1999.

8. Service activities (within and outside of the institution)

- Reviewer of Journal Papers in robotics, power systems, intelligent systems

9. Briefly list the most important publications and presentations from the past five years -title, co-authors if any, where published and/or presented, date of publication or presentation

- E. Kamal, A. Aitouche, R. Ghorbani and M. Bayart. Fuzzy Scheduler Fault-Tolerant Control for Wind Energy Conversion Systems. IEEE Transactions on Control Systems Technology, 22 (1), 119-131, 2014.
- Sepasi, S. Ghorbani, R., and Liaw, B. Y., A Novel On-Board State of Charge Estimation Method for Aged Li-ion Batteries Based on Model Adaptive Extended Kalman Filter, Journal of Power Sources, 245 (I), 337-344,2014.
- Sepasi, S. Ghorbani, R., and Liaw, B. Y., Improved extended Kalman filter for state of charge estimation of battery pack, Journal of Power Sources, 255 (1), 368-376, 2014.
- E. Kamal, A. Aitouche, R. Ghorbani and M. Bayart. Robust Fuzzy Logic Control of Wind Energy Conversion Systems. International Journal of Electrical Power and Energy Systems. Vol.44, no.1, 202-209,2013.
- Kamal, Elkhatib, Mohamad, Oueidat, Aitouche, Abdelouahab, Ghorbani, Reza, Robust Scheduler Fuzzy Controller of DFIG Wind Energy Systems. IEEE Transactions on Sustainable Energy 4 (3), 706-715,2013.
- Schwarzer, V., and Ghorbani, R., Drive Cycle Generation for Large-Scale Optimization of Electric Vehicles. IEEE Transactions on Vehicular Technology, Vol. 62, (1), pp. 89-97,2013.
- E. Kamal, A. Aitouche, R. Ghorbani and M. Bayart. Robust Fuzzy Logic Control of Wind Energy Conversion Systems with Unknown Inputs. Acta Press, International Journal Power and Energy Systems. Vol. 32, no.2, 2012.
- Kamal, Elkhatib, Aitouche, Abdelouahab, Ghorbani, Reza & Bayart, Mireille, Robust, Fuzzy Fault-Tolerant Control of Wind Energy Conversion Systems Subject to Sensor Faults. IEEE Transactions on Sustainable Energy 3 (2), 231-241, 2012.
- Kamal, Elkhatib, Aitouche, Abdel, Ghorbani, Reza & Bayart, Mireille, Intelligent Control of WECS Subject to Parameter Uncertainties, Actuator and Sensor Faults. Control and Intelligent Systems 40 (3), 1-9,2012.
- Ghorbani, R., Bibeau, E., and Filizadeh, S. On Conversion of Hybrid Electric Vehicles to Plug-ln. IEEE Transactions on Vehicular Technology, V59, Issue 4, pp. 2016-2020,2010.
- Ghorbani, R., and Wu, Q., On Improving Bipedal Walking Energetics Through Adjusting the Stiffness of Elastic Elements at the Ankle Joint. The International Journal of Humanoid Robotics, Vol. 6, No. I, 2009.
- Ghorbani, R., and Wu, Q., Conceptual Design of the Adjustable Stiffuess Artificial Tendons for Legged Robotics. Mechanism and Machine Theory, Vol. 44, No. 1, pp. 140-161,2009.
- Ghorbani, R., Wu, Q., and Wang, G. G., Nearly optimal neural network stabilization of bipedal standing using genetic algorithm. Engineering Applications of Artificial Intelligence. Vol. 20, No. 4, pp. 473-480, 2007.

- Briefly list the most recent professional development activities
- Organized: Smartgrid Workshop at the UH Manoa, April. 13-17,2015

1. BRYANT. GLAZER
PhD, Associate Professor of Oceanography

2. Education

Pennsylvania State University	Biology	B.S. (1997)
University of Delaware	Marine Studies	M.S. (2000)
University of Delaware	Marine Studies	Ph.D. (2004)

3. Academic experience

UH Department of Oceanography, Associate Professor	2011-present
Hanse-Wissenschaftskolleg Fellow, Delmenhorst, Germany	2012-2013
UH Department of Oceanography, Assistant Professor	2006-2011
UH Department of Ocean and Resources Engineering, Cooperating Graduate Faculty	2007-present
UH NASA Astrobiology Institute, Postdoctoral Fellow	2004-2006
University of Delaware College of Marine Studies, Research Assistant	1997-2004

4. Non-academic experience

5. Certifications or professional registrations

6. Current membership in professional organizations
American Association for the Advancement of Science (AAAS); American Chemical Society (ACS); American Geophysical Union (AGU); American Society of Limnology and Oceanography (ASLO); Geological Society of America (GSA)

7. Honors and a'vards
University of Hawaii University Research Council Faculty Travel Fund Award, 2008
University of Hawaii NASA Astrobiology Institute Postdoctoral Fellowship, 2004-2006
University of Delaware Graduate College of Marine Studies E. Sam Fitz Award, in recognition of student displaying greatest aptitude for professional development in marine studies, 2005

8. Service Activities
Deep submergence fieldwork: Participated in 21 UNOLS research cruises, 11 DSV *Alvin* dives, 1 DSV *Pisces V* dive, 7 DSV *Jason*-II cruises, since 2000.

Reviewer: NSF Chemical Oceanography, NSF Ocean Technology & Interdisciplinary Coordination, NSF ODP, NSF MOO, NSF RIDGE, NASA Exobiology, NOAA SeaGrant, NOAA NURP; Associate editor, Frontiers in Microbiological Chemistry; reviewer, Aquatic Geochemistry, Aquatic Microbial Ecology, Geochemical Transactions, Geochimica et Cosmochimica Acta, Geomicrobiology Journal, Journal of Geophysical Research, Limnology & Oceanography: Methods.

Public education & outreach: Ho'ala School (K-12) Science Fair Keynote and Judge, "Extreme science at the bottom of the sea", 2008; UH-NASA Astrobiology Institute Instructor Development Course Lectures, 2004-present; University of Hawaii-Hilo public seminar series: "Deep-sea hydrothermal vents", 2005

University education: instructor for graduate Chemical Oceanography and Aquatic Microbial Geochemistry, and undergraduate Global Biogeochemistry; guest lectures for graduate UH

Computational Astrobiology Course, UH Astrobiology Seminar Series; coordinator for Oceanography Department Biogeochemistry Brown Bag series; chair of UH Oceanography Marine Geology & Geochemistry Division Curriculum Committee; invited seminar, University of Hawaii Ocean and Resources Engineering Department, "Technology development for marine biogeochemistry and geomicrobiology", Member, cooperating graduate faculty, University of Hawaii Department of Ocean and Resources Engineering, 2007-present; invited lecture, Oregon Health and Science University, "In situ investigations of geomicrobial synergy within oxic-anoxic transition zones"

International workshops: member, NSF *Center for Dark Energy Biosphere Investigations* Crustal Steering Committee; participant, Kavli Frontiers of Research Symposium, Irvine, CA, December 2012; participant, Research Coordination Network "Subseafloor Microbiology Workshop", UNC, Chapel Hill, NC, March 20II; participant, "IODP New Ventures in Exploring Scientific Targets" workshop, September 2009; member, Planning Committee for Research Coordination Network Subseafloor Biosphere Workshop, UH, Kona, HI, October 2009; participant, "Proposal for a Deep Biosphere Institute" workshop, USC, Catalina Island, CA, March 2008.

Collaboration and Co-Editor: 15
Advisor and/or advisory committee member: II MS/PhD students

9. Briefly list the most important publications:

Briggs, R, Ricardo, A, Ruttenberg, K, Glazer, BT. Linking source, abundance and lability of sedimentary organic matter to remineralization efficiency. *in press, Aquatic Geochemistry.*

Hannides, AK, Glazer, BT, Sansone, FJ. Extraction and quantification ofmicrophytobenthic pigments within calcareous reef sands. *accepted, Limnology & Oceanography: Methods.*

Fram, JP, Sansone, FJ, Pawlak, GR, Hannides, A, Glazer, BT. Miniature thermistor chain for determining surficial sediment porewater advection. *accepted, Limnology & Oceanography: Methods.*

Cowen, J.P., Copson, D., Jolly, J., Hsieh, C.-C., Matsumoto, R., Glazer, B.T. et al. (2012) Advanced instrument system for real-time and time-series microbial geochemical sampling of the deep (basaltic) crustal biosphere., *Deep-Sea Research L* 61: 43-56.

Sansone, FJ, Pawlak, G, Stanton, T, McManus, MA, Glazer, BT, DeCarlo, EH, Bandet, M, Sevadjian, J., Stierhoff, K, Colgrove, C, Hebert, AB, Chen, IC. (2008) Kilo Nalu: Physical/Biogeochemical dynamics above and within permeable sediments. *Oceanography,* 21(4): 173-178.

Other significant products:

Edwards, KJ, Glazer, BT, Rouxel, O, Bach, W., Emerson, D, Davis, RE, Toner, B, Chan, C, Tebo, BM, Staudigel, H., Moyer, CL. (20 II) Ultra-diffuse hydrothermal venting supports Fe-oxidizing bacteria and massive umber deposition at 5000m off Hawaii. *The ISME Journal,* doi:I0.1038/ismej.2011.48.

Glazer, BT and Rouxel, OJ. (2009) Redox speciation and distribution within diverse iron-dominated microbial habitats at Loihi Seamount. *Geomicrobiology Journal,* 26:8, 606-622.

Glazer, BT, Luther III, GW, Konovalov, SK, Freiderich, GE, Nuzzio, DB, Trouwborst, RE, Tebo, BM, Clement, BG, Romanov, AS. (2006) Documenting the suboxic zone of the Black Sea via high-resolution real time redox profiling. *Deep Sea Research IL* 53:1740-1755.

10. Briefly list the most recent professional development activities: none

1. Name and Academic Rank

Stephen M. Masutani, Researcher

2. Degrees with fields, institution. and date

Ph.D., Mechanical Engineering, Stanford University, 1985
M.S. Mechanical Engineering, Stanford University, 1980
B.S., Mechanical Engineering, University of Hawaii, Manoa, 1977

3. Academic experience:

Years of Service at UH: 15; Original appointment: May 1994 (non-tenure track R4); August 1999 (tenure track); Tenured: July 2003.
2000-Present: Cooperating Graduate Faculty, Dept. of Molecular Biosciences and Biosystems Engineering, UH
1989-Present: Cooperating Graduate Faculty & Lecturer, Dept. of Mechanical Engineering, UH
1997-1998: Pacific International Center for High Technology Research (PICHTR), UH, Program Manager
1989-1994: PICHTR, Energy & Resources Division, UH, Sr Mechanical Engineer & C02 Project Manager
1985-1989: Visiting Scientist (Shokutaku), The Hitachi Research Laboratory, Hitachi, Ltd., Ibaraki, Japan

4. Non-Academic Experience

1991-Present: Owner, Combustion and Power, Honolulu, Hawaii
Engineering consultant, Combustion and Power; client list available on request
Co-developer of several patents on low-NOx combustors held and commercialized by Hitachi, Ltd.

5. Professional Registration

Licensed Professional Engineer (Mechanical), State of Hawaii

6. Membership of Scientific and Professional Societies

American Society of Mechanical Engineers
American Geophysical Union

7. Honors and Awards

8. Institutional and professional service in the last 5 years

- HNEI Personnel Committee Chair
- Tenure & Promotion Review Committee member
- 1st – 9th International Workshop on Methane Hydrate Research and Development organizing committee
- *Journal of Marine Science and Technology* editorial board
- Reviewer: *Environmental Science and Technology, A/ChE Journal, Journal of Marine Research, Marine Pollution Bulletin, Chemical Engineering Data, Ocean Engineering, Geophysical Research Letters, Nanoscale Research Letters, Chemical Engineering & Technology, Interpretation, Atomization and Sprays,* and *Journal of Petroleum Science and Technology*
- Proposal reviewer: Department of Energy Office of Science, ACS Petroleum Research Fund, Norwegian Research Council; W.M. Keck Foundation
- Advisory Committee to the Sec. of Energy for the National Methane Hydrate R&D Program

9. Publications and presentations: most important in the last 5 years (2010–2015)

REFEREED JOURNAL ARTICLES

North E.W., E.E. Adams, A.E. Thessen, Z. Schlag, R. He, S.A. Socolofsky, S.M. Masutani, and S.D. Peckham. 2015. The influence of droplet size and biodegradation on the transport of subsurface oil droplets during the

Deepwater Horizon spill: a model sensitivity study. *Environ. Res. Lett.* 10 024016 doi:IO.I088/1748-9326110/2/024016.

Itoga, N.K., C.K. Kinoshita, S.M. Masutani, and L.G. Yamamoto. 2014. Mechanical factors affecting nebulized albuterol aerosol particle sizes for asthma drug delivery. *Am. J. Emerg. Med.* doi: 10.1016/j.ajem.2014.02.015.

Harada, R.M.; B.A. Yoza, S.M. Masutani, and Q.X. Li. 2013. Diversity of Achaea communities within contaminated sand samples from Johnston Atoll. *Bioremediation Journal* /7(3):182-189.

Manya, J.J., M.J. Antal, Jr., C.K. Kinoshita, and S.M. Masutani. 2011. Specific heat capacity of pure water at 4.0 MPa between 298.15 and 465.65 *K.Ind. Eng. Chern. Res.* dx.doi.org/10.1021/iel02462g.

Nihous, G.C., K. Kuroda, J.R. Lobos-Gonzalez, R.J. Kurasaki and S.M. Masutani. 2010. An analysis of gas hydrate dissociation in the presence of thermodynamic inhibitors. *Chem. Eng. Sci.* 65(5): 1748-1761.

10. Recent professional development activities:

1. Gary M. McMurtry

2. Education:
Ph.D. Geology and Geophysics, University of Hawaii, Honolulu, 1979
M.S. Geology and Geophysics, University of Hawaii, Honolulu, 1975
B.S. Geological Sciences, University of California, Riverside, 1972

3. Academic experience:

1988-Present	Associate Professor, Department of Oceanography, University of Hawaii, Honolulu, Hawaii.
1999-2000	Affiliate Scientist, In Situ Center of Excellence, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California.
1991-1992	Guest Scientist, Earth and Environmental Sciences Division, Los Alamos National Laboratory, Los Alamos, New Mexico.
1986-1988	Associate Geochemist, Marine Geochemistry Division, Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii.
1983-1988	Science Program Director, National Undersea Research Program at the University of Hawaii, Hawaii Undersea Research Laboratory.
1983-1986	Associate Director, Electron Microscopy Laboratory, Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii.
1980-1986	Assistant Geochemist, Marine Geochemistry Division, Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii.

4. Non-academic experience:

1998-Present	President, Pacific Environmental Technologies, LLC (Pace Tech Hawaii)
1980-Present	Consultant in various geochemical techniques, environmental senor R&D

5. Certifications or professional registrations: none

6. Professional organizations:

Member, American Association for the Advancement of Science
Member, American Geophysical Union
Member, Marine Technology Society
Member, Pacific Congress on Marine Science & Technology (PACON) Society
Member, Sigma Xi, the Scientific Research Society of North America
Lifetime Member, The Hawaiian Academy of Science

7. . Honors and awards:

Member, California Scholarship Federation, 1968
Honors at entrance, University of California, Riverside, 1968
Honors at graduation, University of California, Riverside, 1972
National Science Foundation Antarctic Service Medal, 1979

8. Service activities:
Panels and Committees: International:

Member au jury devant examiner, Halbilitation a Diriger des Recherches Sciences Terre, Dr. Anthony Hildenbrand, Universite Paris-Sud, Orsay Cedex, France, 2011

Panels and Committees: National:
Consortium for Ocean Leadership, Gulf of Mexico Research Initiative, 2011, 2014, 2015 Technology Panelist.
NASA, Planetary Instrument Definition & Development Program (PIDDP), 2010 Program Panelist.
NSF, Major Research Instrumentation and Ocean Technology Panel, 2008 Program Panelist.
West Coast and Polar Regions National Undersea Research Center, 1999 Program Panel
Science Steering Advisory Panel, National Undersea Research Program, National Oceanic and Atmospheric Administration, 1983-88.
Special Study Committee, Deep Submergence Research Vehicle *Alvin*, University-National Oceanographic Laboratory System, 1987.

Panels and Committees: State/University:
Tenure and Promotion Review Committee, University of Hawaii, Manoa, 2007-present
Committee for the Cooperative Agreement between the University of Hawaii and the Christian-Aibrechts-Universitat zu Kiel, Kiel, Germany, 1990-2000.
Radiation Safety Committee, University of Hawaii, 1991-97, 1998-2000.

9. Important publications & presentations, past 5 years:

2015 McMurtry, G. M., and D. R. Hilton, Development of a Field-Portable He-Isotope Detector: A Novel Instrumental Approach for Quantitative Assessment of Magma Compositional Dynamics and Monitoring Fluxes of Magmatic Volatiles, Deep Carbon Observatory, 2nd Int. Science Meeting, Munich, Germany. (Invited).

McMurtry, G. M., and T. Fischer, VGAM: Volcanic Gas Analytical Monitor using compact, low-power mass spectrometry for in-situ multi-species determinations, Deep Carbon Observatory, 2nd Int. Science Meeting, Munich, Germany (Invited).

2012 McMurtry, G. M., I. Kolotyrkina, J. S. Lee and K. H. Kim, Underwater Mass Spectrometers for *In Situ* Monitoring of Dissolved Gases and Volatile Organic Compounds in Deep Ocean and Coastal Environments, in Proceed. Oceans 2012, MTS and IEEE, Yeosu, South Korea, 6 pp.

2011 McMurtry, G. M., I. Kolotyrkina, G. Brucker and J. Rathbone, New Generation Underwater Mass Spectrometers for Dissolved Gases and Volatile Organic Compound Detection and *In Situ* Monitoring in the Oceans, in Proceed. Oceans 2011, MTS and IEEE, Kona, Hawaii, 4 pp.

2010 Filri, E., D. R. Hilton, M.D. Tryon, K. M. Brown, G. M. McMurtry, W. BrOckmann, and C. G. Wheat, Carbon release from submarine seeps at the Costa Rica fore arc: Implications for the volatile cycle at the Central America convergent margin, *Geochem. Geophys. Geosyst.*, II, Q04S21, doi:10.1029/2009GC002810.

McMurtry, G. M., J. F. Campbell, G. J. Fryer, and J. Fietzke, Uplift of Oahu, Hawaii during the past 500 k.y. as recorded by elevated reef deposits, *Geology* 38, 27-30.

1. Mark Andre·w Merrifield
Department of Oceanography, University of Hawaii

2. Education

A. B.	Physics	University of California, Berkeley	1982
Ph.D.	Oceanography	Scripps Institution of Oceanography	1989

3. Academic Experience
Joint Institute of Marine and Atmospheric Research, Director, 2011-present, part time
Oceanography, University of Hawaii, I5, Professor, 2004- present, full time
Oceanography, University of Hawaii, I4, Associate Professor, 1999-2004, full time
Oceanography, University of Hawaii, I3, Assistant Professor, 1997-1999, full time
Oceanography Engineering, University of Hawaii, I3, Assistant Professor, 1994-1997, full time
Scripps Institution of Oceanography, Assistant Researcher, 1993-1994, full time
Scripps Institution of Oceanography, Project Scientist, 1991-1993, full time
University ofNew South Wales, Post-doctoral Researcher, 1989-1991, full time

4. Non-academic Experience: none

5. Certifications or professional registrations: none

6. Professional Organizations
American Geophysical Union

7. Honors and Awards: none

8. Service Activities
Director, University of Hawaii Sea Level Center, 1997-present.
Lead Author, Working Group I, Fifth Assessment Report ofthe IPCC 2010-2013.
Chair, GLOSS Group of Experts, 2005-2011.
Lead Author, Sea Level section, State of the Climate Report, Bulletin of American Meteorological Society, 2010-present.
Contributing Author, Pacific Island Region Climate Assessment, 2012.

9. Publications
[I] Pequignet, A. -C., J. M. Becker, M.A. Merrifield, and S. J. Boc (2011), The dissipation of wind wave energy across a fringing reef at Ipan, Guam, *Coral Reefs*, 30:70-82, doi:10.1007/s00338-011-0719-5.

[2] Merrifield, M. A. (2011), A shift in western tropical Pacific sea level trends during the 1990s, *J. Climate, 24,* 4126-4138, doi:10.1175/2011JCLI3932.1.

[3] Zilberman, N. V., M.A. Merrifield, G. S. Carter, D. S. Luther, M.D. Levine, and T. J. Boyd (2011), Incoherent nature of M2 internal tides at the Hawaiian Ridge, *J. Phys. Oceanogr.*, 41,2021-2036, DOI:10.1175/JPO-D-10-05009.1.

[4] Merrifield, M. A., and M. E. Maltrud (2011), Regional sea-level trends due to a Pacific trade wind intensification, *Geophys. Res. Lett., 38,* L21605, doi:10.1029/2011GL049576.

[5] Aucan, J., R. Heeke, and M.A. Merrifield (2012), Wave-driven sea level anomalies at the Midway tide gauge as an index of North Pacific storminess over the past 60 years, *Geophys. Res. Lett., 39,* 17, doi:10.1029/2012GL052993.

[6] Merrifield, M.A., P.R. Thompson, and M. Lander (2012), Multidecadal sea level anomalies and trends in the western tropical Pacific, *Geophys. Res. Lett., 39,* 13, doi:I O.I 029/20I2GL052032.

[7] Chambers, D.P., M.A. Merrifield, and R. S. Nerem (20I2), Is there a 60-year oscillation in global mean sea level? *Geophys. Res. Lett., 39(18),* L18607.

[8] Merrifield, M.A., A. S. Genz, C. P. Kontoes, and J. J. Marra (2013), Annual maximum water levels from tide gauges: Contributing factors and geographic patterns, submitted to *J Geophys. Res.,* I18, 2535-2546.

[9] Ford, M., J. M. Becker, M.A. Merrifield, andY. T. Song (2013), Marshall Islands fringing reef and atoll lagoon observations of the Tohoku tsunami, *Pure and Applied Geophysics,* 1O.I 007/s00024-013-0757-8.

[10] Becker, J. M., M.A. Merrifield, and M. Ford (20I4), Water level effects on breaking wave setup for Pacific Island fringing reefs, *J Geophys. Res.: Oceans,* 1I9, 914-932, doi:I O.I 002/2013JC009373.

[II] Thompson, P.R., M.A. Merrifield, J. R. Wells, and C. M. Chang (2014), Wave-driven coastal sea level variability in the Northeast Pacific, *J. Climate, 27,* 4733-4751.

[I2] McGregor, S., A. Timmermann, M. F. Stuecker, M. H. England, M. Merrifield, F.-F. Jin, andY. Chikamoto (2014), Recent Walker circulation strengthening and Pacific cooling amplified by Atlantic warming, *Nature Climate Change,* doi:10.1038/nclimate2330.

[I3] Thompson, P.R., and M.A. Merrifield (20I4), A unique asymmetry in the pattern of recent sea level change. *Geophys. Res. Lett.,* doi:10.1002/20I4GL061263.

[14] Pequignet, A.-C., J. M. Becker, and M.A. Merrifield (2014), Breakpoint transfer of energy between wind waves and low frequency oscillations on a fringing reef, Ipan Guam, *J Geophys. Res.: Oceans,* 119,6709-6724, doi:IO.I002/2014JC010179.

[I5] Merrifield, M.A., Becker, J. M., Ford, M., and Yao, Y. (2014), Observations and estimates of wave-driven water level extremes at the Marshall Islands. *Geophys. Res. Lett.,* doi:I O.I 002/2014GL061005.

[16] Church, J. A., P. U. Clark, A. Cazenave, J. M. Gregory, S. Jevrejeva, A. Levermann, M.A. Merrifield, G. A. Milne, R. S. Nerem, P. D. Nunn, A. J. Payne, W. T. Pfeffer, D. Stammer, A. S. Unnikrishnan (2013), Sea Level Rise by 2100, *Science,* Vol. 342, No. 6I65, p.I445, DOl: 1O.II26/science.342.6165.1445-a.

10. Recent professional development activities: none

1) H. Ronald Riggs

2. Education

Ph.D. Civil Engineering.University of California, Berkeley, Berkeley, CA (1981)
M.S. Civil Engineering University of California, Berkeley, Berkeley, CA (1976)
B.S.C.E.. Civil Engineering California State University, Chico, Chico, CA. (1975)

3. Academic Experience

Assistant professor, August 1987- July 1991.
Assosiate professor, August 1991 -July 1996.
Professor, August 1996 – present.

4. Other Experience

- Senior Research Engineer – Exxon Production Research Co., Houston, TX (November 1984-July 1987).
- Research Engineer- Hochtief AG, Frankfurt, Germany, (February 1982- August 1984).
- Professional consulting.

5. Professional License

Hawai'i

6. Professional Memberships

American Society of Civil Engineers (ASCE), American Society of Mechanical Engineers (ASME),

7. Honors and Awards

Fellow, ASME

8. Service

- Chief Editor, ASCE J. of Waterway, Port, Coastal and Ocean Engineering
- Editorial Board, Ocean Engineering
- Extended Executive Committee, ASME Ocean, Offshore and Arctic Engineering Division
- Reviewed papers for conferences and journals
- Reviewed proposals for NSF

9. Recent Publications

1. Riggs, H. R., Cox, D. T., Naito, C. J., Kobayashi, M. H., Piran Aghl, P., Ko, H. T.-S., and Khowitar, E. (2014). "Experimental and analytical study of water-

driven debris impact forces on structures." *Journal of Offshore Mechanics and Arctic Engineering,* 136, doi:10.1115/1.4028338, OMAE-13-1042.

2. Piran Aghl, P., Naito, C. J., and Riggs, H. R. (2014). "Estimation of demands resulting from inelastic axial impact of steel debris." *Engineering Structures,* 82,(1), 10.1016/j.engstruct.2014.10.021, 11-21.

3. Piran Aghl, P., Naito, C., and Riggs, H. R. (2014). "Full-scale experimental study of impact demands resulting from high mass, low velocity debris." *Journal of Structural Engineering,* 10.1061/(ASCE)ST.1943-541X.0000948, 04014006.

4. Naito, C., Cercone, C., Riggs, H. R., and Cox, D. (2014). "Procedure for site assessment of the potential for tsunami debris impact." *Journal of Waterway, Port, Coastal, and Ocean Engineering,* 140, 10.1061/(ASCE)WW.1943-5460.0000222, 223-232.

5. Ko, H. T.-S., Cox, D. T., Riggs, H. R., and Naito, C. J. (2014). "Hydraulic experiments on impact forces from tsunami-driven debris." *Journal of Waterway, Port, Coastal, and Ocean Engineering,* 10.1061/(ASCE)WW.1943-5460.0000286, 04014043.

6. Khowitar, E., Riggs, H. R., and Kobayashi, M. H. (2014). "Beam response to longitudinal impact by a pole." *Journal of Engineering Mechanics,* 10.1061/(ASCE)EM.1943-7889.0000765, 04014045.

7. Robertson, I. N., Paczkowski, K., Riggs, H. R., and Mohamed, A. (20I3). "Experimental investigation of tsunami bore forces on vertical walls." *Journal of Offshore Mechanics and Arctic Engineering,* I35, 02I60I.

8. Piran Aghl, P., Naito, C. J., and Riggs, H. R. (20I3). "An experimental study of demands resulting from in-air impact of debris." *Sate.fy, Reliability, Risk and Life-Cycle Performance of Structures and Infrastructures,* G. Deodatis, B. R. Ellingwood, and D. M. Frangopol, eds., Taylor and Francis Group, London, 554I-5547.

9. Paczkowski, K., Riggs, H. R., Naito, C. J., and Lehmann, A. (20I2). "A one-dimensional model for impact forces resulting from high mass, low velocity debris." *Structural Engineering and Structural Mechanics,* 42(6), 83I-847.

I0. Kobayashi, M. H., Genest, R., Riggs, H. R., and Paczkowski, K. (2012). "Simple hydroelastic impact models for water-borne debris." *Proceedings of the Institution of Mechanical Engineers, Part M: Journal of Engineering for the Maritime Environment,* 226(2), 10.1177/I475090212437627, 170-179.

10. Professional development activities: none

1. JOHN R. SMITH, Jr.
University ofHawai'i Undersea Research Lab

2. EDUCATION

· B.S., Geological Oceanography, Florida Institute of Technology, *with Honor*, 1983.
· M.S., Geological Oceanography, University of Hawai'i at Manoa, 1989.
·_Ph.D., Geological Oceanography, University ofHawai'i at Manoa, 1996.

3. ACADEMIC APPOINTMENTS

Current Positions

Science Program Director, UH HURL, Aug *2007-Present.* Full time.

Marine Geophysical Specialist, (for Marine Geophysical Operations program), UHURL, August *2007-Present.* Full time.

Previous Positions

Assistant Specialist, Marine Geophysical Spec, HURL, 211995 - 4/1997. Full time.

Research Assistant, University ofHawai'i at Manoa, 8/1986- 111995. Part time.

Institutional Positions

Cooperating Graduate Faculty member, Department of Ocean and Resources Engineering, University ofHawai'i at Manoa/SOEST, *1998-Present.*

4. NON-ACADEMIC APPOINTMENTS

Geophysicist, Western Geophysical Company of America, Houston, TX, 4/1984 - 3/1985.

Observer, Western Geophysical Company of America, Houston, TX, 7/1983 - 3/1984.
Both were full time.

5. CERTIFICATIONS OR PROFESSIONAL REGISTRATIONS: none

6. CURRENT MEMBERSHIP in PROFESSIONAL ORGANIZATIONS

American Geophysical Union

7. Honors and Awards: none

8. SERVICE ACTIVITIES

Recent Service to the University, School, Department, and UHURL

- SOEST Research Council, 2012-Present.
- SOEST Ship Operations Subcommittee, 2010-Present; Chairperson Dec 2011-Present.
- SOEST ROY Science Advisory Committee, 2012-Present.

Service to the National and International Scientific Community

Requests for Proposals

- Prepared RFP for HURL's submersible-based research program for dives in 2010-2012 and beyond. Handled 20 pre-proposals, 12 full proposals, sought external reviews, revised guidelines, formed a review panel, and carried out extensive correspondence.

Selected Conferences, Meetings, Workshops

- Session chairperson, AGU Fall Meeting, Contributions of Ocean Exploration and Research to the Designation and Management of Marine Protected Areas (MPAs), 2012.
- Invited speaker at the *Hawaiian Islands Symposium,* Multibeam Synthesis of the Northwestern Hawaiian Islands in Support of Diverse Research, 2012.
- Invited participant for the Mariana Trench Marine National Monument Science Exploration and Research Plan workshop sponsored by NOAA, Waikoloa, HI, 2011.

Referee

- Provided five reviews of manuscripts for journals and one proposal in past five years.

Selected Service to the Public and Community Outreach Activities

- Worked with the nonprofit *Whaletimes* on a K-12 Edu/Outreach project for two UHURL cruises in 2010 and 2011. Totals for both programs, >1275 students reached, 55 schools across the U.S.
- Featured scientist in documentary on Amelia Earhart Expedition, 8/2012 on Discovery.
- Featured scientist in the documentary *How the Earth Works* for Discovery, aired 2013.
- Featured scientist in the documentary *Drain the Ocean* for the National Geographic Channel (aired 2009). Focused on some of my personal research of the Hawaiian Islands.

Students supervised within the last five years.

David Hashisaka, Global Environmental Science (GES), undergraduate senior thesis, graduated 2014. Served as lead mentor. Evaluation and Improvement of the Atmospheric Data Acquisition System Aboard RIV *Kilo Moana.*

Max Young, Ocean & Resources Engineering (ORE) Dept., M.S. Plan B, graduated 2013.

Served as Chairperson. Feasibility Study of a Manipulator-Held, Hydraulic Core Rig.

9. PUBLICATIONS and PRESENTATIONS

Kelley, C., J.R. Smith, J. Tree, J. Miller, B. Boston, M. Garcia, G. Ito, J. Taylor, F. Lichowski, D. Wagner, J. Leonard, B. Dechnik, D. Luers, (2015), New insights from seafloor 1napping of a Hawaiian marine 1nonument, *Eos, 96,* doi:l0.1029/2015E0030235. *Presented talk on this at the 2014 AGU Fall Meeting.*

Garcia, M.O., Smith, J.R., Tree, J.P., Weis, D., Harrison, L., and Jicha, B.R., 2015, Petrology, geochemistry, and ages of lavas from Northwest Hawaiian Ridge volcanoes, *in* Neal, C.R., Sager, W.W., Sano, T., and Erba, E., eds., The Origin, Evolqtion, and Environmental Impact of Oceanic Large Igneous Provinces: Geological Society of America Special Paper 511, doi:l0.1130/2015.2511(01).

McGovern, P.J., Grosfils, E.B., Galgana, G.A., Morgan, J.K., Rumpf, M.E., Smith, J.R. and Zimbelman, J.R., Lithospheric flexure and volcano basal boundary conditions: keys to the structural evolution of large volcanic edifices on the terrestrial planets, *Geological Society, London, Special Publications,* doi 10.1144/SP401.7, 2014.

Ito, G., Garcia, M.O., Smith, J.R., Taylor, B., Flinders, A., Jicha, B.R., Yamasaki, S. Weis·D., Swinnard, L., Blay, C., A low-relief shield volcano origin for the South Kaua'i Swell. *Geochemistry, Geophysics, Geosystems,* doi: 10.1002/ggge.20159, 2013. Wright, D.J., Roberts, J., Fenner, D., Smith, J.R., Koppers, A.A.P., Naar, D.,

Hirsch, E.R., Clift, L.W., and Hogrefe, K.R., Seamounts, ridges, and reef habitats of American Samoa, in Harris, P.T. and Baker, E.K. (eds.), *Seafloor Geomorphology as Benthic Habitat: GeoHab Atlas of Seafloor Geomorphic Features and Benthic Habitats,* Elsevier, Amsterdam, 791-806,2012.

10. PROFESSIONAL DEVELOPMENT ACTIVITIES

HYPACK software training (2013), SOEST videowall training (2012), Google Ocean training (2012), HMRG SMD software training (2010, 20 II).

Attended various grant workshops, funding agency site visit instructional presentations, and entrepreneurial bootcamps made available at the University ofHawai'i

Served as Chief Scientist on several test and training cruises for SOEST's new robotic submersible (2013, 2014), continued participation in the upkeep, testing, and operation of other marine science systems aboard the two University of Hawai'i res

APPENDIX B

AFFILIATE FACULTY

1. Name
   Geno Pawlak, Professor (Affiliate Faculty, University of Hawaii)

2. Education
   University of California at San Diego, Ph.D. Mechanical Engineering/Applied Ocean Science, 1997
   University of California at San Diego, M. S. E. Mechanical Engineering, 1994
   University of Minnesota, B.S.E. Aerospace Engineering and Mechanics, 1991

3. Academic Experience
   - Professor, 2015-Present; Associate Professor, 2012-2015; Mechanical and Aerospace Engineering Dept. University of California San Diego
   - Associate Professor, 2007-2012; Assistant Professor, 2001-2007; Director, Kilo Nalu Observatory, 2004-2012; Graduate Program Chair, 2010-2012; Dept. of Ocean and Resources Engineering, University of Hawaii at Manoa
   - Visiting Researcher, 2009, Fluid Mechanics Group, Dept. of Mechanical and Mining Engineering, University of Jaen, Jaen, Spain
   - Visiting Researcher, 2003, Fluid Mechanics Group, Dept. of Thermal and Fluids Engineering, Carlos III University, Madrid, Spain

4. Related Experience
   - Cooperating Graduate Faculty, Dept. of Oceanography, School of Ocean and Earth Science and Technology, University of Hawaii, 2002 -Present
   - Research Associate, School of Oceanography, University of Washington, 1998- 2001
   - Postdoctoral Researcher, Physical Oceanography Dept., Scripps Institution of Oceanography, University of California, San Diego, 1997- 1998
   - Graduate Researcher, Physical Oceanography Dept., Scripps Institution of Oceanography, University of California, San Diego, 1993 – 1997

5. Professional Registrations

6. Professional Associations
   American Physical Society, 2007- Present
   Marine Technology Society, 2002-Present
   American Geophysical Union, 1998 - Present

7. Honors and Awards
   Office ofNaval Research, Young Investigator Award, 2003-2006
   Charles Lee Powell Foundation Fellowship, UCSD, 1992-1993

8. Institutional and Professional Service in the Last Five years
   - Referee for Journal of Fluid Mechanics, Environmental Fluid Mechanics, ASME Journal of Fluid Engineering, Journal of Atmospheric and Oceanic Technology, ASLO Limnology and Oceanography, Deep Sea Research, Journal of Physical Oceanography,

Journal of Geophysical Research-Oceans, Ocean Engineering, Journal of Coastal Research, Advances in Water Research.

- Proposal Reviews: National Science Foundation, American Chemical Society, NOAA, Agencia Nacional de Evaluacion y Prospectiva (ANEP, Spain)

9. Publications

- M. Canals and G. Pawlak, "Three-dimensional vortex dynamics in oscillatory flow separation", *Journal of Fluid Mechanics,* doi: 10.1017/S0022112011000012, 2011
- M.S. Tomlinson, E. H. De Carlo, M.A. McManus, G. Pawlak, G. F. Steward, F. J. Sansone, O.D. Nigro, C. E. Ostrander, R.E. Timmerman, J. Patterson, S. Jaramillo*, "Monitoring the Effects of Storms on Coastal Water Quality with the Hawai'i Ocean Observing System (HiOOS)", *Oceanography,* June 2011
- S. Jaramillo and G. Pawlak, "AUV-based bed-roughness mapping over a tropical reef', *Coral Reefs,* doi: 10.1007/s00338-011-0731-9, 2011
- E. Sanmiguel-Rojas, J. I. Jimenez-Gonzalez, P. Bohorquez, G. Pawlak, and C. Martinez-Bazan, "Stability effects of base cavities on the wake of slender blunt-based axisymmetric bodies", *Physics of Fluids,* doi: 10.1063/1.3658774, 23:I1, Nov. 201I
- A. Aryal, B. A. Brooks, M. E. Reid, G. W. Bawden and G. Pawlak, "Displacement Fields from Point Cloud Data: Application of Particle Imaging Velocimetry to Landslide Geodesy" Vol. 117, FOI029, doi: 10.1029/20 II JF002I61, *Journal of Geophysical Research Surface Processes,* 20I2
- Y. Yamazaki, K.F. Cheung, G. Pawlak, T. Lay, "Surges along the Honolulu Coast from the 2011 Tohoku Tsunami", *Geophysical Research Letters,* 39, 9, doi:10.1029/2012GL05I624, 2012
- J.R. Wells, J. P. Fram and G. Pawlak, "Solar warming of near bottom water over a fringing reef', *J. Marine Research,* 2012
- J.P. Fram, G. Pawlak, F.J. Sansone, B.T. Glazer and A.K. Hannides, "Miniature Thermistor Chain for Determining Surficial Sediment Porewater Advection", *Limnology and Oceanography Methods,* 12:I55-165, 2014
- J. Fiedler, M.A. McManus, M. S. Tomlinson, E. H. De Carlo, G. Pawlak, G. F. Steward, O. D. Nigro, R. E. Timmerman, P. S. Drupp, J. R. Wells, C. E. Ostrander, Real-time Observations of the February 2010 Chile and March 2011 Japan Tsunamis in Honolulu, Hawai'i, as recorded by the Pacific Islands Ocean Observing System, *Oceanography,* 27:2, 2014
- L. Molina, G. Pawlak, J.R. Wells, S.G. Monismith, and M.A. Merrifield, "Cross-shore Thermal Exchange on a Tropical Fore-reer', Journal of Geophysical Research, doi:1O.I002/2013JC00962I 2014

10. <u>Professional Development Activities</u>

Panelist, National Science Foundation, Coastal SEES Panel, Spring 2013
Organizing Committee, Session Chair, American Physical Society Division of Fluid Dynamics Meeting, Nov. 20I2
Session Chair, American Geophysical Union Fall Meeting, Dec. 20I0
Organizer, ONR Workshop: Circulation around and within atolls/reefs/lagoons, UCSD/SIO, Sept. 2010
Session Organizer, American Geophysical Union Ocean Sciences Meeting, Feb. 2010

1. Name and academic rank
David Rezachek, PhD, PE
Affiliate Faculty

2. Degrees with fields, institution, and date
1991, PhD, Ocean Engineering, University of Hawaii at Manoa
1980, MS, Mechanical Engineering, University of Hawaii at Manoa
1976, BS, Environmental Technology and Urban Systems, Florida International University
1973, US Navy Nuclear Power School and Nuclear Power Plant Prototype
1972, BS, Chemistry (with distinction), University of Minnesota
1972, Ensign, US Navy Officer Candidate School

3. Academic experience Number of years of service on this faculty, including date of original appointment advancement
10 years; Affiliate Graduate Faculty, 1999 – Present

4. Other related experience, i.e., teaching, industrial, etc.
Owner/Principal Consulting, Rezachek & Associates, Hawaii, 1993 – Present.
Associate Development Director/Consultant, Honolulu Seawater Air Conditioning, LLC, 2003- 2009.
Alternate Energy Specialist, Energy Division, Department of Business, Economic. Development and Tourism, State of Hawaii, 1987- Present.
Assistant Mechanical Engineer, Sugar Technology and Engineering Department, Hawaiian Sugar Planters' Association (HSPA), 1980 – 1987.

Consulting, patents, etc.
Owner/Principal Consulting, Rezachek & Associates, Hawaii, 1993 – Present.
Associate Development Director/Consultant, Honolulu Seawater Air Conditioning, LLC, 2003- 2009.

5. States in which professionally licensed or certified, if applicable
Professional Engineer (Mechanical), License No. 5485, State of Hawaii.
6. Scientific and professional societies of which a member
American Society of Mechanical Engineers (ASME)
Hawaii Academy of Science (HAS)
Hawaii Solar Energy Association (HSEA)
International District Energy Association
7. Honors and a·wards
8. Service activities (within and outside of the institution)
Affiliate Grad Faculty, Department of Ocean and Resources Engineering, SOEST, University of Hawaii at Manoa
Alternate Energy Technologies System Modeling Contest (AETSMC) (PM-D)

Development of an Integrated Suite of Energy- and Environmentally-Related Distance Learning Courses (Educ, Pro, Under Development)

Earth Day Displays and Demonstrations (Educ)

Energy and Environment Course, Sustainable Energy Engineering International Master of Science Program, School of Mechanical and Materials Science, Swedish Royal Institute of Technology, Stockholm, Sweden- Delivered three lectures (EleGtric Vehicle Technology, Principles of Sustainable Development, and Energy Conservation Technologies), Spring 1999 (Educ, Con)

Energy and Environmental Summit (Educ, Leg)

Energy Awareness Month Displays and Demonstrations (Educ)

Hawaii State Science and Engineering Fair, Junior Display Division, Chief Judge (Educ)

Ka'ahele La (Tour of the Sun) Interscholastic Photovoltaic-Powered Vehicle Competition - Pilot Program (PM-D)

Ka'ahele La (Tour of the Sun) Interscholastic Photovoltaic-Powered Vehicle Competition- Year 2 (PM-D)

Ocean Engineering Design Courses- ORE 783, Department of Ocean and Resources, SOEST, UHM (Spring 2009 "Preliminary Design of a Cooling Station, Seawater Pipe System, and Chilled Water Distribution System for an Up to 20,000- ton Seawater Air Conditioning (SWAC) District Cooling System for Pearl Harbor/Hickam/Honolulu

Provided presentations to numerous environmental, engineering, and business groups, as well as the Downtown Neighborhood Board, and Ala Moana and Kaka'ako Neighborhood Board. As a result, the Project has received considerable support from all groups. Personally met and/or communicated with at least 145 of the 150 agencies, organizations, and individuals consulted to date. Instrumental in achieving the strong support of the Sierra Club, Life of the Land, Hawaii Renewable Energy Alliance, Hawaii Solar Energy Association, and other energy and environmental groups for SWAC-related legislation, SWAC technology, and various SWAC projects in Hawaii (Con

Review and Selection Committee, Sterling Scholar Scholarship Program

Technical Advisor to the Hawaii Electron Marathon Program (Assist, TA, SA)

Technical Advisor to the Kauai Community College Sunrayce Solar Car Team

9. Principal publications/presentations of the last five years (2010 -2015)

Awaiting update

10. Briefly list the most recent professional development activities

1. Name and academic rank

Dayananda H. Vithanage, Affiliate Faculty

2. Degrees with fields, institution, and date

PhD, Ocean Engineering, University of Hawaii, 1987
Diploma of Hydraulic Engineering, International Course in Hydraulic Engineering, Delft, The Netherlands, 1984-85
BS, Civil Engineering, University of Ceylon, Sri Lanka, 1978

3. Number of years of service on this faculty, including date of original appointment and advancement

10 years

4. Other related experience, i.e., teaching, industrial, etc.

38 years in Civil, Coastal and Environmental Engineering in the Private sector
Technical Director and Vice President, Oceanit Laboratories, Inc., Honolulu, Hawaii, 2000-2003
Senior Projects Engineer and Vice President, Oceanit Laboratories, Inc., Honolulu, Hawaii, 1990 – 2000
Chief Engineer, Lanka Hydraulic Institute, Colombo, Sri Lanka, 1987 to 1989
Engineer, Coast Conservation Department, Sri Lanka, 1978 to 1983
Lecturer, Coastal Engineering, University ofMoratuwa, Sri Lanka, 1978-1983

Consulting

Oceanit Laboratories Inc.

Patents

Lysimeter for Collecting Chemical Samples from the Vadose Zone- US Patent Number: 5,567,889. Inventors: Patrick K. Sullivan, PhD, PE, Dayananda Vithanage, PhD, PE, and Robert E. Bourke.
Flexible Pipe Diffuser- US Patent Number: 5,590,979. Inventors: Patrick K. Sullivan, PhD, PE, Dayananda Vithanage, PhD, PE, and Warren E. Bucher, PhD.

5. States in which professionally licensed or certified, if applicable

Professional Engineer (Civil), License No. 9348, Hawaii, 1989.
Licensed Surveyor and Leveler, Sri Lanka, 1980.

6. Scientific and professional societies of which a member

Member ASCE
MemberAWWA
MemberHWEA

7. Honors and a\vards

8. Service Activities (within and outside of the institution)

6. Principal publications/presentations of the last five years (2010-2015)

Environmental Impact Statement Honokohau Harbor Expansion

Environmental Assessment for Tinian Wastewater treatment plant outfall

- Mercury spill cleanup for the Honolulu Board of Water Supply,
- Conducting all field measurements in Mamala Bay to track submerged wastewater plumes using satellite data of ocean surface,
- Environmental analysis of Kagman and Tinian proposed wastewater outfalls in Commonwealth of the Northern Mariana Islands
- Managing environmental impact statement preparation for Kona Kai Ola development in the Island of Hawaii,
- Compliance evaluations for wastewater outfalls in Oahu and Kauai
- Remediation of diesel spills and removal of leaking underground storage tanks
- Brennecki Beach erosion control scheme design and construction supervision
- Hilo Harbor Pier 4 dredging design and permitting
- Kahului Harbor landfill feasibility and design
- Maunalahilahi Beach Park erosion control scheme design and construction supervision and sand replenishment
  - Kalaeloa reverse osmosis seawater desalination plant design and preparation of environmental impact statement and permits
  - Maui High School drainage improvements design
  - Kawainui marsh bird habitat design and construction supervision
  - Preparation of Sacred Falls Master Plan
  - Cathodic protection for Board of Water Supply pipe lines
  - Design of Gentry Wahiawa offsite sewer line
  - Sanitary Survey of the Board of Water Supply drinking water system
  - Construction dust monitoring and management

10. Briefly list the most recent professional development activities

APPENDIX C

LABORATORY EQUIPMENT

SOEST Vessels: 25ft outboard motor boat
225 ft Ocean going vessel (R/V Kaimikai-O-Kanaloa)

University of Hawaii Marine Center - ROV and AUV support facility

SOEST Makai Research Pier – instrumented ocean test facility with 20' by 50' covered moon pool with 12 foot ocean water depth

Kilo Nalu Nearshore Reef Observatory – major cabled observatory (fully described in criterion 7- p.59)

Aloha Cabled Observatory (fully described in criterion 7- p.59)

Environmental Fluid Dynamics Laboratory

Wave Channel - 10-meter long, 30 x 10 cm wave simulation

Computer clusters – various ORE professors (fully described in criterion 7- p.59)

Hawaii Undersea Research Laboratory – staff of technicians, two submersibles and a machine shop and instrumentation facility (fully described in criterion 7- p.59)

APPENDIX D

INSTITUTIONAL SUMMARY

Appendix D – Institutional Summary

1. The Institution

University of Hawai'i at Mānoa, Hawai'i Hall 202, Honolulu, HI 96822

Chief Executive Officer: Robert Bley-Vroman, Chancellor

a. *Name and title of the person submitting the Self-Study Report.*

Brian Taylor, Dean, School of Ocean Earth Science and Technology

b. *Name the organizations by which the institution is now accredited, and the dates of the initial and most recent accreditation evaluations.*

The University of Hawai'i at Mānoa is accredited by the Western Association of Schools and Colleges (WASC). It was first accredited in 1952. The most recent Educational Effectiveness Review was 2011. Information on the WASC accreditation may be found at: http://manoa.hawaii.edu/wasc/

Mānoa's accreditation was reaffirmed through Spring 2021.

2. Type of Control

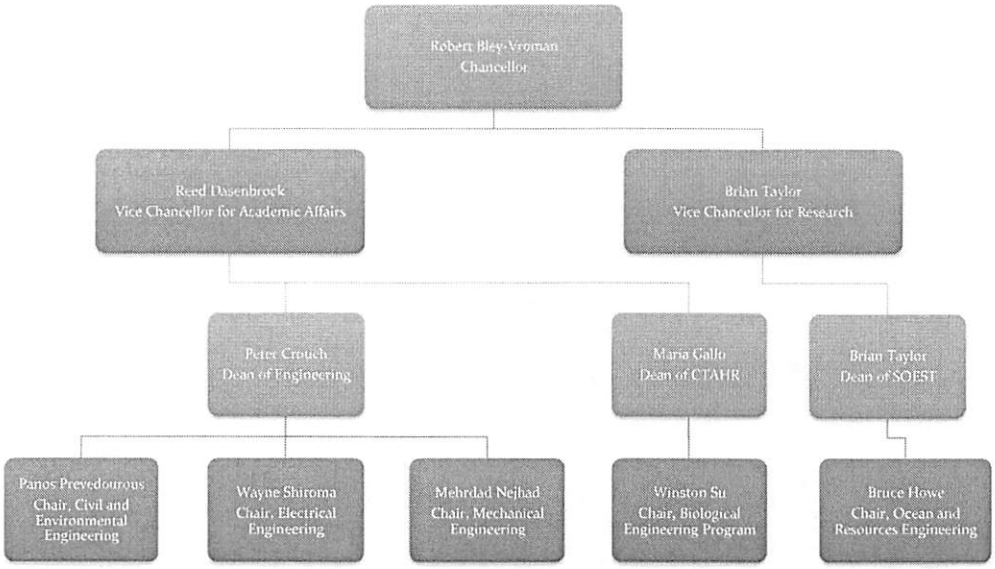
The University of Hawai'i at Mānoa is a public state institution.

3. Educational Unit

The engineering programs at the University of Hawai'i at Mānoa are in three units: the College of Engineering and the College of Tropical Agriculture and Human Resources (CTAHR), which are under the Vice Chancellor for Academic Affairs and the School of Ocean and Earth Science and Technology (SOEST), which is under the Vice Chancellor for Research.

The College of Engineering has four programs: **Civil Engineering** (in the Department of Civil and Environmental Engineering), **Computer Engineering** and **Electrical Engineering** (in the Department of Electrical Engineering), and **Mechanical Engineering**. SOEST has one engineering program: Ocean and Resources Engineering. CTAHR has one engineering program: Biological Engineering (in the Department of Molecular Biosciences and Biotechnology). All these are under the Chancellor, the chief administrative officer of the University of Hawai'i at Mānoa, as shown in the organizational chart below.

University of Hawai'i at Mānoa Organizational Chart



Ocean Engineering is in the Department of **Ocean and Resources** Engineering, which is one of four academic departments in the School of Ocean and Earth Science and Technology. The chair of the Department is **Bruce Howe**, who reports to Brian Taylor, Dean of the School of Ocean and Earth Science and Technology. Brian Taylor also serves as interim Vice Chancellor and reports to Robert Bley-Vroman, Chancellor of the University of Hawaii at Mānoa.

4. Academic Support Units

- Biology, College of Natural Sciences, Kathleen S. Cole, Chair
- Chemistry, College of Natural Sciences, Kristin Kumashiro, Chair
- Communicology (formerly Speech), College of Arts and Humanities, R. Kelly Aune, Chair
- Economics, College of Social Sciences, Sumner La Croix, Chair
- English, College of Languages, Linguistics, and Literature, Laura Lyons, Chair
- Information and Computer Sciences, College of Natural Sciences, David Chin, Chair
- Mathematics, College of Natural Sciences, Erik Guentner, Chair
- Physics, College of Natural Sciences, Pui Lam, Chair

5. Non-academic Support Units

List the names and titles of the individuals responsible for each of the units that provide non-academic support to the program being evaluated, e.g., library, computing facilities, placement, tutoring, etc.

Computing Facilities, Garret Yoshimi, VP for Information Technology and Chief Information Officer (www.hawaii.edu/technology)

Library Services, Irene Herold, University Librarian; Eileen Herring, Science and Technology Reference Department Head (manoa.hawaii.edu/libraries)

Faculty and Student Services, Office of Faculty Development and Academic Support, Kuykendall 107, Kathleen O. Kane (www.ofdas.hawaii.edu)

Office of Student Affairs, Queen Liliuokalani Center for Student Services, Room 409

Francisco Hernandez, Vice Chancellor for Students (studentaffairs.manoa.hawaii.edu)

Center for Career Development and Student Employment, Queen Liliuokalani Center for Student Services, Room 412, Wendy Sora, Mānoa Career Center Interim Director (manoa.hawaii.edu/careercenter)

6. Credit Unit

One semester or quarter credit represents one class hour or three laboratory hours per week. One academic year represents at least 28 weeks of classes, exclusive of final examinations.

7. Tables

Table D-1. Program Enrollment and Degree Data

D-1 Enrollment

	Academic Year		Degrees Awarded										
			1st	2nd	3rd	4th	5th			Associates	Bachelors	Masters	Doctorates
Current Year	2014	FT					20	0	8	0	0	6	3
		PT					4	0	1				
1	2013	FT				26		0	4	0	0	6	0
		PT				6		0	2				
2	2012	FT			25			0	5	0	0	5	2
		PT			4.			0	2				
3	2011	FT		31				0	5	0	0	2	3
		PT		2				0	0				
4	2010	FT	27					0	7	0	0	5	2
		PT	3					0	0				

D-2 Personnel-Spring 2015

	HEAD COUNT		FTE[2]
	FT	PT	
Administrative[2]	1		1
Faculty (tenure-track)[3]	6		6
Other Faculty (excluding student Assistants)	2		2
Student Teaching Assistants[4]	1		1
Technicians/Specialists	1		1
Office/Clerical Employees		1	.5

Others[5]			

Table D-3. Program Enrollment and Degree Data

OCEAN AND RESOURCES ENGINEERING

Academic Year	Total Undergrad	Total Grad Students		Degrees Conferred			
				Bachelor	Master	Doctor	Other
FALL 2014	0	18	FT	0	1	2	0
SPRING 2015	0	3	PT		2	0	
1. 2014	0	11	FT	0	9	3	0
	0	7	PT				
2. 2013	0	12	FT	0	5	0	0
	0	10	PT				
3. 2012	0	16	FT	0	4	2	0
	0	8	PT				
4. 2011	0	16	FT	0	2	3	0
	0	2	PT				
5. 2010	0	19	FT	0	7	2	0
	0	5	PT				

FT--full time PT--part time

Table D-4. Faculty Salary Data

OCEAN AND RESOURCES ENGINEERING

Academic Year: 2015

	Professor	Associate Professor	Assistant Professor	Instructor
Number	5	2	1	0
High	196,272.00	106,080.00	90,636.00	
Mean	139,802.40	101,160.00		
Low	114,144.00	96,240.00		

Prof- Cheung, Ertekin, Howe, Greeson, Wiltshire

Associate Prof.- Nihous, Nosal, Huang

Asst. Prof. none

Table D-5. Enrollment Trends for Past Five Academic Years

	Year 2010	Year 2011	Year 2012	Year 2013	Year 2014	Year 2015
Full-time Students	19	16	16	12	11	18
Part-time Students	5	2	8	10	7	3
Student FTE[1]	21.5	17	20	17	13	19.5
Graduates	7	2	4	5	9	4

[1] FTE = Full-Time Equivalent

**Data calculated up to Fall 2014 student enrollment

APPENDIX E

DEPARTMENT PUBLICATIONS

2015

Bai, Y. and Cheung, K.F. (2015). Dispersion and kinematics in multi-layer non-hydrostatic model. *Ocean Modelling*, in revision.

Hayatdavoodi, M. and Ertekin, R.C. (2015), "Nonlinear Wave Loads on a Submerged Deck by the Green-Naghdi Equations," *J. Offshore Mechanics and Arctic Engineering,* Vol. 137, Issue 1, February, pp. 011102-1 to 011102-9, DOI: http://dx.doi.org/10.1115/1.4028997 SOEST No. 9244.

Hayatdavoodi, M., Seiffert, B. and Ertekin, R.C. (2015), "Experiments and Calculations of Cnoidal Wave Loads on a Flat Plate in Shallow Water," *J. Ocean Engineering and Marine Energy*, Vol. 1, No. 1, February, pp. 77-99, DOI: 10.1007/s40722-014-0007-x, SOEST No. 9260.

Howe, B. M., Duennebier, F. K. , Lukas, R. The ALOHA Cabled Observatory, in Seafloor Observatories: A new vision of the Earth from the Abyss, Eds. P. Favali, L. Beranzoli and A. De Santis, Springer/Praxis Publishing, ISBN 978-3-642-11374-1, in press, 2015.

Yue, H., Lay, T., Li, L., Yamazaki, Y., Cheung, K.F., Rivera, L., Hill, E.M., Sieh, K., Kongko, W., and Muhari, A. (2015). Validation of linearity assumptions for using tsunami waveforms in joint inversion of kinematic rupture models: Application to the 2010 Mw 7.8 Mentawai tsunami earthquake. *Journal of Geophysical Research: Solid Earth*, 120, in press.

Zhao, B.B., Duan, W.Y., Ertekin, R.C. and Hayatdavoodi, M. (2015), "High-Level Green-Naghdi Wave Models for Nonlinear Wave Transformation in Three Dimensions," *J. Ocean Engineering and Marine Energy*, Vol. 1, No. 2, May, DOI: http://dx.doi.org/10.1007/s40722-014-0009-8.

Zhao, B.B., Ertekin, R.C. and Duan, W.Y. (2015) "A Comparative Study of Diffraction of Shallow-water Waves by High-Level IGN and GN Equations," *J. Computational Physics,* Vol. 283, February, pp. 129-147, DOI:http://dx.doi.org/10.1016/j.jcp.2014.11.020, SOEST No. 9247.

Zhao, B.B., Ertekin, R.C., Duan, W.Y. and Kim, J.W. (2015) "Particle Trajectory Calculations under a Solitary Wave by High-level IGN Equations," *J. Waterway, Port, Coastal and Ocean Engineering*, DOI: http://dx.doi.org/10.1061/(ASCE)WW.1943-5460.0000283

2014

Bai, Y., Cheung, K.F., Yamazaki, Y., Lay, T., and Ye, L. (2014). Surges around the Hawaiian Islands from the 1 April 2014 North Chile Mw 8.1 earthquake. *Geophysical Research Letters*, 41(23), 8512-8521.

Carter, R.W. and Ertekin, R.C. (2014), "Focusing of Wave-Induced Flow through a Submerged Disk with a Tubular Opening," *Applied Ocean Research*, Vol. 47, August, pp. 110-124.

Chen, Y., **Howe, B. M.** and C. Yang, Actively Controllable Switching for Tree Topology Seafloor Observation Networks, IEEE J. Oceanic Engineering, 10.1109/JOE.2014.2362830, 2014.

Deng, Z., Huang, Z. and Law, A.W.K. (2014). Wave power extraction from a bottom-mounted oscillating water column converter with a V-shaped channel. *Proceedings of the Royal Society A.* Vol. 470 (2167). Article No. 20140074.

Ertekin, R.C., Hayatdavoodi, M. and Kim, J.W. (2014) "On Some Solitary and Cnoidal Wave Diffraction Solutions of the Green-Naghdi Equations," *Applied Ocean Research,* Vol. 47, August, pp. 125-137.

Ertekin, R.C. and Xia, D. (2014), "Hydroelastic response of a floating runway to cnoidal waves," *Physics of Fluids*, AIP, Vol., 26, No. 2, February, pp. 027101-1 to 0127101-16.

Foster, J., Li, N., and Cheung, K.F. (2014). Sea state determination from ship-based geodetic GPS. *Journal of Atmospheric and Oceanic Technology*, 31(11), 2556-2564.

Gemba, K., Nosal, E-M, and Reed, T. (2014). Partial dereverberation used to characterize open circuit scuba diver signatures. JASA 136(2), 623-633.

Gemba, K., Nosal, E-M (2014). Estimating source spectra from recordings made in a reverberant underwater channel. 2nd International conference & exhibition on underwater acoustics, Rhodes Greece, June 2014.

Hayatdavoodi, M., Seiffert, B. and Ertekin, R.C. (2014), "Experiments and Computations of Solitary-Wave Forces on a Coastal-Bridge Deck. Part II: Plate with Girders," *Coastal Engineering,* Vol. 88, June, pp. 210-226.

He, F. and Huang, Z. (2014). Hydrodynamic performance of pile-supported OWC-type structures as breakwaters: An experimental study. *Ocean Engineering*. Vol. 88, pp. 618-626.

Howe, B. M., A Deep Cabled Observatory: Biology and Physics in the Abyss, *Eos, Trans. AGU*, 95(47), 429-430, 2014. DOI: 10.1002/2014EO470001

Korde, U. A. and Ertekin, R.C. (2014) "On wave energy focusing and conversion in open water," *Renewable Energy*, Vol. 62, February, pp. 84-99.

Li, N., Roeber, V., Yamazaki, Y., Heitmann, T.W., Bai, Y., and Cheung, K.F. (2014). Integration of coastal inundation modeling from storm tides to individual waves. *Ocean Modelling*, 83, 26-42.

Nihous, G.C., "The Method of Imbedded Lagrangian Element to estimate wave power absorption by some submerged devices," *Journal of Marine Science and Application*, 13, 134-142, 2014.

Nihous, G.C., "Maximum wave power absorption by slender bodies of arbitrary cross sections in oblique seas," *Applied Ocean Research*, 47, 17-27, 2014.

Nolte, J. and Ertekin, R.C. (2014), "Wave Power Calculations for a Wave Energy Conversion Device Connected to a Drogue," *J. Renewable and Sustainable Energy*, AIP, Vol. 6, No. 1, pp. 013117-1 to 013117-21

Rajagopalan, K. and G.C. Nihous, "Predictions of water-column properties under widespread artificial upwelling scenarios in the North Pacific Subtropical Gyre using an Ocean General Circulation Model," *Journal of Marine Environmental Engineering*, 9, 285-304, 2014.

Seiffert, B., Hayatdavoodi, M. and Ertekin, R.C. (2014), "Experiments and Computations of Solitary-Wave Forces on a Coastal-Bridge Deck. Part I: Flat Plate," *Coastal Engineering,* Vol. 88, June, pp. 194-209.

Song, H. C., **Howe, B. M.,** Brown, M. G. and R. K. Andrew, Diversity-based acoustic communication with a glider in deep water, J. Acoust. Soc. Am. Express Letters, 135, 1023–1026, (2014), DOI:http://dx.doi.org/10.1121/1.4864299

Stopa, J.E. and Cheung, K.F. (2014). Intercomparison of wind and wave data from the ECMWF Reanalysis Interim and NCEP Climate Forecast System Reanalysis. *Ocean Modelling*, 75, 65-83.

Stopa, J.E. and Cheung, K.F. (2014). Periodicity and pattern of ocean wind and wave climate. *Journal of Geophysical Research: Oceans*, 119(8), 5563–5584.

Yim, S.C., Olsen, M.J., Cheung, K.F., and Azadbahkt, M. (2014). Tsunami modeling, structural load simulation, and validation using geospatial field data. *Journal of Structural Engineering*, 140(8), A4014012.

Yue, H., Lay, T., Rivera, L.A., Bai, Y., Yamazaki, Y., Cheung, K.F., Hill, E.M., Sieh, K.E., Kongko, W., and Muhari, A. (2014). Rupture process of the 2010 Mw 7.8 Mentawai tsunami earthquake from joint inversion of near-field hr-GPS and teleseismic body wave recordings constrained by tsunami observations. *Journal of Geophysical Research: Solid Earth*, 119(7), 5574-5593.

Zhao, B.B., Duan, W.Y. and Ertekin, R.C. (2014), "Application of Higher-Level GN Theory to some Wave Transformation Problems," *Coastal Engineering*, Vol. 83, January, pp. 177–189.

Zhao, B.B., Ertekin, R.C., Duan, W.Y. and Hayatdavoodi, M. (2014). "On the steady solitary-wave solution of the Green-Naghdi equations of different levels," *Wave Motion*, Vol. 51, No. 8, December, Elsevier, DOI: 10.1016/j.wavemoti.2014.08.009

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Ardhuin, F., Lavanant, T. , Obrebski, M., Marie, L., Royer, J.Y., d'Eu, J. F., **Howe, B. M.,** Lukas, R., and J. Aucan, A numerical model for ocean ultra low frequency (UFL) noise: wave-generated acoustic-gravity and Rayleigh modes, *J. Acoust. Soc. Am.*,134, 3242-3259 (2013), DOI:http://dx.doi.org/10.1121/1.4818840.

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Chandrayadula, T. K., Colosi, J. A., Worcester, P. F., Dzieciuch, M. A., Mercer, J. A., Andrew, R. K. and **B. M. Howe**, Observations and transport theory analysis of low frequency, acoustic mode propagation in the Eastern North Pacific Ocean, *J. Acoust. Soc. of Am.*, 134, 3144-3160 (2013), DOI:http://dx.doi.org/10.1121/1.4818883.

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Howe, B., Bingham, B., Carter, G., Duennebier, F., Kraus, N., Nosal, E-M, Roth, E., VanUffelen, L. (2013). Acoustics in ocean observing: From abyssal cabled systems to gliders. International conference & exhibition on underwater acoustics, Corfu Greece, June 2013.

Howe, B., Carter, G., Nosal, E-M, Powell, B., VanUffelen, L., Chandrayadula, T., Colosi, J., Cornuelle, B., Dzieciuch, M., Worcester, P. (2013). Oceanography and Acoustics in the PhilSea10 Experiment. Pacific-Asian Marginal Seas (PAMS) Meeting, Hangzhou, China, April 23-25, 2013.

Lay, T., Ye, L., Kanamori, H., Yamazaki, Y., Cheung, K.F., and Ammon, C.J. (2013). The February 6, 2013 M_w 8.0 Santa Cruz Islands earthquake and tsunami. *Tectonophysics*, 608, 1109-1121.

Lay, T., Ye, L., Kanamori, H., Yamazaki, Y., Cheung, K.F., Kwong, K., and Koper, K.D. (2013). The October 28, 2012 M_w 7.8 Haida Gwaii underthrusting earthquake and tsunami: Slip partitioning along the Queen Charlotte Fault transpressional plate boundary. *Earth and Planetary Science Letters*, 375, 57-70.

Nihous, G.C., "Maximum wave power absorption by flexible line attenuators," *Applied Ocean Research*, 43, 68-70, 2013.

Nihous, G.C.: Chapter 16: OTEC in "Handbook of Energy," World Scientific Publishing Company, G.M. Crawley ed., 359-372, 2013.

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Nosal, E-M (2013). Chapter 8: Model-based marine mammal localization methods. In: Eds. O Adam and F Samaran, Detection Classification and Localization of Marine Mammal using Passive Acoustics – 10 years of progress. Dirac NGO, Paris.

Nosal, E-M (2013). Passive acoustic localization using received sound pressure levels. 6th International workshop on detection classification, localization and density estimation of marine mammals using passive acoustics, St. Andrews Scotland, June 2013.

Nolte, J., Ertekin, R.C., Davis, E.P. (2013), "In-Ocean experiments of a wave energy conversion device moored to an anchor and to a drogue," *J. Ocean Technology,* March, Vol. 8, No.1, pp. 72-85.

Nosal, E-M, Young, J., Host-Madsen, A. (2013). Using inter-click intervals to separate multiple odontocete click trains. JASA 134, 3987

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Rajagopalan, K. and G.C. Nihous, "An assessment of Global Ocean Thermal Energy Conversion (OTEC) resources with a high-resolution Ocean General Circulation Model," *Journal of Energy Resources Technology*, 135, 041202, 9 p., 2013.

Rajagopalan, K. and G.C. Nihous, "Estimates of global Ocean Thermal Energy Conversion (OTEC) resources using an Ocean General Circulation Model," *Renewable Energy*, 50, 532-540, 2013.

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APPENDIX F

EMPLOYER AND ALUMNI SURVEY RESULTS

Department of Ocean and Resources Engineering
School of Ocean and Earth Science and Technology
University of Hawaii at Manoa

Employer Survey 2015

Please rate the following skills, abilities, and attributes generally expected of an ocean engineering graduate by using a 5-point scale indicating low to high and marking (×) at the space provided. Rate each topic or skill in terms of its **importance** relative to our graduate's duties. Next, rate the effectiveness of the **preparation** the graduates received from our program.

Importance: 1 - Not Important, 2 - Somewhat Important, 3 – Important, 4 - Very Important, 5 - Extremely Important
Preparation: 1 - Not Prepared, 2 - Somewhat Prepared, 3 – Prepared, 4 - Well Prepared, 5 - Very Well Prepared

		Importance					Preparation				
		1	2	3	4	5	1	2	3	4	5
An understanding and ability to:											
1	apply advanced mathematics	O	O	O	O	O	O	O	O	O	O
2	apply knowledge of engineering science and principles	O	O	O	O	O	O	O	O	O	O
3	conduct lab and field experiments, analyze and interpret data	O	O	O	O	O	O	O	O	O	O
4	design and optimize engineering systems to meet the needs	O	O	O	O	O	O	O	O	O	O
5	identify, formulate, and solve engineering problems	O	O	O	O	O	O	O	O	O	O
6	work in multi-disciplinary teams and improve team performance	O	O	O	O	O	O	O	O	O	O
7	synthesize and integrate knowledge across disciplines	O	O	O	O	O	O	O	O	O	O
8	function in culturally and ethnically diverse environments	O	O	O	O	O	O	O	O	O	O
9	communicate orally in informal and prepared presentations	O	O	O	O	O	O	O	O	O	O
10	communicate in writing, business letters, and technical reports	O	O	O	O	O	O	O	O	O	O
11	use computing technology in communications	O	O	O	O	O	O	O	O	O	O
12	use computing technology in engineering analysis and design	O	O	O	O	O	O	O	O	O	O
13	use the techniques, skills, and engineering tools for ocean engineering practice	O	O	O	O	O	O	O	O	O	O
14	engage in life long learning and professional development	O	O	O	O	O	O	O	O	O	O
An understanding of:											
15	professional and ethical responsibility in engineering practice	O	O	O	O	O	O	O	O	O	O
16	product design or development from a business perspective	O	O	O	O	O	O	O	O	O	O
17	the environmental impact of engineering practice	O	O	O	O	O	O	O	O	O	O
18	the practice of ocean engineering on a global scale	O	O	O	O	O	O	O	O	O	O
19	the practice of ocean engineering and its relation to societal or cultural issues	O	O	O	O	O	O	O	O	O	O
20	Becoming a Licensed Professional Engineer	O	O	O	O	O	O	O	O	O	O

Please provide any other feedback in the space below. If you have any suggestions for improving our program, please include those as well.

EMPLOYER SURVEY 2015

Question #	Level of Importance								
An understanding and ability to:	1	2	3	4	5	#	Total	Avg.	Adj. Avg.
1 apply advanced mathematics	0	1	1	4	4	10	30	3.00	2.00
2 apply knowledge of engineering science and principles	0	0	0	3	7	10	41	4.10	3.10
3 conduct lab and field experiments, analyze and interpret data	0	1	1	4	4	10	30	3.00	2.00
4 design & optimize engineering systems to meet the needs of the marine community	0	0	2	5	3	10	29	2.90	1.90
5 identify, formulate, and solve ocean engineering problems	0	0	0	3	7	10	41	4.10	3.10
6 work in multi-disciplinary teams and improve team performance	0	0	1	5	4	10	32	3.20	2.20
7 synthesize and integrate knowledge across disciplines	0	1	3	4	2	10	24	2.40	1.40
8 function in culturally and ethnically diverse environments	1	0	4	4	1	10	22	2.20	1.20
9 commicate orally in infromal and prepared presentations	0	0	2	7	1	10	23	2.30	1.30
10 communicate in writing, business letters, and technical reports	0	0	1	7	2	10	26	2.60	1.60
11 use computer technology in communications	0	0	3	6	1	10	23	2.30	1.30
12 use computing technology in engineering analysis and design	0	0	1	4	5	10	35	3.50	2.50
13 use the techniques, skills and engineering tools for ocean engineering practice	1	0	2	2	5	10	34	3.40	2.40
14 engage in lifelong learning and professional development	0	0	2	5	3	10	29	2.90	1.90
An understanding of:									
15 professional and ethical responsibility in engineering practice	0	0	1	5	4	10	32	3.20	2.20
16 product design development or design from a business perspective	1	2	5	2	0	10	15	1.50	0.50
17 the environmental aspects of engineering practice	1	1	3	4	1	10	20	2.00	1.00
18 the practice of ocean engineering on a global scale	2	2	4	2	0	10	14	1.40	0.40
19 the practice of ocean engineering and its relation to societal or cultural issues	2	2	3	3	0	10	14	1.40	0.40
20 Becoming a Licensed Professional Engineer	1	1	2	5	1	10	20	2.00	1.00

Question #	Level of Preparation								
An understanding and ability to:	1	2	3	4	5	#	Total	Avg.	Adj. Avg.
1 apply advanced mathematics	0	1	2	5	2	10	24	2.40	1.40
2 apply knowledge of engineering science and principles	0	0	1	6	3	10	29	2.90	1.90
3 conduct lab and field experiments, analyze and interpret data	0	0	2	4	4	10	32	3.20	2.20
4 design & optimize engineering systems to meet the needs of the marine community	0	0	1	7	2	10	26	2.60	1.60
5 identify, formulate, and solve ocean engineering problems	0	0	2	5	3	10	29	2.90	1.90
6 work in multi-disciplinary teams and improve team performance	0	0	1	7	2	10	26	2.60	1.60
7 synthesize and integrate knowledge across disciplines	0	0	2	6	2	10	26	2.60	1.60
8 function in culturally and ethnically diverse environments	0	0	1	5	4	10	32	3.20	2.20
9 commicate orally in infromal and prepared presentations	0	0	1	6	3	10	29	2.90	1.90
10 communicate in writing, business letters, and technical reports	0	0	1	6	3	10	29	2.90	1.90
11 use computer technology in communications	0	0	1	5	4	10	32	3.20	2.20
12 use computing technology in engineering analysis and design	0	0	1	4	5	10	35	3.50	2.50
13 use the techniques, skills and engineering tools for ocean engineering practice	0	0	3	3	4	10	32	3.20	2.20
14 engage in lifelong learning and professional development	0	1	2	3	4	10	30	3.00	2.00
An understanding of:									
15 professional and ethical responsibility in engineering practice	0	0	0	6	4	10	32	3.20	2.20
16 product design development or design from a business perspective	1	0	7	0	2	10	25	2.50	1.50
17 the environmental aspects of engineering practice	0	0	4	4	2	10	26	2.60	1.60
18 the practice of ocean engineering on a global scale	0	1	6	1	2	10	24	2.40	1.40
19 the practice of ocean engineering and its relation to societal or cultural issues	0	1	4	2	3	10	27	2.70	1.70
20 Becoming a Licensed Professional Engineer	0	0	5	3	2	10	26	2.60	1.60

ABET Employer Survey Comments:

1) Ensure student still take programming classes, Python, Fortran, C C++.
Most students come out knowing Matlab but not basic programming.
Promote students have either a second minor, or dual discipline engineering;
Example could be, electrical and hydro; hydro and structure, metocean, etc.
Keep statistics in the program, and increase the amount of class requirement.
Ocean engineering is a lot about data, not just management, but data understanding.
Creating metocean design basis, understand joint.

2) The employee's educational background and training in ocean engineering has been an asset To the firm and will be beneficial on several forthcoming projects.

3) Employee superbly prepared for our group. Employee had outstanding skills and was very highly motivated. The ORE program produced a true champion in this employee. We only wish we could get a few more equally trained engineers.

4) Employee is highly prepared engineer. Employee met and exceeded all the goals of the program. Training employee received in ORE is invaluable in its depth and level of skill. Employee has mastered all the key ocean engineering relevant to our work. ORE emphasis on internships and working with real world problems has proved invaluable in the employee's contribution to our work. We wish we could get a second employee from the ORE program. We would not hesitate to hire more ORE graduates.

Department of Ocean and Resources Engineering
School of Ocean and Earth Science and Technology
University of Hawaii at Manoa
2014 **Alumni Survey**

Year of Graduation: _____ **Degree:** MS ☐ PhD ☐

Please rate the following skills, abilities, and attributes generally expected of an ocean engineering graduate by using a 5-point scale indicating low to high and marking (×) at the space provided. Rate each topic or skill in terms of its **importance** relative to your employment experience since graduation. Next, please rate the effectiveness of the **preparation** you received from our program

Please feel free to use the space after the list to briefly explain any of your responses, especially if you feel your preparation was less than adequate.

Importance: 1 - Not Important, 2 - Somewhat Important, 3 – Important, 4 - Very Important, 5 - Extremely Important
Preparation: 1 - Not Prepared, 2 - Somewhat Prepared, 3 – Prepared, 4 - Well Prepared, 5 - Very Well Prepared

		Importance					Preparation				
		1	2	3	4	5	1	2	3	4	5
An understanding and ability to:											
1	apply advanced mathematics	O	O	O	O	O	O	O	O	O	O
2	apply knowledge of engineering science and mechanics	O	O	O	O	O	O	O	O	O	O
3	apply knowledge of an ocean engineering subdiscipline (coastal, offshore or ocean resources)	O	O	O	O	O	O	O	O	O	O
4	conduct lab and field experiments and/or analyze and interpret data	O	O	O	O	O	O	O	O	O	O
5	design and optimize engineering systems to meet the needs of the marine community	O	O	O	O	O	O	O	O	O	O
6	identify, formulate, and solve ocean engineering problems	O	O	O	O	O	O	O	O	O	O
7	function on multi-disciplinary or cross-functional teams	O	O	O	O	O	O	O	O	O	O
8	synthesize and integrate knowledge across disciplines	O	O	O	O	O	O	O	O	O	O
9	function in culturally and ethnically diverse environments	O	O	O	O	O	O	O	O	O	O
10	communicate orally, informally, and in prepared talks	O	O	O	O	O	O	O	O	O	O
11	communicate in writing, in business letters, and technical reports	O	O	O	O	O	O	O	O	O	O
12	use computing technology in communications	O	O	O	O	O	O	O	O	O	O
13	use computing technology in engineering analysis and design	O	O	O	O	O	O	O	O	O	O
14	use the techniques, skills, and engineering tools for ocean engineering practice	O	O	O	O	O	O	O	O	O	O
15	engage in life long learning and professional development	O	O	O	O	O	O	O	O	O	O
An understanding of:											
16	professional and ethical responsibility in engineering practice	O	O	O	O	O	O	O	O	O	O
17	product development or design from a business perspective	O	O	O	O	O	O	O	O	O	O
18	research and contemporary issues in and beyond the marine community	O	O	O	O	O	O	O	O	O	O
19	the environmental aspects of engineering practice	O	O	O	O	O	O	O	O	O	O
20	the practice of ocean engineering on a global scale	O	O	O	O	O	O	O	O	O	O
21	the relation of ocean engineering practice to societal or cultural issues	O	O	O	O	O	O	O	O	O	O
22	Becoming a Licensed Professional Engineer	O	O	O	O	O	O	O	O	O	O

Additional Comments: _____

SURVEY CONTINUED ON BACK

Please answer the following questions:

	1	2	3	4	5
Are you currently working in a field related to Ocean and Resources Engineering? (1 not related at all, 5 very related)	O	O	O	O	O
Overall, how satisfied are you with the education you received in ORE at UH? (1 not satisfied at all, 5 very satisfied)	O	O	O	O	O

	Y	N	
Licensed Professional Engineer (Y/N, if yes, give year)	O	O	_____
Passed the Fundamentals Examination (formerly known as the EIT) (Y/N, if yes, give year)	O	O	_____
Has your employer recruited/hired UH ORE graduates within the last 5-10 years? (Y/N)	O	O	
Have participated in a continuing education activity(ies) – (do not include graduate degrees)	O	O	
Have attended a professional/technical society conference(s)	O	O	

What is your annual salary range (US dollars)?

- O < $40,000
- O $40,000-$50000
- O $50,000-$60000
- O $60,000-$80000
- O >$80000

In your opinion, what job options are available today for graduates in Ocean and Resources Engineering?

_____

_____

_____

Please list what you consider the strengths of the Ocean and Resources Engineering program to be in preparation for your career?

_____

_____

_____

What do you consider the weaknesses of the Ocean and Resources Engineering program to be in preparation for your career?

_____

_____

_____

ALUMNI SURVEY

Question #	Level of Importance 1	2	3	4	5	#	Total	Avg.	Adj. Avg.	Level of Preparation 1	2	3	4	5	#	Total	Avg.	Adj. Avg.
An understanding and ability to:																		
1 apply advanced mathematics		5	13	14	10	42	447	10.64	9.64		1	10	23	8	42	534	12.71	11.71
2 apply knowledge of engineering science and mechanics			2	16	24	42	862	20.52	19.52			7	19	15	41	580	14.15	13.15
3 apply knowledge of an ocean engineering sub discipline (coastal, offshore or ocean resources)	2	3	4	11	21	41	740	18.05	17.05			8	17	16	41	581	14.17	13.17
4 conduct lab and field experiments and/or analyze and interpret data	1	3	9	18	11	42	494	11.76	10.76	1	3	18	11	9	42	470	11.19	10.19
5 design and optimize engineering systems to meet the needs of the marine community	2	2	9	17	11	41	487	11.88	10.88		4	18	13	7	42	461	10.98	9.98
6 identify, formulate, and solve ocean engineering problems	2		6	17	16	41	633	15.44	14.44		1	6	21	14	42	580	13.81	12.81
7 function on multi-disciplinary or cross-functional teams			8	14	19	41	711	17.34	16.34		5	10	19	7	41	468	11.41	10.41
8 synthesize and integrate knowledge across disciplines			8	17	17	42	670	15.95	14.95		2	15	15	10	42	512	12.19	11.19
9 function in culturally and ethnically diverse environments	1	4	10	17	10	42	459	10.93	9.93		1	14	13	14	42	548	13.05	12.05
10 communicate orally, informally, and in prepared talks			4	13	25	42	878	20.90	19.90		3	11	18	10	42	516	12.29	11.29
11 communicate in writing, in business letters, and technical reports			2	15	25	42	886	21.10	20.10		1	12	16	13	42	551	13.12	12.12
12 use computing technology in communications			5	17	19	41	723	17.63	16.63		3	12	14	12	41	509	12.41	11.41
13 use computing technology in engineering analysis and design			3	7	31	41	1019	24.85	23.85		1	9	13	18	41	575	14.02	13.02
14 use the techniques, skills, and engineering tools for ocean engineering practice	2	1	3	14	22	42	789	18.79	17.79		2	9	18	13	42	551	13.12	12.12
15 engage in lifelong learning and professional development			5	19	18	42	706	16.81	15.81			13	15	14	42	564	13.43	12.43
An understanding of:																		
16 professional and ethical responsibility in engineering practice			8	22	12	42	550	13.10	12.10		3	12	18	9	42	507	12.07	11.07
17 product development or design from a business perspective		6	14	17	5	42	316	7.52	6.52	2	12	20	5	3	42	311	7.40	6.40
18 research and contemporary issues in and beyond the marine community		4	19	12	7	42	358	8.52	7.52	1	6	18	11	4	40	383	9.58	8.58
19 the environmental aspects of engineering practice		5	11	16	10	42	455	10.83	9.83		6	20	11	4	41	401	9.78	8.78
20 the practice of ocean engineering on a global scale	1	3	12	16	10	42	458	10.90	9.90	2	2	13	17	8	42	484	11.52	10.52
21 the relation of ocean engineering practice to societal or cultural issues	2	5	19	11	5	42	289	6.88	5.88	1	5	19	11	6	42	427	10.17	9.17
22 Becoming a Licensed Professional Engineer	2	3	12	14	11	42	475	11.31	10.31	1	3	18	16	4	42	445	10.60	9.60

	1	2	3	4	5				
Please answer the following questions:									
23 Are you currently working in a field related to Ocean and Resources Engineering? (1 not related at all, 5 very related)	4	1	2	7	28	42	923	21.98	20.98
24 Overall, how satisfied are you with the education you received in ORE at UH? (1 not satisfied at all, 5 very satisfied)			4	18	20	42	758	18.05	17.05

	Y	N	#	
25 Licensed Professional Engineer (Y/N, if yes, give year)	17	25	42	1990, 1993, 2010, 2014, 2013, 2008, 2010, 2000, 2003, 2001, 2004, 2007, 1998, 1986
26 Passed the Fundamentals Examination (formerly known as the EIT) (Y/N, if yes, give year)	25	16	41	1985, 1990, 1995, 2011, 2010, 2003, 2005, 2002, 1994, 1998, 1996, 2010, 2013, 2011, 2010, 2008, 1982, 2014, 2014
27 Has your employer recruited/hired UH ORE graduates within the last 5-10 years? (Y/N)	20	22	42	
28 Have participated in continuing activity(ies)-(do not include graduate degrees)	30	12	42	
29 Have attended a professional/technical society conference(s)	38	4	42	

	<$40,000	$40,000 - $50,000	$50,000 - $60,000	$60,000 - $80,000	>$80,000	#
30 What is your annual salary range (US dollars)?	2	1	5	8	26	42

Survey Stats

Year Graduated	#	Comments
1980 - 1989	4	* As early as 1984 cohort
1990 - 1999	5	
2000 - 2009	16	
2010 - 2015	17	* As recent as 2014 cohort
Total:	42	

Alumni Survey comments

Collected prior to 01/06/15

Please answer the following questions:

1. In your opinion, what job options are available today for graduates in Ocean and Resources Engineering?

- Railroad Company, Information Industry
- Civil Engineer in the desalination plant industry, Port & Harbor Designer, FS Expert on Coastal & Urban Planning, Ocean Plant Engineer
- Energy, Underwater/Offshore for Oil/Gas and Navy Applications
- AUV/ROV development, operation, and maintenance.
- Waterfront and port engineering, environmental consulting, equipment companies such as side scan sonar, coastal engineering for both private consultants and public entities such as the Corps, research and development in energy such as wave and tidal energy sea level rise consulting
- Energy sector (oil and gas), coastal engineering
- Design and analysis engineers for offshore projects; design review engineers for offshore projects
- In so far as offshore engineering programs, variety of job options are available
- Not sure. There are always demands for coastal engineer or scientist
- Naval Architect, Riser/Umbilical engineer
- Oil and gas, navy, research institutions, consulting
- Many! Graduates in ORE are given lots of tools knowledge to fit and adapt well in all kinds of sectors, being academia or the private sector, industry...
- Federal positions with the US Navy, USACE, Offshore engineering, ocean renewable energy
- Oil industry, Coastal Engineering Industry, University Faculty position, research position
- Offshore Oil & Gas, Coastal Engineering
- Coastal offshore, Emergency Planning and Preparation and Response.
- Renewable and petroleum energy industries, US Navy (military or civilian), US Army (military or civilian), Oceanographic, environmental, and meteorological related government agencies, construction and engineering firms that work in maritime areas, marine sensing and technology firms.
- Oil & Gas industry (operators and service providers), shipbuilding, coastal engineering firms, defense, government
- Offshore oil and gas, offshore renewable energy development, coastal engineering
- Coastal Engineering in East Coast and Offshore engineering jobs in the gulf region.
- Naval Architecture
- NAVFAC Engineering and Expeditionary Warfare Center, Oceans Department – Project Management and Design
- Depends on job location, consulting, certain government jobs
- Universities, federal institutes, and consultant companies
- Oil/Gas Industry or Several local Ocean Engineering Companies
- Unlimited for coastal specialization
- Many jobs available with U.S. government, especially in the military. But there are many private sector jobs available dealing with renewable energy (my interest) as well as many jobs in academia and as teachers at a variety of levels
- Not many are offered locally and specific to ORE. If interested in staying in Hawaii, you'd probably

have to get a different engineering job, or work in Academia.

- Options are limited if you want to stay in Hawaii and do ocean engineering
- Coastal and offshore engineering industry
- Engineering design and analysis, engineering team management, project management, program management
- Coastal Engineering related to coastal resilience, adaptation, and coastal flood protection. Offshore Industry
- Numerous job opportunities in ocean engineering and ocean sciences
- Academic positions (research, teaching). Jobs in industry including offshore & coastal engineering
- Coastal, offshore, ocean observation, academia, research-really anything that the department teaches
- Offshore engineering in gas and natural gas related fields, autonomous ocean monitoring equipment, offshore pipeline design, computer modeling of physical oceanic properties, deployment of instruments for scientific research, coastal engineering, harbor design.
- Oil/gas, naval architecture, renewable energy, coastal engineering
- I think job prospects are very good for those who want to practice ocean engineering
- University employment (research, teaching), I am not familiar with private opportunities

2. Please list what you consider the strengths of the Ocean and Resources Engineering program to be in preparation for your career?

- Theoretical & Numerical Work
- Ocean field Surrey during Spring or Summer Semester, Ocean Design class (class project – in field related), Hydraulic/Model test
- Practical (and field) applications of what it was taught in the classroom
- Good variety of classes, a couple of the professors were excellent in terms of the information both research practical considerations discussed in classes
- Multidisciplinary training, emphasis on wave mechanics and classical ocean engineering disciplines (as opposed to offshoots from civil/mechanical engineering disciplines).
- Offshore engineering
- Computing technology
- Many courses on the wave theory and coastal design
- Quite international. Had to chance to publish papers
- Great connections with industry and Internship opportunity. Nice to work with students with diverse background.
- In my case, having had the opportunity to do lots of field work during my time in ORE provided hands-on experience that proved very valuable when I was looking for a position. Also the diversity of courses I was exposed to allowed me to have a broad knowledge of the ORE world.
- Giving students an in depth understanding of solving ocean engineering problems. Working through a variety of practical real world problems from Naval Architecture to Coastal Engineering to Offshore Engineering
- I was impressed by the broad coverage of ORE classes, designed projects, as well as paper-writing training during my PhD program at ORE.
- Strong theoretical background in ocean engineering
- Provided sufficient background to generally apply in selected field. Background was diverse and understands many aspects of profession and related fields.

- Integrating and collaborating with multiple technical disciplines into wholistic and viable design solutions.
- Quality of faculty; solid theoretical foundation
- UH ORE program exposes and prepares students to broad topics encompassed by ORE. The multi-cultural environment and student body was helpful to prepare folks to work in similar environments outside of school.
- Focus on the fundamentals of fluid mechanics, numerical modeling and sediment transport
- A perspective of the big picture experience working with differing personality types.
- Emphasis on practical engineering – designing, building and deploying sensors and analyzing the data; Coastal Engineering – I felt I was able to design structures after the classes on Coastal Engineering
- Lots of research skills and independent study skills. Also writing skills.
- Computing technology in engineering, tools analysis, and design. Writing skills for publications and technical support.
- Numerical Analysis/Modeling
- Wide range of courses/faculty such as coastal, offshore, fundamental (turbulence)
- I was able to engage in topics that are very interesting and relevant to my career aspirations and to society, like renewable energy and climate change. The academic rigor is high, so graduates are well prepared to take on challenging tasks.
- Strong theoretical background for many of the calculations/analysis I do. Also learned practical skills-programing, data analysis, etc. that are applicable to my work.
- The professors were great, very knowledgeable and well respected, especially Dr. Cheung. The ORE department has good relationships with other companies/individuals in the ocean engineering field in Hawaii (e.g. Sea Engineering, USACE, etc.), which is a good resource for the students.
- Coastal Engineering discipline
- Practical knowledge and application of theory to developing engineering solution to ocean engineering problems. Working in and designing systems to endure in the marine environment.
- Strong theoretical background, great faculty staff, been part of the SOEST that helps expand your knowledge international group alumni
- I learned the economics of ocean energy are more challenging than the physics
- Great advisor and the ability to work on numerous projects that enhanced both technical skills and my research experience. The courses are very strong and prepare you for real life engineering.
- A strong research-oriented environment
- The department provided me with a strong foundation in ocean engineering principles, wave and coastal dynamics and hydrodynamics in particular.
- Strong research faculty, focus on numerical modeling of tsunami, lab classes with access to equipment and techniques used by ocean engineers to collect data, statistical analysis of ocean properties, availability of research assistantships especially with local companies, job prospects after school.
- Small department size
- ORE 601 and 609 are good courses
- Good overview of the field, solid master program education.

3. What do you consider the weaknesses of the Ocean and Resources Engineering program to be in preparation for your career?

- Experimental Work

- Small scale department, lab facilities, and project experiences
- Limited funding of the faculty. Also far from the mainland student lack exposure to the active research and engineering field.
- More classes on Port facilities, environmental considerations, practical aspects of design including modeling for non-research projects such as harbor development would have been a plus
- Not much focus/contact on industry requirements outside of Hawaii. The program used to be geared more towards local needs.
- No lab experience related to offshore engineering/naval architecture
- Since the department size is small, alumni are less
- The department is too small. Took too long to graduate
- Program is fairly one-sided and tends to focus coastal rather than other disciplines. Also tends to favor international/students versus domestic. Some of the professors could be nice too.
- I wish I would have been able to have information about how to become a P.E. for example.
- Exposure to additional software programs as AQWA and Orcaflex
- Trainings in theories and math are relatively weak, probably because ORE is an engineering department. These trainings will benefit ORE students if they want to become a professor or researcher after graduation.
- Take long time to graduate and limited connection to the industry due to location of school.
- Provide additional design related focus areas. Broad background was provided, but focus was generally kept in scholarly direction. Provide additional real-world design insight and experience.
- There needs to be more support for achieving recognized professional qualifications/credentials than purely academic ones.
- Limited experimental facilities for coastal & ocean engineering, virtually no interaction with industry outside Hawaii. Limited scope to consider business aspects in design during the coursework.
- Early in my offshore oil and gas career, I did a lot of work dealing with geophysical survey (multi-beam and shallow seismic), but had little exposure to this type of technology while at UH ORE.
- When I attended the focus was learning the fundamentals. There was a lack of focus on learning software tool such as the USACE software commonly used in the industry.
- None
- N/A
- Lack of large-scale wave flume
- I got the offshore structures option and those classes
- Long PhD programs, which averaged 6-7 years until end 2010 but appear to be getting shorter which is a good sign.
- I think the greatest weakness is the difficulty of finding research , lab, and field experience that directly relates to a student's interests and focus in class. For example, a student studying renewable energy does not get engage in lab or field experience in this field, and the personal research topic for the thesis may be unrelated as well, because that is at the mercy of available funds for research. If the program could expand its lab course to have 1 lab course for each of the three focus areas rather than 1 "all-encompassing" lab course, it would benefit students especially as future engineers.
- Could emphasize more how engineering design is done for a company developing a product.
- As mentioned above, I think there could have been more emphasis on using simple equations to solve problems. Understanding theory is important but not as useful if not going into research. On the other hand, more experience running coastal models would have been useful.
- Lab and field experiments
- For me specifically I would have benefited from more undersea cable design information (design

and construction) of the cable (materials and armor – not the data/power handling) and associated facilities (shore landings, etc.). For the US Navy additional focus on waterfront facilities maintenance and design would be good [although Dr. Cheung's Piers and Harbor class is excellent].

- Limited connection with the industry outside of Hawaii, office staff not so helpful and often under staff, need more presence on the web, ORE department seems to be moving to be an applied physical oceanography department instead of an engineering department, need to hire more people with engineering and design experience.
- Assist graduates and alumni in the transition to jobs and further research positions. More attention on laboratory work and taking ocean measurements.
- More variety in the courses. Better laboratory (in fact, at my time ORE didn't have a laboratory). Better computer lab and access to software. Better working environment for students.
- It would be good for the department to integrate more widely utilized open source wind and wave models into the curriculum (e.g., SWAN, ADCIRC, SELFE, DEFLFT3D, etc.) – tools that are commonly used in coastal engineering in the profession.
- Training in the use and access to widely accepted ocean engineering programs such as the Delft 3D modeling packages, Army Corps of Engineers modeling packages, and commonly used software in the offshore industry. Access to National and International conferences for all students.
- I don't think ORE 603 should be required. This is an ocean engineering department, not an oceanography department. There should be more focus on traditional ocean engineering and coastal engineering coursework.
- The acoustic program needs to be included in the fundamentals (see previous question). The qualifying exam is outdated and, in my opinion, should be replaced with publishing papers (e.g. being the 2nd author on a paper. That scope of the paper should not be the student's primary research focus and therefore contributes to overall education).

4. Additional Comments:

- All experiences and discussions during class work together with term project are very important for the present teaching job and as an expert at the government commissionary.
- Expose students to a real world by encouraging them to present paper and attend conferences. The department may need additional funds set aside to help students to attend meetings.
- My professional career after graduation is more focused on ocean-related research rather than engineering.
- Found the program to be well structured. Gave foundation necessary to succeed. Felt it was more geared towards continuing in research than general knowledge and better preparation necessary for design and project management. Though design experience was limited, sufficient foundation was available to quickly learn in the consulting environment.
- Much of my professional work uses computer software to solve engineering problems (CFD codes, computer scripts, etc.). I feel that the ORE department did an exceptional job at preparing me with a theoretical background for my work. Many of the practical skills, however, I learned on the job.
- Now that I am practicing as a coastal engineer, I'm finding that my coastal engineering courses were heavy on theory. It would have been useful to have more practical concepts and equations included.
- I currently serve the US Navy's Civil Engineer Corp as an Ocean Facilities Program Officer and Marine Engineering Dive Officer as Program Manager on a large effort installing and maintaining undersea instrumental cabal ranges.

- Overall the department is extremely strong. More attention needs to be placed on observing and more opportunity for the students to design experiments in the ocean.
- Currently working as a research and development engineer so there is not as much emphasis placed on the professional engineer license. Am planning on getting one in the case I diversity into another field of Ocean Engineering.

APPENDIX G

COURSE OUTCOMES

Course Outcome Questionnaire

Course: ORE _____ Semester: _____

Department of Ocean and Resources Engineering
School of Ocean and Earth Science and Technology
University of Hawaii at Manoa

This questionnaire is NOT a course evaluation. It determines the learning outcomes as perceived by the students or the instructor. Please rate the program outcomes using a five-point scale in terms of the students' achievement in this course.

Scale: (0) None or Not Applicable, (1) Low, (2) Reasonable, (3) High, (4) Very high

The following outcomes are inclusive of the ORE program and pre-program. Each ORE course only covers a sub-set and therefore low ratings in specific outcomes do not reflect negatively on this course. Indicate a level of "0", if a program outcome is not applicable.

This course has increased or improved the students'	Level of Achievement				
	0	1	2	3	4
1. General education necessary to understand the impact of engineering solutions in a global and societal context	O	O	O	O	O
2. Ability to apply knowledge of mathematics, science, and basic engineering topics	O	O	O	O	O
3. Proficiency in the core disciplines necessary for ocean and resources engineering practice	O	O	O	O	O
4. Knowledge of at least one of the three option areas that include coastal, offshore, and ocean resources engineering	O	O	O	O	O
5. Ability to use techniques, skills, & latest engineering tools necessary for ocean and resources engineering practice	O	O	O	O	O
6. Ability to identify, formulate, and solve ocean and resources engineering problems	O	O	O	O	O
7. Ability to design and optimize engineering systems for given design requirements and constraints	O	O	O	O	O
8. Ability to work independently and function on multi-disciplinary teams	O	O	O	O	O
9. Appreciation of professional and ethical responsibilities in engineering practice	O	O	O	O	O
10. Ability to communicate effectively to technical and non-technical audiences	O	O	O	O	O
11. Awareness of latest research and contemporary issues in and beyond the ocean and resources engineering disciplines	O	O	O	O	O
12. Recognition of the need for, and ability to engage in life-long learning and continuing professional development	O	O	O	O	O
▶ This questionnaire is completed by	Student O O Instructor				

2009-2010 Academic Year

Average Rating by Students

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education	4.0	1.8	3.4	2.9	3.0	3.0	3.0	2.0				2.2	3.3	3.0	3.7	3.8	4.0	4.0		3.5
2. Basic science, math & eng	3.0	2.6	3.4	2.6	3.6	3.3	3.0	3.0				2.5	3.3	3.5	3.8	3.0	4.0	4.0		3.0
3. Ocean engineering core	3.0	2.6	3.9	3.1	3.6	3.3	3.7	3.0				2.8	3.3	3.0	3.8	3.2	3.0	3.8		3.5
4. Ocean engineering specialization	4.0	2.6	3.6	3.3	3.9	3.3	3.7	3.0				2.8	3.3	3.0	4.0	4.0	3.0	4.0		3.5
5. Use of latest tools	3.0	2.2	4.0	2.3	3.6	3.3	2.9	2.0				1.8	3.3	3.0	3.6	2.6	4.0	3.8		3.0
6. Problem formulation and solution	3.0	2.2	3.9	2.8	3.5	2.3	3.9	3.0				2.3	3.3	3.0	3.0	2.4	4.0	3.8		3.0
7. Design and Optimization	0.0	1.4	3.6	1.6	3.1	2.3	2.7	1.0				1.7	3.3	3.0	3.3	2.0	4.0	3.5		3.5
8. Independent and team work	0.0	2.0	3.9	2.4	2.3	2.3	2.7	2.0				2.0	3.0	3.0	2.2	2.8	4.0	4.0		3.0
9. Professional and non-technical issues	0.0	2.2	2.4	2.2	2.0	1.7	2.3	2.0				2.3	3.3	2.5	2.8	3.6	4.0	3.8		3.5
10. Communication skills	0.0	1.8	3.6	2.9	1.5	2.0	2.6	3.0				3.0	2.5	2.5	2.3	4.0	4.0	4.0		3.5
11. Research and contemporary issues	4.0	1.6	3.7	3.4	3.3	2.3	2.6	1.0				2.8	3.3	3.5	3.5	4.0	4.0	4.0		4.0
12. Need for life long learning	2.0	1.8	3.1	2.8	2.6	2.3	3.0	3.0				3.0	3.3	3.0	3.0	3.6	4.0	3.8		4.0
Sum	26.00	24.80	42.43	32.25	36.00	31.67	35.95	28.00				29.33	38.75	36.00	39.10	39.00	46.00	46.25		41.00
Standard Deviation	1.70	0.40	0.42	0.50	0.75	0.59	0.51	0.78				0.46	0.25	0.30	0.60	0.69	0.39	0.17		0.36
# credits	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1

Normalized Average Rating by Credit Hours by Student

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education	0.46	0.22	0.24	0.27	0.25	0.28	0.25	0.21				0.22	0.26	0.25	0.28	0.29	0.26	0.26		0.09
2. Basic science, math & eng	0.35	0.31	0.24	0.25	0.30	0.32	0.25	0.32				0.26	0.26	0.29	0.29	0.23	0.26	0.26		0.07
3. Ocean engineering core	0.35	0.31	0.27	0.29	0.30	0.32	0.31	0.32				0.29	0.26	0.25	0.29	0.25	0.20	0.24		0.09
4. Ocean engineering specialization	0.46	0.31	0.25	0.30	0.32	0.32	0.31	0.32				0.29	0.26	0.25	0.31	0.31	0.20	0.26		0.09
5. Use of latest tools	0.35	0.27	0.28	0.21	0.30	0.32	0.24	0.21				0.19	0.26	0.25	0.28	0.20	0.26	0.24		0.07
6. Problem formulation and solution	0.35	0.27	0.27	0.26	0.29	0.22	0.32	0.32				0.24	0.26	0.25	0.23	0.18	0.26	0.24		0.07
7. Design and Optimization	0.00	0.17	0.25	0.15	0.26	0.22	0.23	0.11				0.17	0.26	0.25	0.26	0.15	0.26	0.23		0.09
8. Independent and team work	0.00	0.24	0.27	0.22	0.19	0.22	0.22	0.21				0.20	0.23	0.25	0.17	0.22	0.26	0.26		0.07
9. Professional and non-technical issues	0.00	0.27	0.17	0.20	0.17	0.16	0.19	0.21				0.24	0.26	0.21	0.22	0.28	0.26	0.24		0.09
10. Communication skills	0.00	0.22	0.25	0.27	0.13	0.19	0.21	0.32				0.31	0.19	0.21	0.18	0.31	0.26	0.26		0.09
11. Research and contemporary issues	0.46	0.19	0.26	0.31	0.27	0.22	0.21	0.11				0.29	0.25	0.29	0.27	0.31	0.26	0.26		0.10
12. Need for life long learning	0.23	0.22	0.22	0.26	0.22	0.22	0.25	0.32				0.31	0.26	0.25	0.23	0.28	0.26	0.24		0.10
Sum	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00				3.00	3.00	3.00	3.00	3.00	3.00	3.00		1.00
Standard Deviation	0.20	0.05	0.03	0.05	0.06	0.06	0.04	0.08				0.05	0.02	0.03	0.05	0.05	0.03	0.01		0.01

Course achievement ratings by students

	Total				Normalized Total			
Course Outcomes	CE	OE	OR	ALL	CE	OE	OR	ALL
1. General education	2.1	1.8	2.1	3.6	1.00	0.98	1.03	1.02
2. Basic science, math & eng	2.2	2.0	2.2	3.9	1.07	1.10	1.06	1.09
3. Ocean engineering core	2.3	2.1	2.4	4.0	1.12	1.17	1.13	1.11
4. Ocean engineering specialization	2.4	2.2	2.5	4.1	1.13	1.18	1.18	1.14
5. Use of latest tools	2.1	1.8	2.1	3.6	1.02	1.00	1.00	1.00
6. Problem formulation and solution	2.2	2.1	2.1	3.7	1.07	1.12	1.03	1.03
7. Design and Optimization	1.9	1.5	1.8	3.1	0.90	0.81	0.86	0.85
8. Independent and team work	2.0	1.7	1.9	3.2	0.94	0.92	0.89	0.90
9. Professional and non-technical issues	1.8	1.5	1.8	3.2	0.86	0.84	0.87	0.88
10. Communication skills	1.8	1.7	1.9	3.4	0.88	0.95	0.92	0.95
11. Research and contemporary issues	2.2	1.7	2.2	3.6	1.03	0.94	1.05	1.01
12. Need for life long learning	2.0	1.8	2.0	3.6	0.97	1.00	0.97	1.01
Sum	25.0	22.0	25.0	43.0	12.0	12.0	12.0	12.0
Standard Deviation	0.19	0.22	0.21	0.33	0.09	0.12	0.10	0.09

2009-2010 Academic Year

Average Rating by Instructors

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education			1	3			3	2				3			3	3	3			3
2. Basic science, math & eng			4	3			4	4				2			3	2	4			1.5
3. Ocean engineering core			3	2			4	3				2			2	2	3			1
4. Ocean engineering specialization			1	1			4	3				2			4	3	1			1.5
5. Use of latest tools			4	1			4	3				2			2	0	3			0.5
6. Problem formulation and solution			4	2			4	3				2			3	0	2			1
7. Design and Optimization			2	1			0	2				2			3	2	3			0.5
8. Independent and team work			4	3			2	2				2			0	2	4			0
9. Professional and non-technical issues			3	3			3	2				2			2	4	1			4
10. Communication skills			4	4			3	3				2			0	4	4			2.5
11. Research and comtemporary issues			3	4			4	1				2			2	4	1			4
12. Need for life long learning			1	4			2	3				2			0	3	3			3.5
Sum			34.00	31.00			37.00	31.00				25.00			24.00	29.00	32.00			23.00
Standard Deviation			1.27	1.16			1.24	0.79				0.29			1.35	1.38	1.15			1.43

Normalized Average Rating by Credit Hours by Instructor

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education			0.09	0.29			0.24	0.19				0.36			0.38	0.31	0.28			0.13
2. Basic science, math & eng			0.35	0.29			0.32	0.39				0.24			0.38	0.21	0.38			0.07
3. Ocean engineering core			0.26	0.19			0.32	0.29				0.24			0.25	0.21	0.28			0.04
4. Ocean engineering specialization			0.09	0.10			0.32	0.29				0.24			0.50	0.31	0.09			0.07
5. Use of latest tools			0.35	0.10			0.32	0.29				0.24			0.25	0.00	0.28			0.02
6. Problem formulation and solution			0.35	0.19			0.32	0.29				0.24			0.38	0.00	0.19			0.04
7. Design and Optimization			0.18	0.10			0.00	0.19				0.24			0.38	0.21	0.28			0.02
8. Independent and team work			0.35	0.29			0.16	0.19				0.24			0.00	0.21	0.38			0.00
9. Professional and non-technical issues			0.26	0.29			0.24	0.19				0.24			0.25	0.41	0.09			0.17
10. Communication skills			0.35	0.39			0.24	0.29				0.24			0.00	0.41	0.38			0.11
11. Research and comtemporary issues			0.26	0.39			0.32	0.10				0.24			0.25	0.41	0.09			0.17
12. Need for life long learning			0.09	0.39			0.16	0.29				0.24			0.00	0.31	0.28			0.15
Sum			3.00	3.00			3.00	3.00				3.00			3.00	3.00	3.00			1.00
Standard Deviation			0.11	0.11			0.10	0.08				0.03			0.17	0.14	0.11			0.06

Course achievement ratings by instructor	Total				Normalized Total			
Program Outcomes	CE	OE	OR	ALL	CE	OE	OR	ALL
1. General education	0.8	0.9	1.4	2.3	0.9	0.9	1.1	1.1
2. Basic science, math & eng	1.0	1.4	1.6	2.6	1.2	1.3	1.2	1.3
3. Ocean engineering core	0.8	1.1	1.3	2.1	1.0	1.0	1.0	1.0
4. Ocean engineering specialization	0.6	0.9	1.4	2.0	0.7	0.8	1.0	1.0
5. Use of latest tools	0.8	1.1	1.0	1.9	1.0	1.0	0.8	0.9
6. Problem formulation and solution	0.9	1.2	1.3	2.0	1.1	1.1	1.0	1.0
7. Design and Optimization	0.3	0.5	0.9	1.6	0.4	0.5	0.7	0.8
8. Independent and team work	0.8	1.0	1.0	1.8	1.0	0.9	0.8	0.9
9. Professional and non-technical issues	1.0	1.2	1.6	2.2	1.2	1.1	1.2	1.0
10. Communication skills	1.1	1.4	1.5	2.4	1.3	1.3	1.1	1.2
11. Research and comtemporary issues	1.2	1.2	1.8	2.2	1.4	1.2	1.4	1.1
12. Need for life long learning	0.8	1.1	1.1	1.9	0.9	1.0	0.8	0.9
Sum	10.0	13.0	16.0	25.0	12.0	12.0	12.0	12.0
Standard Deviation	0.23	0.25	0.29	0.28	0.28	0.23	0.21	0.13

2010-2011 Academic Year

Average Rating by Students

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education		3.2	2.6	3.2	3.0	3.5	3.0			3.0		3.3	2.0		3.0		3.7	3.5	3.4	3.0
2. Basic science, math & eng		3.5	2.8	2.9	3.6	3.5	3.5			3.0		3.3	3.0		2.3		3.5	3.2	3.4	3.0
3. Ocean engineering core		3.2	3.4	3.2	3.5	3.5	3.3			3.0		3.0	3.0		2.3		3.0	3.5	3.1	3.0
4. Ocean engineering specializat		3.3	3.4	3.2	3.9	3.5	3.3			4.0		3.0	3.5		3.0		1.8	3.7	2.0	3.0
5. Use of latest tools		2.9	3.6	2.1	3.6	3.5	2.5			2.5		2.0	3.0		1.8		3.5	3.7	2.4	3.0
6. Problem formulation and solut		3.4	2.6	2.5	3.7	3.5	3.5			3.0		2.7	3.0		3.0		2.8	3.7	2.0	3.0
7. Design and Optimization		2.6	3.0	1.8	3.6	3.5	2.3			2.0		3.0	3.5		2.8		2.8	3.2	3.0	3.0
8. Independent and team work		2.6	3.2	2.0	2.8	3.5	2.0			3.0		3.0	3.5		2.0		3.2	3.7	3.1	3.0
9. Professional and non-technica		2.6	2.0	2.3	1.9	3.5	2.0			2.0		1.7	2.5		1.8		2.2	2.8	2.7	3.0
10. Communication skills		2.4	2.4	2.7	1.8	3.5	2.0			2.5		3.3	3.0		1.8		3.0	3.6	2.9	3.0
11. Research and comtemporary		2.5	2.2	3.1	3.4	3.5	2.8			3.5		4.0	3.0		3.3		2.5	3.8	2.8	3.0
12. Need for life long learning		3.0	2.4	3.1	3.0	3.5	3.3			3.5		2.7	2.0		2.5		3.0	3.3	2.7	3.0
Sum		35.2	33.6	32.0	37.8	42.0	33.3			35.0		35.0	35.0		29.3		35.0	41.6	33.3	36.0
Standard Deviation		0.4	0.5	0.5	0.7	0.0	0.6			0.6		0.6	0.5		0.6		0.5	0.3	0.5	0.0
# credits	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1

Normalized Average Rating by Credit Hours by Student

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education		0.27	0.23	0.30	0.24	0.25	0.27			0.26		0.29	0.17		0.31		0.31	0.25	0.30	0.08
2. Basic science, math & eng		0.29	0.25	0.27	0.28	0.25	0.32			0.26		0.29	0.26		0.23		0.30	0.23	0.31	0.08
3. Ocean engineering core		0.27	0.30	0.30	0.28	0.25	0.29			0.26		0.26	0.26		0.23		0.26	0.25	0.28	0.08
4. Ocean engineering specializat		0.28	0.30	0.30	0.31	0.25	0.29			0.34		0.26	0.30		0.31		0.16	0.26	0.18	0.08
5. Use of latest tools		0.25	0.32	0.20	0.28	0.25	0.23			0.21		0.17	0.26		0.18		0.30	0.26	0.21	0.08
6. Problem formulation and solut		0.29	0.23	0.23	0.29	0.25	0.32			0.26		0.23	0.26		0.31		0.24	0.26	0.18	0.08
7. Design and Optimization		0.22	0.27	0.17	0.28	0.25	0.20			0.17		0.26	0.30		0.28		0.24	0.23	0.27	0.08
8. Independent and team work		0.22	0.29	0.19	0.22	0.25	0.18			0.26		0.26	0.30		0.21		0.27	0.26	0.27	0.08
9. Professional and non-technica		0.22	0.18	0.21	0.15	0.25	0.18			0.17		0.14	0.21		0.18		0.19	0.20	0.24	0.08
10. Communication skills		0.20	0.21	0.26	0.15	0.25	0.18			0.21		0.29	0.26		0.18		0.26	0.26	0.26	0.08
11. Research and comtemporary		0.22	0.20	0.29	0.27	0.25	0.25			0.30		0.34	0.26		0.33		0.21	0.27	0.25	0.08
12. Need for life long learning		0.26	0.21	0.29	0.24	0.25	0.29			0.30		0.23	0.17		0.26		0.26	0.24	0.24	0.08
Sum		3.00	3.00	3.00	3.00	3.00	3.00			3.00		3.00	3.00		3.00		3.00	3.00	3.00	1.00
Standard Deviation		0.03	0.05	0.05	0.05	0.00	0.05			0.05		0.05	0.04		0.06		0.05	0.02	0.04	0.00

Program achievement ratings by	Total				Normalized Total			
Course Outcomes	CE	OE	OR	ALL	CE	OE	OR	ALL
1. General education	1.8	1.6	2.0	3.5	0.99	1.04	1.07	1.06
2. Basic science, math & eng	2.0	1.7	2.0	3.6	1.08	1.09	1.07	1.09
3. Ocean engineering core	2.0	1.8	2.0	3.6	1.11	1.12	1.10	1.07
4. Ocean engineering specializat	2.1	1.8	2.1	3.6	1.16	1.16	1.17	1.09
5. Use of latest tools	1.9	1.6	1.8	3.2	1.03	1.03	0.98	0.96
6. Problem formulation and solut	2.0	1.7	2.0	3.4	1.07	1.08	1.10	1.03
7. Design and Optimization	1.8	1.5	1.7	3.2	0.96	0.92	0.95	0.97
8. Independent and team work	1.8	1.5	1.7	3.3	0.96	0.92	0.90	0.98
9. Professional and non-technica	1.5	1.2	1.4	2.6	0.79	0.78	0.77	0.79
10. Communication skills	1.6	1.3	1.5	3.0	0.87	0.85	0.83	0.91
11. Research and comtemporary	1.8	1.6	1.9	3.5	1.00	1.00	1.04	1.06
12. Need for life long learning	1.8	1.6	1.9	3.3	0.97	1.02	1.02	1.00
Sum	22.00	19.00	22.00	40.00	12.00	12.00	12.00	12.00
Standard Deviation	0.19	0.18	0.21	0.29	0.10	0.11	0.12	0.09

2010-2011 Academic Year

Average Rating by Instructors

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education		4		4													2	3	0	4
2. Basic science, math & eng		3		3													4	3	4	1
3. Ocean engineering core		3		2													3	2	2	2
4. Ocean engineering specialization		4		2													2	4	0	2
5. Use of latest tools		4		1													4	2	2	2
6. Problem formulation and solution		4		2													4	3	2	2
7. Design and Optimization		2		0													2	3	2	1
8. Independent and team work		3		2													3	3	2	1
9. Professional and non-technical issues		3		3													1	2	0	4
10. Communication skills		3		4													2	3	2	2
11. Research and comtemporary issues		3		4													2	2	4	4
12. Need for life long learning		4		3													3	2	0	4
Sum		40.00		30.00													32.00	32.00	20.00	29.00
Standard Deviation		0.65		1.24													0.98	0.65	1.44	1.24

Normalized Average Rating by Credit Hours by Instructor

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education		0.30		0.40													0.19	0.28	0.00	0.14
2. Basic science, math & eng		0.23		0.30													0.38	0.28	0.60	0.03
3. Ocean engineering core		0.23		0.20													0.28	0.19	0.30	0.07
4. Ocean engineering specialization		0.30		0.20													0.19	0.38	0.00	0.07
5. Use of latest tools		0.30		0.10													0.38	0.19	0.30	0.07
6. Problem formulation and solution		0.30		0.20													0.38	0.28	0.30	0.07
7. Design and Optimization		0.15		0.00													0.19	0.28	0.30	0.03
8. Independent and team work		0.23		0.20													0.28	0.28	0.30	0.03
9. Professional and non-technical issues		0.23		0.30													0.09	0.19	0.00	0.14
10. Communication skills		0.23		0.40													0.19	0.28	0.30	0.07
11. Research and comtemporary issues		0.23		0.40													0.19	0.19	0.60	0.14
12. Need for life long learning		0.30		0.30													0.28	0.19	0.00	0.14
Sum		3.00		3.00													3.00	3.00	3.00	1.00
Standard Deviation		0.05		0.12													0.09	0.06	0.22	0.04

Course achievement ratings by instructor	Total				Normalized Total			
Course Outcomes	CE	OE	OR	ALL	CE	OE	OR	ALL
1. General education	1.1	1.1	1.1	1.3	1.3	1.3	1.3	1.0
2. Basic science, math & eng	0.8	0.8	0.8	1.8	1.0	1.0	1.0	1.4
3. Ocean engineering core	0.7	0.7	0.7	1.3	0.8	0.8	0.8	0.9
4. Ocean engineering specialization	0.9	0.9	0.9	1.1	1.1	1.1	1.1	0.8
5. Use of latest tools	0.7	0.7	0.7	1.3	0.8	0.8	0.8	1.0
6. Problem formulation and solution	0.9	0.9	0.9	1.5	1.0	1.0	1.0	1.1
7. Design and Optimization	0.5	0.5	0.5	1.0	0.6	0.6	0.6	0.7
8. Independent and team work	0.7	0.7	0.7	1.3	0.9	0.9	0.9	1.0
9. Professional and non-technical issues	0.9	0.9	0.9	0.9	1.0	1.0	1.0	0.7
10. Communication skills	1.0	1.0	1.0	1.5	1.2	1.2	1.2	1.1
11. Research and comtemporary issues	1.0	1.0	1.0	1.7	1.1	1.1	1.1	1.3
12. Need for life long learning	0.9	0.9	0.9	1.2	1.1	1.1	1.1	0.9
Sum	10.00	10.00	10.00	16.00	12.00	12.00	12.00	12.00
Standard Deviation	0.17	0.17	0.17	0.27	0.21	0.21	0.21	0.20

2011-2012 Academic Year

Average Rating by Students

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education	3.4	3.2	4.0	3.1	3.1		3.5	2.9				3.7	3.7	3.3	3.6	3.4	2.4	3.8		4.0
2. Basic science, math & eng	2.2	3.3	3.5	3.0	3.7		3.9	2.7				3.3	3.7	3.9	3.4	2.6	3.8	4.0		0.0
3. Ocean engineering core	3.4	3.4	4.0	3.1	3.7		4.0	2.7				3.0	4.0	3.8	3.4	3.4	3.2	3.8		1.0
4. Ocean engineering specialization	3.0	3.6	3.5	3.5	3.8		4.0	3.1				3.7	3.7	3.9	4.0	3.4	3.0	2.0		2.0
5. Use of latest tools	3.8	3.4	4.0	2.8	3.2		3.4	2.4				3.0	2.7	3.7	3.4	2.8	3.8	3.3		0.0
6. Problem formulation and solution	3.4	3.3	4.0	2.6	3.3		4.0	2.6				2.7	3.7	3.7	3.0	2.2	3.6	3.0		1.0
7. Design and Optimization	3.6	3.3	4.0	2.3	3.2		3.3	2.3				3.0	4.0	2.7	3.4	1.8	3.2	3.3		0.0
8. Independent and team work	2.2	3.4	3.8	2.6	2.8		3.0	1.4				2.0	1.3	2.6	2.3	2.6	2.6	4.0		0.0
9. Professional and non-technical issu	3.8	3.4	2.8	2.5	2.8		2.8	2.6				2.3	1.7	2.2	2.7	3.4	2.2	3.5		4.0
10. Communication skills	3.6	3.4	3.5	3.3	2.5		2.7	2.1				2.0	1.7	3.2	1.9	4.0	2.8	3.5		0.0
11. Research and comtemporary issu	3.8	3.7	3.0	3.5	3.0		3.3	2.9				3.3	3.0	3.9	3.7	3.4	2.2	3.0		4.0
12. Need for life long learning	4.0		3.8	3.3	3.3		3.4	3.1				3.0	1.3	3.1	3.0	3.6	3.4	3.3		4.0
Sum	40.20	37.67	43.75	35.66	38.25		41.18	30.86				35.00	34.33	39.89	37.86	36.60	36.20	40.25		20.00
Standard Deviation	0.60	0.12	0.42	0.41	0.39		0.46	0.47				0.57	1.08	0.58	0.62	0.64	0.58	0.55		1.83
# credits	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1

Normalized Average Rating by Credit Hours by Student

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education	0.25	0.26	0.27	0.26	0.24		0.25	0.28				0.31	0.32	0.25	0.28	0.28	0.20	0.28		0.20
2. Basic science, math & eng	0.16	0.27	0.24	0.25	0.29		0.28	0.26				0.29	0.32	0.29	0.27	0.21	0.31	0.30		0.00
3. Ocean engineering core	0.25	0.27	0.27	0.26	0.29		0.29	0.26				0.26	0.35	0.28	0.27	0.28	0.27	0.28		0.05
4. Ocean engineering specialization	0.22	0.28	0.24	0.30	0.29		0.29	0.31				0.31	0.32	0.29	0.32	0.28	0.25	0.15		0.10
5. Use of latest tools	0.28	0.27	0.27	0.24	0.25		0.25	0.24				0.26	0.23	0.28	0.27	0.23	0.31	0.24		0.00
6. Problem formulation and solution	0.25	0.27	0.27	0.22	0.26		0.29	0.25				0.23	0.32	0.28	0.24	0.18	0.30	0.22		0.05
7. Design and Optimization	0.27	0.27	0.27	0.19	0.25		0.24	0.22				0.26	0.35	0.20	0.27	0.15	0.27	0.24		0.00
8. Independent and team work	0.16	0.27	0.26	0.22	0.22		0.22	0.14				0.17	0.12	0.19	0.18	0.21	0.22	0.30		0.00
9. Professional and non-technical issu	0.28	0.27	0.19	0.21	0.22		0.21	0.25				0.20	0.15	0.17	0.22	0.28	0.18	0.26		0.20
10. Communication skills	0.27	0.27	0.24	0.28	0.20		0.20	0.21				0.17	0.15	0.24	0.15	0.33	0.23	0.26		0.00
11. Research and comtemporary issu	0.28	0.29	0.21	0.30	0.24		0.24	0.28				0.29	0.26	0.29	0.29	0.28	0.18	0.22		0.20
12. Need for life long learning	0.30		0.26	0.28	0.26		0.25	0.31				0.26	0.12	0.23	0.24	0.30	0.28	0.24		0.20
Sum	3.00	3.00	3.00	3.00	3.00		3.00	3.00				3.00	3.00	3.00	3.00	3.00	3.00	3.00		1.00
Standard Deviation	0.04	0.01	0.03	0.03	0.03		0.03	0.05				0.05	0.09	0.04	0.05	0.05	0.05	0.04		0.09

Program achievement ratings by stud Total					Normalized Total			
Course Outcomes	CE	OE	OR	ALL	CE	OE	OR	ALL
1. General education	2.34	2.04	2.33	3.69	1.12	1.11	1.12	1.11
2. Basic science, math & eng	2.24	1.89	2.11	3.59	1.08	1.03	1.01	1.08
3. Ocean engineering core	2.35	1.98	2.27	3.69	1.13	1.08	1.09	1.11
4. Ocean engineering specialization	2.27	1.96	2.25	3.73	1.09	1.07	1.08	1.12
5. Use of latest tools	2.03	1.76	2.02	3.34	0.97	0.96	0.97	1.00
6. Problem formulation and solution	2.18	1.84	2.01	3.38	1.05	1.00	0.96	1.01
7. Design and Optimization	2.01	1.68	1.88	3.18	0.97	0.92	0.90	0.95
8. Independent and team work	1.80	1.63	1.89	2.72	0.86	0.89	0.91	0.82
9. Professional and non-technical issu	1.86	1.80	2.05	2.99	0.89	0.98	0.98	0.90
10. Communication skills	1.83	1.65	1.92	2.92	0.88	0.90	0.92	0.88
11. Research and comtemporary issu	2.25	1.97	2.27	3.57	1.08	1.08	1.09	1.07
12. Need for life long learning	1.83	1.79	2.01	3.21	0.88	0.97	0.97	0.96
Sum	25.00	22.00	25.00	40.00	12.00	12.00	12.00	12.00
Standard Deviation	0.21	0.14	0.16	0.34	0.10	0.08	0.08	0.10

2011-2012 Academic Year

Average Rating by Instructors

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education	4	3		3			3	3							3	4	2	3		4
2. Basic science, math & eng	2	4		2			4	4							3	1	4	3		2
3. Ocean engineering core	3	3		3			4	4							2	3	3	2		2
4. Ocean engineering specializa	2	4		3			4	4							4	4	1	3		3
5. Use of latest tools	3	4		1			4	3							2	2	3	2		1
6. Problem formulation and sol	3	4		2			4	4							3	3	3	3		2
7. Design and Optimization	2	4		2			0	2							3	2	1	3		1
8. Independent and team work	2	4		3			2	0							0	3	2	3		0
9. Professional and non-technic	4	3		3			0	2							2	4	1	3		3
10. Communication skills	3	4		4			2	0							0	4	2	3		1
11. Research and comtemporar	4	4		4			4	3							2	4	3	3		4
12. Need for life long learning	4	3		4			0	2							0	4	3	3		4
Sum	36.00	44.00		34.00			31.00	31.00							24.00	38.00	28.00	34.00		27.00
Standard Deviation	0.85	0.49		0.94			1.73	1.44							1.35	1.03	0.98	0.39		1.36

Normalized Average Rating by Credit Hours by Instructor

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education	0.3	0.2		0.3			0.3	0.3							0.4	0.3	0.2	0.3		0.1
2. Basic science, math & eng	0.2	0.3		0.2			0.4	0.4							0.4	0.1	0.4	0.3		0.1
3. Ocean engineering core	0.3	0.2		0.3			0.4	0.4							0.3	0.2	0.3	0.2		0.1
4. Ocean engineering specializa	0.2	0.3		0.3			0.4	0.4							0.5	0.3	0.1	0.3		0.1
5. Use of latest tools	0.3	0.3		0.1			0.4	0.3							0.3	0.2	0.3	0.2		0.0
6. Problem formulation and sol	0.3	0.3		0.2			0.4	0.4							0.4	0.2	0.3	0.3		0.1
7. Design and Optimization	0.2	0.3		0.2			0.0	0.2							0.4	0.2	0.1	0.3		0.0
8. Independent and team work	0.2	0.3		0.3			0.2	0.0							0.0	0.2	0.2	0.3		0.0
9. Professional and non-technic	0.3	0.2		0.3			0.0	0.2							0.3	0.3	0.1	0.3		0.1
10. Communication skills	0.3	0.3		0.4			0.2	0.0							0.0	0.3	0.2	0.3		0.0
11. Research and comtemporar	0.3	0.3		0.4			0.4	0.3							0.3	0.3	0.3	0.3		0.1
12. Need for life long learning	0.3	0.2		0.4			0.0	0.2							0.0	0.3	0.3	0.3		0.1
Sum	3.00	3.00		3.00			3.00	3.00							3.00	3.00	3.00	3.00		1.00
Standard Deviation	0.07	0.03		0.08			0.17	0.14							0.17	0.08	0.11	0.03		0.05

Course achievement ratings by Total					Normalized Total			
Course Outcomes	CE	OE	OR	ALL	CE	OE	OR	ALL
1. General education	1.2	1.5	1.9	2.4	1.1	1.1	1.2	1.1
2. Basic science, math & eng	1.2	1.6	1.6	2.4	1.1	1.2	1.0	1.2
3. Ocean engineering core	1.1	1.5	1.6	2.3	1.0	1.1	1.0	1.1
4. Ocean engineering specializa	1.3	1.7	2.1	2.6	1.2	1.3	1.3	1.3
5. Use of latest tools	1.0	1.3	1.4	2.0	0.9	0.9	0.9	1.0
6. Problem formulation and sol	1.2	1.6	1.8	2.5	1.1	1.2	1.1	1.2
7. Design and Optimization	0.8	0.9	1.3	1.6	0.7	0.7	0.8	0.8
8. Independent and team work	1.0	1.0	1.2	1.4	0.9	0.7	0.8	0.7
9. Professional and non-technic	0.8	1.0	1.4	1.7	0.8	0.8	0.9	0.8
10. Communication skills	1.1	1.1	1.4	1.7	1.0	0.8	0.9	0.8
11. Research and comtemporar	1.4	1.7	2.0	2.6	1.3	1.3	1.3	1.2
12. Need for life long learning	1.0	1.2	1.3	1.8	0.9	0.9	0.8	0.9
Sum	13.00	16.00	19.00	25.00	12.00	12.00	12.00	12.00
Standard Deviation	0.19	0.28	0.30	0.43	0.17	0.21	0.19	0.21

2012-2013 Academic Year

Average Rating by Students

Program Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1 General education	3.5	3.3	2.9	3.3	3.3	0.0	2.3						3.5		2.3	3.7	3.3	4.0		3.2
2. Basic science, math & eng	2.8	3.3	3.2	3.3	3.6	3.0	3.5						4.0		2.7	2.3	3.7	3.9		1.7
3. Ocean engineering core	3.3	3.8	3.3	3.4	3.7	3.0	3.5						4.0		2.3	3.0	3.0	3.7		2.3
4. Ocean engineering specialization	3.8	3.3	2.9	3.0	3.9	3.0	3.5						4.0		3.0	3.0	3.0	4.0		3.5
5. Use of latest tools	2.8	3.5	3.7	2.7	3.6	4.0	2.3						4.0		2.7	2.3	3.6	3.4		2.5
6. Problem formulation and solution	2.8	3.0	3.0	2.7	3.4	4.0	2.8						4.0		2.7	3.0	3.9	4.0		2.5
7. Design and Optimization	1.5	2.3	3.2	1.9	3.4	3.0	2.0						4.0		2.7	3.3	3.4	3.6		2.5
8. Independent and team work	2.3	3.5	3.3	2.3	3.6	2.0	1.8						3.5		2.3	4.0	3.6	3.7		1.8
9. Professional and non-technical issues	2.8	3.5	2.4	2.4	3.3	3.0	2.5						3.5		2.3	4.0	3.3	3.0		2.0
10. Communication skills	2.8	2.8	3.3	2.7	2.4	3.0	2.0						2.5		2.3	4.0	3.4	3.7		2.8
11. Research and contemporary issues	3.8	2.3	3.1	2.9	3.6	3.0	1.8						2.5		3.0	3.7	3.6	3.7		4.0
12. Need for life long learning	3.5	2.8	3.0	2.7	2.4	3.0	2.0						3.5		3.3	3.7	3.7	3.3		3.3
Sum	35.25	37.08	37.44	33.29	40.14	34.00	29.75						43.00		31.67	40.00	41.43	44.00		32.13
Standard Deviation	0.66	0.50	0.31	0.45	0.46	1.03	0.68						0.56		0.33	0.60	0.27	0.31		0.71
# credits	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1

Normalized Average Rating by Credit Hours by Student

Program Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education	0.30	0.26	0.23	0.30	0.25	0.00	0.23						0.24		0.22	0.28	0.24	0.27		0.10
2. Basic science, math & eng	0.23	0.26	0.26	0.30	0.27	0.26	0.35						0.28		0.25	0.18	0.27	0.26		0.05
3. Ocean engineering core	0.28	0.30	0.27	0.31	0.28	0.26	0.35						0.28		0.22	0.23	0.22	0.25		0.07
4. Ocean engineering specialization	0.32	0.27	0.23	0.27	0.29	0.26	0.35						0.28		0.28	0.23	0.22	0.27		0.11
5. Use of latest tools	0.23	0.28	0.29	0.24	0.27	0.35	0.23						0.28		0.25	0.18	0.26	0.23		0.08
6. Problem formulation and solution	0.23	0.24	0.24	0.24	0.26	0.35	0.28						0.28		0.25	0.23	0.28	0.27		0.08
7. Design and Optimization	0.13	0.18	0.26	0.17	0.26	0.26	0.20						0.28		0.25	0.25	0.25	0.24		0.08
8. Independent and team work	0.19	0.28	0.27	0.21	0.27	0.18	0.18						0.24		0.22	0.30	0.26	0.25		0.06
9. Professional and non-technical issues	0.23	0.28	0.20	0.22	0.25	0.26	0.25						0.24		0.22	0.30	0.24	0.20		0.06
10. Communication skills	0.23	0.22	0.27	0.24	0.18	0.26	0.20						0.17		0.22	0.30	0.25	0.25		0.09
11. Research and contemporary issues	0.32	0.18	0.25	0.26	0.27	0.26	0.18						0.17		0.28	0.28	0.26	0.25		0.12
12. Need for life long learning	0.30	0.22	0.24	0.24	0.18	0.26	0.20						0.24		0.32	0.28	0.27	0.22		0.10
Sum	3.00	3.00	3.00	3.00	3.00	3.00	3.00						3.00		3.00	3.00	3.00	3.00		1.00
Standard Deviation	0.06	0.04	0.02	0.04	0.03	0.09	0.07						0.04		0.03	0.05	0.02	0.02		0.02

Program achievement ratings by students

	Total				Normalized Total			
Program Outcomes	CE	OE	OR	ALL	CE	OE	OR	ALL
1. General education	1.9	1.6	2.1	2.6	1.02	1.03	1.02	0.92
2. Basic science, math & eng	2.0	1.8	2.2	3.0	1.11	1.11	1.05	1.06
3. Ocean engineering core	2.1	1.8	2.3	3.0	1.15	1.16	1.10	1.07
4. Ocean engineering specialization	2.1	1.8	2.3	3.1	1.13	1.13	1.11	1.08
5. Use of latest tools	1.9	1.6	2.1	2.9	1.04	1.03	0.99	1.04
6. Problem formulation and solution	1.9	1.6	2.1	3.0	1.03	1.02	1.00	1.06
7. Design and Optimization	1.7	1.4	1.9	2.7	0.91	0.88	0.91	0.95
8. Independent and team work	1.8	1.5	2.0	2.7	0.96	0.95	0.97	0.96
9. Professional and non-technical issues	1.7	1.5	2.0	2.7	0.93	0.92	0.95	0.96
10. Communication skills	1.6	1.5	2.0	2.7	0.89	0.92	0.95	0.94
11. Research and contemporary issues	1.7	1.5	2.1	2.8	0.92	0.95	0.99	0.98
12. Need for life long learning	1.7	1.4	2.0	2.8	0.91	0.90	0.96	0.98
Sum	22.00	19.00	25.00	34.00	12.00	12.00	12.00	12.00
Standard Deviation	0.17	0.15	0.12	0.16	0.09	0.10	0.06	0.06

2012-2013 Academic Year

Average Rating by Instructors

Program Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education			4.0	3.0			4.0								3.0	3.0	2.0	3.0		3.0
2. Basic science, math & eng			4.0	2.0			4.0								3.0	2.0	4.0	3.0		0.0
3. Ocean engineering core			3.0	3.0			4.0								2.0	3.0	4.0	2.0		0.0
4. Ocean engineering specializatio			3.0	2.0			3.0								4.0	3.0	2.0	4.0		2.0
5. Use of latest tools			4.0	1.0			3.0								2.0	3.0	4.0	2.0		0.0
6. Problem formulation and soluti			4.0	2.0			3.0								3.0	3.0	3.0	3.0		0.0
7. Design and Optimization			4.0	1.0			2.0								3.0	3.0	3.0	4.0		0.0
8. Independent and team work			4.0	2.0			3.0								0.0	3.0	3.0	3.0		0.0
9. Professional and non-technical			3.0	3.0			4.0								2.0	4.0	1.0	2.0		3.0
10. Communication skills			4.0	3.0			3.0								0.0	3.0	2.0	4.0		0.0
11. Research and comtemporary i			4.0	4.0			4.0								2.0	4.0	2.0	2.0		3.0
12. Need for life long learning			4.0	4.0			4.0								0.0	4.0	3.0	2.0		3.0
Sum			45.00	30.00			41.00								24.00	38.00	33.00	34.00		14.00
Standard Deviation			0.45	1.00			0.67								1.35	0.58	0.97	0.83		1.47

Normalized Average Rating by Credit Hours by Instructor

Program Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education			0.3	0.3			0.3								0.4	0.2	0.2	0.3		0.2
2. Basic science, math & eng			0.3	0.2			0.3								0.4	0.2	0.4	0.3		0.0
3. Ocean engineering core			0.2	0.3			0.3								0.3	0.2	0.4	0.2		0.0
4. Ocean engineering specializatio			0.2	0.2			0.2								0.5	0.2	0.2	0.4		0.1
5. Use of latest tools			0.3	0.1			0.2								0.3	0.2	0.4	0.2		0.0
6. Problem formulation and soluti			0.3	0.2			0.2								0.4	0.2	0.3	0.3		0.0
7. Design and Optimization			0.3	0.1			0.1								0.4	0.2	0.3	0.4		0.0
8. Independent and team work			0.3	0.2			0.2								0.0	0.2	0.3	0.3		0.0
9. Professional and non-technical			0.2	0.3			0.3								0.3	0.3	0.1	0.2		0.2
10. Communication skills			0.3	0.3			0.2								0.0	0.2	0.2	0.4		0.0
11. Research and comtemporary i			0.3	0.4			0.3								0.3	0.3	0.2	0.2		0.2
12. Need for life long learning			0.3	0.4			0.3								0.0	0.3	0.3	0.2		0.2
Sum			3.00	3.00			3.00								3.00	3.00	3.00	3.00		1.00
Standard Deviation			0.03	0.10			0.05								0.17	0.05	0.09	0.07		0.10

Program achievement ratings by i	Total				Normalized Total			
Program Outcomes	CE	OE	OR	ALL	CE	OE	OR	ALL
1. General education	1.34	1.34	1.95	2.13	1.24	1.24	1.23	1.16
2. Basic science, math & eng	1.02	1.02	1.56	1.92	0.95	0.95	0.98	1.05
3. Ocean engineering core	0.97	0.97	1.46	1.82	0.89	0.89	0.92	0.99
4. Ocean engineering specializatio	1.12	1.12	1.85	2.03	1.03	1.03	1.17	1.11
5. Use of latest tools	0.76	0.76	1.25	1.61	0.70	0.70	0.79	0.88
6. Problem formulation and soluti	0.95	0.95	1.56	1.84	0.88	0.88	0.99	1.00
7. Design and Optimization	0.87	0.87	1.48	1.75	0.80	0.80	0.93	0.95
8. Independent and team work	0.95	0.95	1.19	1.46	0.88	0.88	0.75	0.80
9. Professional and non-technical	1.18	1.18	1.75	1.84	1.09	1.09	1.10	1.00
10. Communication skills	1.14	1.14	1.38	1.56	1.05	1.05	0.87	0.85
11. Research and comtemporary i	1.35	1.35	1.92	2.10	1.25	1.25	1.21	1.14
12. Need for life long learning	1.35	1.35	1.67	1.94	1.25	1.25	1.05	1.06
Sum	13.00	13.00	19.00	22.00	12.00	12.00	12.00	12.00
Standard Deviation	0.20	0.20	0.25	0.21	0.18	0.18	0.16	0.11

2013-2014 Academic Year

Average Rating by Students

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education	4.00	3.14		4.00	3.29	4.00	3.83						3.50	3.40	4.00	3.67		4.00		4.00
2. Basic science, math & eng	3.00	3.43		3.50	3.86	3.50	4.00						3.50	3.80	3.67	3.33		4.00		4.00
3. Ocean engineering core	3.00	3.29		3.50	3.29	3.00	4.00						3.17	3.80	4.00	3.67		4.00		4.00
4. Ocean engineering specialization	3.00	3.71		3.50	3.57	3.00	3.17						4.00	4.00	4.00	3.67		4.00		4.00
5. Use of latest tools	3.00	3.00		2.00	2.71	4.00	3.33						3.83	3.40	3.67	3.67		4.00		4.00
6. Problem formulation and solution	3.00	3.29		2.50	3.14	4.00	3.67						4.00	3.60	3.67	3.33		4.00		4.00
7. Design and Optimization	3.00	2.29		0.50	2.86	3.50	1.83						3.83	1.80	3.67	3.00		4.00		4.00
8. Independent and team work	3.00	2.14		1.50	1.57	3.00	2.17						3.83	2.40	4.00	3.67		4.00		4.00
9. Professional and non-technical issues	4.00	2.71		2.00	2.00	2.50	2.33						3.67	2.40	4.00	3.00		4.00		4.00
10. Communication skills	4.00	2.43		4.00	1.29	4.00	2.17						2.50	2.80	3.67	4.00		4.00		4.00
11. Research and comtemporary issues	4.00	2.86		4.00	2.57	3.50	2.33						2.83	2.80	4.00	4.00		4.00		4.00
12. Need for life long learning	4.00	2.57		4.00	2.71	3.50	3.17						3.33	3.40	4.00	4.00		4.00		4.00
Sum	41.00	34.86		35.00	32.86	41.50	36.00						42.00	37.60	46.33	43.00		48.00		48.00
Standard Deviation	0.51	0.49		1.18	0.78	0.50	0.79						0.47	0.68	0.17	0.35		0.00		0.00
# credits	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1

Normalized Average Rating by Credit Hours by Student

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education	0.29	0.27		0.34	0.30	0.29	0.32						0.25	0.27	0.26	0.26		0.25		0.08
2. Basic science, math & eng	0.22	0.30		0.30	0.35	0.25	0.33						0.25	0.30	0.24	0.23		0.25		0.08
3. Ocean engineering core	0.22	0.28		0.30	0.30	0.22	0.33						0.23	0.30	0.26	0.26		0.25		0.08
4. Ocean engineering specialization	0.22	0.32		0.30	0.33	0.22	0.26						0.29	0.32	0.26	0.26		0.25		0.08
5. Use of latest tools	0.22	0.26		0.17	0.25	0.29	0.28						0.27	0.27	0.24	0.26		0.25		0.08
6. Problem formulation and solution	0.22	0.28		0.21	0.29	0.29	0.31						0.29	0.29	0.24	0.23		0.25		0.08
7. Design and Optimization	0.22	0.20		0.04	0.26	0.25	0.15						0.27	0.14	0.24	0.21		0.25		0.08
8. Independent and team work	0.22	0.18		0.13	0.14	0.22	0.18						0.27	0.19	0.26	0.26		0.25		0.08
9. Professional and non-technical issues	0.29	0.23		0.17	0.18	0.18	0.19						0.26	0.19	0.26	0.21		0.25		0.08
10. Communication skills	0.29	0.21		0.34	0.12	0.29	0.18						0.18	0.22	0.24	0.28		0.25		0.08
11. Research and comtemporary issues	0.29	0.25		0.34	0.23	0.25	0.19						0.20	0.22	0.26	0.28		0.25		0.08
12. Need for life long learning	0.29	0.22		0.34	0.25	0.25	0.26						0.24	0.27	0.26	0.28		0.25		0.08
Sum	3.00	3.00		3.00	3.00	3.00	3.00						3.00	3.00	3.00	3.00		3.00		1.00
Standard Deviation	0.04	0.04		0.10	0.07	0.04	0.07						0.03	0.05	0.01	0.02		0.00		0.00

Program achievement ratings by students	Total				Normalized Total			
Course Outcomes	CE	OE	OR	ALL	CE	OE	OR	ALL
1. General education	2.09	1.57	2.08	2.89	1.14	1.17	1.14	1.12
2. Basic science, math & eng	2.17	1.61	2.08	2.89	1.18	1.21	1.14	1.12
3. Ocean engineering core	2.08	1.55	2.06	2.81	1.13	1.16	1.13	1.09
4. Ocean engineering specialization	2.15	1.54	2.06	2.88	1.17	1.16	1.12	1.11
5. Use of latest tools	1.83	1.29	1.78	2.62	1.00	0.97	0.97	1.01
6. Problem formulation and solution	2.00	1.42	1.89	2.75	1.09	1.07	1.03	1.07
7. Design and Optimization	1.40	0.99	1.43	2.10	0.77	0.74	0.78	0.81
8. Independent and team work	1.44	0.97	1.49	2.17	0.78	0.73	0.81	0.84
9. Professional and non-technical issues	1.57	1.12	1.58	2.22	0.86	0.84	0.86	0.86
10. Communication skills	1.59	1.18	1.70	2.39	0.86	0.89	0.93	0.93
11. Research and comtemporary issues	1.78	1.35	1.89	2.57	0.97	1.01	1.03	0.99
12. Need for life long learning	1.92	1.41	1.95	2.71	1.05	1.06	1.06	1.05
Sum	22.00	16.00	22.00	31.00	12.00	12.00	12.00	12.00
Standard Deviation	0.28	0.23	0.24	0.29	0.15	0.17	0.13	0.11

2013-2014 Academic Year

Average Rating by Instructors

Program Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education	4	3				2	4						3	4	3	4		2		4
2. Basic science, math & eng	2	4				4	4						3	4	3	3		3		2
3. Ocean engineering core	3	4				3	3						1	4	2	3		3		2.5
4. Ocean engineering specialization	3	4				1	3						4	4	4	3		3		3
5. Use of latest tools	2	3				4	3						4	3	2	3		3		1.5
6. Problem formulation and solution	2	4				3	3						4	4	3	2		3		1.5
7. Design and Optimization	2	3				3	1						3	2	3	3		3		1
8. Independent and team work	2	3				3	2						3	4	0	3		2		0.5
9. Professional and non-technical issues	4	3				1	3						3	4	2	4		2		3.5
10. Communication skills	3	3				2	2						1	4	0	4		3		2.5
11. Research and comtemporary issues	4	3				2	3						1	4	2	4		0		3.5
12. Need for life long learning	4	2				3	3						2	4	0	4		2		3
Sum	35.00	39.00				31.00	34.00						32.00	45.00	24.00	40.00		29.00		28.50
Standard Deviation	0.90	0.62				1.00	0.83						1.15	0.62	1.35	0.65		0.90		1.09

Normalized Average Rating by Credit Hours by Instructor

Program Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	766	783	791	792
1. General education	0.34	0.23				0.19	0.35						0.28	0.27	0.38	0.30		0.21		0.14
2. Basic science, math & eng	0.17	0.31				0.39	0.35						0.28	0.27	0.38	0.23		0.31		0.07
3. Ocean engineering core	0.26	0.31				0.29	0.26						0.09	0.27	0.25	0.23		0.31		0.09
4. Ocean engineering specialization	0.26	0.31				0.10	0.26						0.38	0.27	0.50	0.23		0.31		0.11
5. Use of latest tools	0.17	0.23				0.39	0.26						0.38	0.20	0.25	0.23		0.31		0.05
6. Problem formulation and solution	0.17	0.31				0.29	0.26						0.38	0.27	0.38	0.15		0.31		0.05
7. Design and Optimization	0.17	0.23				0.29	0.09						0.28	0.13	0.38	0.23		0.31		0.04
8. Independent and team work	0.17	0.23				0.29	0.18						0.28	0.27	0.00	0.23		0.21		0.02
9. Professional and non-technical issues	0.34	0.23				0.10	0.26						0.28	0.27	0.25	0.30		0.21		0.12
10. Communication skills	0.26	0.23				0.19	0.18						0.09	0.27	0.00	0.30		0.31		0.09
11. Research and comtemporary issues	0.34	0.23				0.19	0.26						0.09	0.27	0.25	0.30		0.00		0.12
12. Need for life long learning	0.34	0.15				0.29	0.26						0.19	0.27	0.00	0.30		0.21		0.11
Sum	3.00	3.00				3.00	3.00						3.00	3.00	3.00	3.00		3.00		1.00
Standard Deviation	0.08	0.05				0.10	0.07						0.11	0.04	0.17	0.05		0.09		0.04

Program achievement ratings by Instructor	Total				Normalized Total			
Program Outcomes	CE	OE	OR	ALL	CE	OE	OR	ALL
1. General education	1.48	0.93	1.61	2.35	1.11	1.12	1.20	1.13
2. Basic science, math & eng	1.59	1.04	1.64	2.58	1.19	1.25	1.23	1.24
3. Ocean engineering core	1.33	0.97	1.45	2.10	1.00	1.16	1.08	1.01
4. Ocean engineering specialization	1.63	0.99	1.71	2.45	1.22	1.19	1.28	1.18
5. Use of latest tools	1.43	0.86	1.33	2.30	1.08	1.03	1.00	1.10
6. Problem formulation and solution	1.58	0.94	1.46	2.39	1.18	1.12	1.10	1.15
7. Design and Optimization	1.08	0.66	1.26	1.97	0.81	0.80	0.95	0.95
8. Independent and team work	1.18	0.63	0.86	1.69	0.88	0.76	0.64	0.81
9. Professional and non-technical issues	1.37	0.83	1.38	2.02	1.03	0.99	1.03	0.97
10. Communication skills	1.17	0.81	1.11	1.66	0.87	0.97	0.83	0.80
11. Research and comtemporary issues	0.98	0.62	1.17	1.72	0.73	0.74	0.88	0.83
12. Need for life long learning	1.18	0.73	1.03	1.78	0.89	0.88	0.77	0.85
Sum	16.00	10.00	16.00	25.00	12.00	12.00	12.00	12.00
Standard Deviation	0.22	0.15	0.26	0.33	0.16	0.17	0.20	0.16

2014-2015 Academic Year

Average Rating by Students

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	202	783	791	792
1. General education	3.67	2.80	3.71	3.50	3.33		3.00					3.00	4.00	3.50	4.00	3.00	3.00	3.80		3.00
2. Basic science, math & eng	1.00	3.30	3.71	3.00	3.67		3.75					3.33	4.00	3.50	4.00	3.00	2.33	4.00		1.50
3. Ocean engineering core	0.00	3.40	3.71	3.30	3.83		3.75					3.33	4.00	4.00	4.00	2.00	3.17	3.20		2.50
4. Ocean engineering specialization	2.67	3.20	3.71	3.50	3.83		3.50					2.00	4.00	4.00	4.00	2.00	3.50	4.00		3.50
5. Use of latest tools	3.33	2.90	3.14	2.80	3.67		3.25					3.33	4.00	3.50	4.00	2.00	2.00	4.00		1.50
6. Problem formulation and solution	3.67	3.00	3.57	2.80	3.67		4.00					3.33	4.00	3.50	4.00	4.00	2.83	3.80		1.00
7. Design and Optimization	2.67	2.40	3.14	1.50	3.33		2.75					3.00	4.00	3.00	4.00	3.00	2.17	4.00		1.00
8. Independent and team work	1.33	2.90	3.29	2.40	2.67		2.25					3.33	4.00	3.00	4.00	0.00	2.00	3.80		0.50
9. Professional and non-technical issues	3.67	2.70	3.00	2.20	2.67		3.25					2.67	3.50	3.50	4.00	4.00	3.00	4.00		2.00
10. Communication skills	3.67	2.50	3.43	3.20	2.17		3.25					3.00	3.00	4.00	4.00	4.00	2.67	3.80		1.00
11. Research and comtemporary issues	3.00	2.20	3.43	3.40	2.67		3.25					3.00	3.50	4.00	4.00	3.00	3.50	4.00		3.50
12. Need for life long learning	3.33	2.80	3.29	3.20	3.50		3.50					2.67	3.50	3.50	3.50	3.00	3.00	4.00		3.00
Sum	32.00	34.10	41.14	34.80	39.00		39.50					36.00	45.50	43.00	47.50	33.00	33.17	46.40		24.00
Standard Deviation	1.23	0.36	0.26	0.61	0.56		0.47					0.40	0.33	0.36	0.14	1.14	0.53	0.23		1.07
# credits	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1

Normalized Average Rating by Credit Hours by Student

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	202	783	791	792
1. General education	0.34	0.25	0.27	0.30	0.26		0.23					0.25	0.26	0.24	0.25	0.27	0.27	0.25		0.13
2. Basic science, math & eng	0.09	0.29	0.27	0.26	0.28		0.28					0.28	0.26	0.24	0.25	0.27	0.21	0.26		0.06
3. Ocean engineering core	0.00	0.30	0.27	0.28	0.29		0.28					0.28	0.26	0.28	0.25	0.18	0.29	0.21		0.10
4. Ocean engineering specialization	0.25	0.28	0.27	0.30	0.29		0.27					0.17	0.26	0.28	0.25	0.18	0.32	0.26		0.15
5. Use of latest tools	0.31	0.26	0.23	0.24	0.28		0.25					0.28	0.26	0.24	0.25	0.18	0.18	0.26		0.06
6. Problem formulation and solution	0.34	0.26	0.26	0.24	0.28		0.30					0.28	0.26	0.24	0.25	0.36	0.26	0.25		0.04
7. Design and Optimization	0.25	0.21	0.23	0.13	0.26		0.21					0.25	0.26	0.21	0.25	0.27	0.20	0.26		0.04
8. Independent and team work	0.13	0.26	0.24	0.21	0.21		0.17					0.28	0.26	0.21	0.25	0.00	0.18	0.25		0.02
9. Professional and non-technical issues	0.34	0.24	0.22	0.19	0.21		0.25					0.22	0.23	0.24	0.25	0.36	0.27	0.26		0.08
10. Communication skills	0.34	0.22	0.25	0.28	0.17		0.25					0.25	0.20	0.28	0.25	0.36	0.24	0.25		0.04
11. Research and comtemporary issues	0.28	0.19	0.25	0.29	0.21		0.25					0.25	0.23	0.28	0.25	0.27	0.32	0.26		0.15
12. Need for life long learning	0.31	0.25	0.24	0.28	0.27		0.27					0.22	0.23	0.24	0.22	0.27	0.27	0.26		0.13
Sum	3.00	3.00	3.00	3.00	3.00		3.00					3.00	3.00	3.00	3.00	3.00	3.00	3.00		1.00
Standard Deviation	0.12	0.03	0.02	0.05	0.04		0.04					0.03	0.02	0.03	0.01	0.10	0.05	0.01		0.04

Course achievement ratings by students	Total				Normalized Total			
Course Outcomes	CE	OE	OR	ALL	CE	OE	OR	ALL
1. General education	2.18	1.67	2.20	3.23	1.05	1.06	1.06	1.05
2. Basic science, math & eng	2.22	1.71	2.23	3.23	1.06	1.08	1.07	1.05
3. Ocean engineering core	2.29	1.75	2.18	3.29	1.10	1.10	1.05	1.07
4. Ocean engineering specialization	2.36	1.82	2.25	3.28	1.13	1.15	1.08	1.06
5. Use of latest tools	2.08	1.58	2.01	2.98	1.00	1.00	0.96	0.97
6. Problem formulation and solution	2.15	1.64	2.26	3.30	1.03	1.04	1.08	1.07
7. Design and Optimization	1.81	1.34	1.86	2.78	0.87	0.84	0.89	0.90
8. Independent and team work	1.82	1.34	1.60	2.53	0.87	0.85	0.77	0.82
9. Professional and non-technical issues	1.91	1.44	2.06	3.02	0.92	0.91	0.99	0.98
10. Communication skills	1.92	1.45	2.06	3.03	0.92	0.91	0.99	0.98
11. Research and comtemporary issues	2.10	1.59	2.12	3.19	1.01	1.01	1.02	1.04
12. Need for life long learning	2.16	1.68	2.17	3.14	1.03	1.06	1.04	1.02
Sum	25.00	19.00	25.00	37.00	12.00	12.00	12.00	12.00
Standard Deviation	0.18	0.16	0.19	0.23	0.09	0.10	0.09	0.08

2014-2015 Academic Year

Average Rating by Instructors

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	202	783	791	792
1. General education	3.0	3.0	4.0	3.0	2.0		3.0					2.0	2.0	4.0	4.0	4.0	4.0	2.5		3.0
2. Basic science, math & eng	2.0	3.0	4.0	3.0	3.0		4.0					4.0	2.0	4.0	4.0	3.0	2.0	3.0		0.0
3. Ocean engineering core	3.0	4.0	4.0	3.0	4.0		4.0					4.0	3.0	4.0	3.0	3.0	3.0	3.5		3.0
4. Ocean engineering specialization	4.0	3.0	3.0	2.0	3.0		4.0					3.0	3.0	4.0	4.0	3.0	2.0	4.0		3.0
5. Use of latest tools	3.0	4.0	4.0	2.0	3.0		3.0					4.0	3.0	4.0	2.0	3.0	2.0	3.5		0.0
6. Problem formulation and solution	3.0	4.0	4.0	1.0	4.0		3.0					4.0	3.0	4.0	4.0	3.0	2.0	3.0		0.0
7. Design and Optimization	3.0	4.0	4.0	2.0	3.0		2.0					3.0	3.0	3.0	4.0	4.0	2.0	4.0		0.0
8. Independent and team work	3.0	3.0	4.0	0.0	3.0		3.0					3.0	2.0	4.0	3.0	4.0	0.0	2.0		0.0
9. Professional and non-technical issues	4.0	3.0	4.0	1.0	1.0		3.0					2.0	2.0	4.0	3.0	4.0	3.0	3.0		3.0
10. Communication skills	4.0	3.0	4.0	4.0	1.0		3.0					3.0	2.0	4.0	2.0	4.0	0.0	4.0		0.0
11. Research and comtemporary issues	4.0	4.0	4.0	4.0	2.0		3.0					3.0	2.0	4.0	3.0	4.0	3.0	1.5		3.0
12. Need for life long learning	4	3	4	3	2		3					3	1	4	2	4	4	3		3
Sum	40.00	41.00	47.00	28.00	31.00		38.00					38.00	28.00	47.00	38.00	43.00	27.00	37.00		18.00
Standard Deviation	0.65	0.51	0.29	1.23	1.00		0.58					0.72	0.65	0.29	0.83	0.51	1.29	0.79		1.57

Normalized Average Rating by Credit Hours by Instructor

Course Outcomes	330	411	601	603	607	608	609	612	630	641	642	654	661	664	677	678	202	783	791	792
1. General education	0.23	0.22	0.26	0.32	0.19		0.24					0.16	0.21	0.26	0.32	0.28	0.44	0.20		0.17
2. Basic science, math & eng	0.15	0.22	0.26	0.32	0.29		0.32					0.32	0.21	0.26	0.32	0.21	0.22	0.24		0.00
3. Ocean engineering core	0.23	0.29	0.26	0.32	0.39		0.32					0.32	0.32	0.26	0.24	0.21	0.33	0.28		0.17
4. Ocean engineering specialization	0.30	0.22	0.19	0.21	0.29		0.32					0.24	0.32	0.26	0.32	0.21	0.22	0.32		0.17
5. Use of latest tools	0.23	0.29	0.26	0.21	0.29		0.24					0.32	0.32	0.26	0.16	0.21	0.22	0.28		0.00
6. Problem formulation and solution	0.23	0.29	0.26	0.11	0.39		0.24					0.32	0.32	0.26	0.32	0.21	0.22	0.24		0.00
7. Design and Optimization	0.23	0.29	0.26	0.21	0.29		0.16					0.24	0.32	0.19	0.32	0.28	0.22	0.32		0.00
8. Independent and team work	0.23	0.22	0.26	0.00	0.29		0.24					0.24	0.21	0.26	0.24	0.28	0.00	0.16		0.00
9. Professional and non-technical issues	0.30	0.22	0.26	0.11	0.10		0.24					0.16	0.21	0.26	0.24	0.28	0.33	0.24		0.17
10. Communication skills	0.30	0.22	0.26	0.43	0.10		0.24					0.24	0.21	0.26	0.16	0.28	0.00	0.32		0.00
11. Research and comtemporary issues	0.30	0.29	0.26	0.43	0.19		0.24					0.24	0.21	0.26	0.24	0.28	0.33	0.12		0.17
12. Need for life long learning	0.30	0.22	0.26	0.32	0.19		0.24					0.24	0.11	0.26	0.16	0.28	0.44	0.24		0.17
Sum	3.00	3.00	3.00	3.00	3.00		3.00					3.00	3.00	3.00	3.00	3.00	3.00	3.00		1.00
Standard Deviation	0.05	0.04	0.02	0.13	0.10		0.05					0.06	0.07	0.02	0.07	0.04	0.14	0.06		0.09

Course achievement ratings by instructor	Total				Normalized Total			
Course Outcomes	CE	OE	OR	ALL	CE	OE	OR	ALL
1. General education	2.07	1.60	2.19	3.26	0.99	1.01	1.05	1.06
2. Basic science, math & eng	2.12	1.65	2.17	3.18	1.02	1.04	1.04	1.03
3. Ocean engineering core	2.60	2.02	2.47	3.69	1.25	1.28	1.19	1.20
4. Ocean engineering specialization	2.30	1.72	2.25	3.28	1.10	1.09	1.08	1.06
5. Use of latest tools	2.15	1.57	1.94	3.06	1.03	0.99	0.93	0.99
6. Problem formulation and solution	2.10	1.52	2.05	3.16	1.01	0.96	0.98	1.03
7. Design and Optimization	2.05	1.53	2.13	3.10	0.98	0.97	1.02	1.01
8. Independent and team work	1.63	1.16	1.68	2.39	0.78	0.74	0.81	0.77
9. Professional and non-technical issues	1.80	1.33	1.84	2.80	0.86	0.84	0.88	0.91
10. Communication skills	2.03	1.56	2.00	2.70	0.97	0.99	0.96	0.88
11. Research and comtemporary issues	2.16	1.70	2.21	3.25	1.04	1.07	1.06	1.05
12. Need for life long learning	2.00	1.64	2.07	3.12	0.96	1.03	1.00	1.01
Sum	25.00	19.00	25.00	37.00	12.00	12.00	12.00	12.00
Standard Deviation	0.24	0.21	0.21	0.33	0.11	0.13	0.10	0.11

APPENDIX H

STUDENT ASSESSMENT FORMS

ORE Student Review Form

Instructions

The Student Review Form is intended to make sure that you get the most out of your study at ORE. By setting your goals for each new semester, working to achieve them during the semester, and reviewing your progress at the end of the semester, you can be sure that you are well prepared for your career through the program.

The Department has identified 12 student-outcomes that the Department believes are essential for our students to prepare themselves for their careers. The 12 student-outcomes are provided on the last page of this form in the Appendix, and also available on the Department's website. The following brief instructions help you to complete your Student Review Form.

Part 1. Achievements in this semester

State briefly the key objectives you set for the past semester and state the extent to which your objectives were achieved.

Since this is the first time we are implementing this form, you didn't document the key objectives you set for this semester. Therefore, for this year, you can identify 2-3 areas listed in the 12 student-outcomes and state how you have improved in these areas in the past semester.

If you are a PhD candidate, you can also highlight your research achievements such as awards received, conferences attended and papers published.

Part 2. Objectives for the next semester

After you have completed section 1, think about the other areas you need further improvement to prepare yourself for your career. Identify 3 student-outcomes that you plan to work on as your objectives for the next semester. Briefly describe how you would achieve these objectives through course study, research, projects, internships, and other activities. You can discuss your objectives with your supervisor if necessary.

Student Progress Review

Department of Ocean and Resources Engineering
University of Hawaii at Manoa

Name:	MS/PhD:	Date:

1. Achievements in this semester

State briefly the key objectives you set for the past semester and state the extent to which your objectives were achieved.

Name:	MS/PhD:	Date:

2. Objectives for the next semester

Identify 3 student outcomes that you plan to work on as your objectives for the next semester. Briefly describe how you would achieve these objectives through course study, research, projects, internships, and other activities. You can discuss your objectives with your supervisor if necessary. The 12 student outcomes can be found on the last page of this form in the Appendix.

3. Comments by supervisor

4. Acknowledgement by Chair

Appendix: Student Outcomes

1. A broad education necessary to understand the impact of engineering solutions in a global and societal context;
2. An ability to apply knowledge of mathematics, science, and basic engineering topics that include statics, dynamics, fluid mechanics, solid mechanics, and probability and statistics;
3. Proficiency in the core program that comprises hydrostatics, oceanography, water waves, fluid-structure interaction, underwater acoustics, laboratory and at-sea experience;
4. Working knowledge of at least one of the three option areas that include coastal, offshore, and ocean resources engineering;
5. An ability to use the techniques, skills, and latest engineering tools necessary for ocean and resources engineering practice;
6. An ability to identify, formulate and solve ocean and resources engineering problems;
7. An ability to design and optimize engineering systems to meet the needs of the marine community;
8. An ability to work independently and function on multi-disciplinary teams;
9. An appreciation of professional and ethical responsibilities;
10. An ability to communicate effectively to technical and non-technical audiences;
11. An awareness of the latest research and contemporary issues in and beyond the marine community, and;
12. Recognition of the need for, and an ability to engage in life-long learning and continuing professional development.

Student Progress Form
Department of Ocean and Resources Engineering
University of Hawaii at Manoa

1. Background Information

Name: _____ SN: _____

Birthplace: _____ Citizenship: _____ Visa Status: _____

Prior Degree: _____

Experience: _____

Degree Sought: _____ Option Area: _____ Admitted: _____

2. Pre-Program Requirements

Prior Degree: ABET: Y Credits: _____ Years: _____ Credits per year: _____

UH courses: 32 credits per year

Advisor: _____

General Education: _____

_____

_____

Prior General Education Credits: _____ Number of Years: _____

Math and Science: _____

_____

_____

Prior Math and Science Credits: _____ Number of Years: _____

Basic Engineering: _____

CAD _____

Statics _____

Dynamics _____

Fluid Mech _____

Solid Mech _____

Prob & Stat _____

other: _____

3rd/4th Year Level: _____

_____

_____

Prior Engineering Credits: _____ Number of Years: _____

UH Engineering Credits: _____ Number of Years: _____

Total Engineering Credits: _____ Number of Years: _____

General Exam: _____

3. Program Requirements

Advisor: _____

Core Program: _____

Hydrostatics _____

Lab & Field _____

Oceanography _____

Acoustics Covered in ORE 601 and 603

Water waves _____

Hydrodynamics _____

Option Area: _____

_____

Capstone Design: _____

Seminar: _____

Electives: _____

_____

Thesis/Project: _____

Total Credits: _____

4. Research Work

Advisor/Chair: _____

Committee: _____

Title: _____

Final Exam: _____

Graduation: _____

5. Exit Interview

Program Outcomes	Comments by Graduate
a broad education necessary to understand the impact of engineering solutions in a global and societal context	
an ability to apply knowledge of mathematics, science, and basic engineering topics that include calculus, algebra, differential equations, probability and statistics, physics, chemistry, statics, dynamics, and fluid and solid mechanics	
proficiency in the core program that comprises hydrostatics, oceanography, water waves, underwater acoustics, and laboratory and field experiments	
working knowledge of at least one of the	

three option areas that include coastal, ocean resources, and offshore engineering	
an ability to use the techniques, skills, and latest engineering tools necessary for ocean & resources engineering practice	
an ability to identify, formulate, and solve ocean and resources engineering problems	
an ability to design and optimize engineering systems to meet the needs of the marine community	
an ability to work independently and function on multi-disciplinary teams	
an understanding of professional and ethical responsibilities	
an ability to communicate effectively to technical and non-technical audiences	
a knowledge of latest research and contemporary issues in and beyond the marine community	
a recognition of the need for, and an ability to engage in life-long learning and continuing professional development	

5. Post Graduation

Position: _____ Period: _____

Company: _____

Address: _____

Email: _____

Phone: _____ Fax: _____

Department of Ocean and Resources Engineering
School of Ocean and Earth Science and Technology
University of Hawaii at Manoa
Exit Survey

Year of Graduation: _____ **Degree:** MS O PhD O

Please rate the following skills, abilities, and attributes generally expected of an ocean engineering graduate by using a 5-point scale indicating low to high and marking (×) at the space provided. Rate each topic or skill in terms of the **importance** you expect it will have in your post-graduate career. Next, please rate the effectiveness of the **preparation** you received from our program

Please feel free to use the space after the list to briefly explain any of your responses, especially if you feel your preparation was less than adequate.

Importance: 1 - Not Important, 2 - Somewhat Important, 3 – Important, 4 - Very Important, 5 - Extremely Important
Preparation: 1 - Not Prepared, 2 - Somewhat Prepared, 3 – Prepared, 4 - Well Prepared, 5 - Very Well Prepared

		Importance					Preparation				
		1	2	3	4	5	1	2	3	4	5
An understanding and ability to:											
1	apply advanced mathematics	O	O	O	O	O	O	O	O	O	O
2	apply knowledge of: engineering science and mechanics	O	O	O	O	O	O	O	O	O	O
3	apply knowledge of an ocean engineering subdiscipline (coastal, offshore or ocean resources)	O	O	O	O	O	O	O	O	O	O
4	conduct lab and field experiments and/or analyze and interpret data	O	O	O	O	O	O	O	O	O	O
5	design and optimize engineering systems to meet the needs of the marine community	O	O	O	O	O	O	O	O	O	O
6	identify, formulate, and solve ocean engineering problems	O	O	O	O	O	O	O	O	O	O
7	function on multi-disciplinary or cross-functional teams	O	O	O	O	O	O	O	O	O	O
8	synthesize and integrate knowledge across disciplines	O	O	O	O	O	O	O	O	O	O
9	function in culturally and ethnically diverse environments	O	O	O	O	O	O	O	O	O	O
10	communicate orally, informally, and in prepared talks	O	O	O	O	O	O	O	O	O	O
11	communicate in writing, in business letters, and technical reports	O	O	O	O	O	O	O	O	O	O
12	use computing technology in communications	O	O	O	O	O	O	O	O	O	O
13	use computing technology in engineering analysis and design	O	O	O	O	O	O	O	O	O	O
14	use the techniques, skills, and engineering tools for ocean engineering practice	O	O	O	O	O	O	O	O	O	O
15	engage in life long learning and professional development	O	O	O	O	O	O	O	O	O	O
An understanding of:											
16	professional and ethical responsibility in engineering practice	O	O	O	O	O	O	O	O	O	O
17	product development or design from a business perspective	O	O	O	O	O	O	O	O	O	O
18	research and contemporary issues in and beyond the marine community	O	O	O	O	O	O	O	O	O	O
19	the environmental aspects of engineering practice	O	O	O	O	O	O	O	O	O	O
20	the practice of ocean engineering on a global scale	O	O	O	O	O	O	O	O	O	O
21	the relation of ocean engineering practice to societal or cultural issues	O	O	O	O	O	O	O	O	O	O
22	Becoming a Licensed Professional Engineer	O	O	O	O	O	O	O	O	O	O

Additional Comments:

Please answer the following questions:

	1	2	3	4	5
Do you have job offers in a field related to Ocean and Resources Engineering? (if not leave blank) (1 not related at all, 5 very related)	O	O	O	O	O
Overall, how satisfied are you with the education you received in ORE at UH? (1 not satisfied at all, 5 very satisfied)	O	O	O	O	O

	Y	N
Will you participate in continuing education activities – (do not include graduate degrees)	O	O
Will you attend a professional/technical society conference(s)	O	O

In your opinion, what job options are available today for graduates in Ocean and Resources Engineering?

Please list what you consider the strengths of the Ocean and Resources Engineering program to be in preparation for your career?

What do you consider the weaknesses of the Ocean and Resources Engineering program to be in preparation for your career?

APPENDIX I

SIGNATURE ATTESTING TO COMPLIANCE

School of Ocean and Earth Science and Technology
1680 East-West Road, POST 802
Honolulu, HI 96822
TEL 808 956-6182 FAX 808 956-9152

Office of the Dean

soest
University of Hawai'i

Signature Attesting to Compliance

By signing below, I attest to the following:

That the Ocean and Resources Engineering department has conducted an honest assessment of compliance and has provided a complete and accurate disclosure of timely information regarding compliance with ABET's *Criteria for Accrediting Engineering Programs* to include the General Criteria and any applicable Program Criteria, and the ABET *Accreditation Policy and Procedure Manual.*

Brian Taylor
Dean's Name (As indicated on the RFE)

Brian Taylor
Signature

6/23/15
Date