Georgia Tech Ocean Science & Engineering
Interdisciplinary Graduate Program

Graduate Handbook

Doctor of Philosophy with a major in
Ocean Science & Engineering (OSE)

Georgia Tech Ocean Science & Engineering
Interdisciplinary Graduate Program

–Graduate Handbook –

Updated: October 23, 2016

College of Science & College of Engineering

School of Earth & Atmospheric Sciences
School of Biological Sciences
School of Civil & Environmental Engineering

Major Degree Name: Doctor of Philosophy with a major in Ocean Science & Engineering (OSE)
Degree CIP Code: 26.1302
Degree Acronym: DR-OSE
Anticipated Effective Date to Implement the Change: October 2016
ICC Project # 4581

OSE Program Directors:

Dr. Emanuele Di Lorenzo
Professor, School of Earth & Atmospheric Sciences, edl@gatech.edu, 404-788-8035

Dr. Annalisa Bracco
Professor, School of Earth & Atmospheric Sciences, abracco@gatech.edu, 404-894-1749

Chair of the OSE Graduate Studies Committee and Graduate Coordinator:
Dr. Kevin Haas, School of Civil and Environmental Engineering, khass@gatech.edu, 404-385-1812

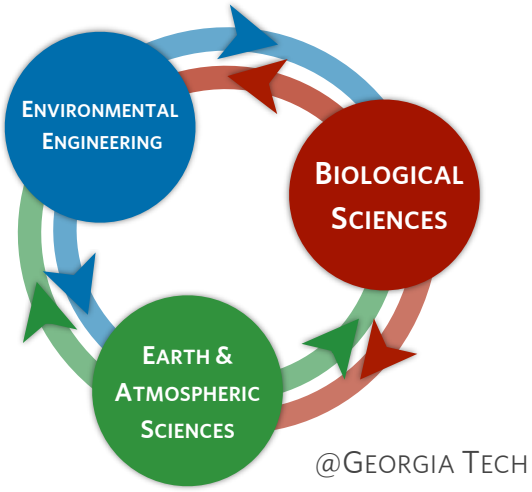
Program Coordinator:
Hollie Meyer, School of Earth & Atmospheric Sciences, hollie.meyer@eas.gatech.edu, 404-894-3955

OSE Web: www.ocean.gatech.edu

VISION OF THE PROGRAM

In our fast-moving age, nature and society are changing ever more rapidly. A faster than ever population growth and the progressive improvement and development of technologies are changing our planet to an unprecedented extent. The greatest challenges of our time result from growing complexity, interconnectedness and linkages across the globe that exceed traditional disciplinary boundaries. The scientific knowledge, too, has grown apace. It has become more diverse and multifaceted. This applies especially to the ocean – the largest environmental resource on Earth. Over recent decades, we have recognized that chemical, biological and physical processes in the marine environment influence and feedback on each other. These processes cannot be viewed in isolation, requiring a more integrated approach to our interpretation of scientific data and to the development of effective solutions. For example, the loss of coral reefs (the Caribbean reefs have lost 80+% and the tropical Pacific 50% of their corals), cascades onto losses of fish and marine biodiversity in general. This threatens food security for one billion people, coastal storm protection and structures, and the discovery of untold bioactive chemicals with potential as pharmaceuticals. Sea level rise reduces wetland ecosystem services of storm buffering fish nurseries, and environmental filtering, while threatening coastal cities over widespread areas of the U.S. Across the country, nearly 5 million people live in 2.6 million homes at less than 4 feet above high tide, which is a level lower than the century flood line for most of those locations.

A synergistic approach at the frontiers of science and engineering will advance scientific knowledge and problem solving in transdisciplinary areas such as those relevant to ocean systems. Georgia Tech (GT) is one of a very few institutions with the engineering and scientific prowess and interdisciplinary culture to effectively address these critical challenges of sustainability that threaten all of us.



The interdisciplinary PhD Program in Ocean Science & Engineering (OSE) integrates, coordinates and expands on-going efforts in ocean science & engineering at GT across the Schools of Earth & Atmospheric Sciences (EAS), Civil and Environmental Engineering (CEE), and Biological Sciences (BIOL).

The OSE training is organized around five themes:

OSE Research Themes

- Ocean Technology
- Ocean Sustainability
- Ocean & Climate
- Marine Living Resources
- Coastal Ocean Systems

Students will learn how to identify cutting-edge questions in the ocean sciences and technologies, and will develop broadly relevant quantitative, computational and laboratory skill-sets to address problems ranging from ocean energy, ocean & climate change, ocean prediction systems, coastal ocean hazards, ocean observing technology, marine ecosystem dynamics & services, marine chemical ecology, global and regional ocean biogeochemistry.
Students will advance the knowledge base in ocean science and engineering and will publish research satisfying the requirements, in part, of a Doctorate in OSE.

The PhD in OSE is designed to be completed over 4.5 – 6 years (fall, spring and summer), with an expected duration of 5 years, with a total of 32-credit hours required for each student. **The program will not grant *undergraduate* or *master degrees*.**

The program includes the 2 Schools within the College of Sciences: Biological Sciences (BIOL) and Earth and Atmospheric Sciences (EAS), and 1 School within the College of Engineering (Civil and Environmental Engineering (CEE). Faculty from these schools provide distinct and complementary expertise leveraged by the OSE PhD, both in terms of coursework and research specialization. Additional program faculty include members of CoS and CoE. Interdisciplinary cooperation and input is ensured by the diversity of faculty in the program. Key to this cooperation is the establishment of a founding program graduate committee comprised of 6 faculty members, representing the 3 Schools within CoS and CoE.

The program is designed to provide much flexibility in order to allow students to tailor the program to their individual career objectives under the **Research Themes of OSE** (e.g. Ocean Sustainability, Ocean Technology, Ocean & Climate, Marine Living Resources, Coastal Ocean Systems).

Students will select 4 core courses in the area of their chosen Research Theme in which the foundations of ocean science and engineering are presented, studied, and applied in the context of ocean relevant domains. Those courses will cover at least three core topics, as defined later. Additional electives will provide the necessary combination of breadth and depth to ensure that students have the necessary skill sets to propose and accomplish their thesis research. The core topics must include two topics outside of the home school of the student (one in each of the other Schools), hence the student, with input from their advisory committee, will need to choose them carefully to tailor a program of study matched to his/her interests, skills and goals. Electives will include courses within and outside the home school and shall be defined by the student with the approval of the student's dissertation advisor, the home unit coordinator and the chair of the OSE Graduate

Studies Committee (GSC) to guarantee breath of knowledge and to reflect the interdisciplinary nature of the program. Each student will put together an Essential Knowledge List (EKL) that will articulate the core topics and minimum course requirements for the OSE PhD degree. Additionally, students will select three courses for their doctoral minor outside their Research Theme but potentially – at the student' choice – within the OSE offerings.

Note: if thesis advisor also acts as home graduate committee chair, the EKL will have to be approved also by one of the program directors.

HOME UNITS AND HOME UNIT REQUIREMENTS

Students in the OSE Program are assigned to a **home unit**. A home unit is an academic unit (Department, Division, or School) at Georgia Tech that has agreed to formally participate in the OSE program. Each home unit has a **home unit coordinator**, who is an OSE faculty member in that unit. The student and the home unit must mutually agree to the home unit affiliation. An initial home unit is determined during either the admissions process or in the process of transferring to the OSE program from another academic program at Georgia Tech. Once admitted, students may change to a new home unit if that unit agrees. Each academic unit determines the rules for allocation of space and financial assistance (e.g., teaching and research assistantships) for students in that unit. The Ph.D. dissertation advisor must have an appointment in the home unit, in addition to being a faculty member of the OSE program.

Students are encouraged to explore research opportunities with faculty in other units beyond their home unit. If a faculty member in another home unit becomes the dissertation advisor, the student would normally change his/her home unit accordingly. Regardless of the home unit, the student must fulfill the degree requirements specified in this document to complete the OSE program degree.

School of Earth and Atmospheric Sciences (EAS)
No additional degree requirements are specified.

School of Civil and Environmental Engineering (CEE)
No additional degree requirements are specified.

School of Biological Sciences (BIOL)
No additional degree requirements are specified.

ADMISSIONS TO THE PH.D. PROGRAM

Students should apply to the program by submitting an application to Georgia Tech admissions. The student must designate in his/her application the desired home unit.

Students that are admitted are expected to have demonstrated (i) excellence in their undergraduate institutions and area of training; (ii) ability to perform research at the graduate level; (iii) interest in the ocean sciences and engineering; (iv) motivation toward ocean stewardship. The rationale for each qualification area is as follows (detailed qualification guidelines will be presented in the proposal):

1. **Excellence in undergraduate/MS training**: Excellence in academic coursework, research and standardized exams are, as a composite, indicators of future success in a Ph.D. program. Given the broad nature of research themes, we will expect student applicants to have excelled in their training thus far, concomitant with standards for admission into individual departments in the CoS and CoE at Georgia Tech.

2. **Ability to perform research at the graduate level**: The OSE program expects students to pass graduate level coursework in physical oceanography, chemical oceanography, coastal ocean engineering, and biological oceanography or marine ecology, plus a number of elective courses. The program will have a structure in place to ensure that each student will be taking coursework and doing research that crosses between traditional fields in the ocean & technology related disciplines. Hence, prior training and/or experience are expected in one or more of these disciplines or in closely related ones (for example a student with a major in physics and proven interest in fluid dynamics, or a student with a major in chemistry and interest in aquatic chemistry). Students with an interest in learning more about the oceans but not necessarily performing focused ocean-related research will be encouraged to apply to a traditional Ph.D. program in one of the Schools.

3. **Interest in ocean sciences and engineering**: There are many opportunities for undergraduate and MS students to initiate environmental-oriented research, and/or take coursework in related topics. While a strong statement of interest is sufficient for an applicant to be admitted to the program, the selection process will give higher priority to applicants that will have at least one example in their curriculum of having pursued successful research experience in ocean sciences or having taken advanced coursework in any of topics related to ocean science and technology (junior level or higher).

4. **Motivation towards ocean stewardship**: A strong motivation towards making a difference in responsible planning and management of the ocean resources is an important predictor of success in Ph.D. programs devoted to the finding solutions to real ocean challenges. Applicants will be evaluated also based on their extra-curriculum activity to assess their interest and commitment to ocean stewardship.

Minimum Requirements from Standardized Tests and GPA

Applicants will be evaluated by a combination of GPA, GRE, letters of reference, and previous experience including research and publications. Applicants with GRE scores lower than 155 quantitative (60 percentile) will not be admitted unless they possess an unusually high undergraduate GPA and extensive research experience, and can demonstrate a strong fit with faculty research interests. There is no minimum requirement on GPA and each student's GPA will be evaluated on a case by case basis because institutions in the US and abroad have different standards. For all international students whose native language is not English, a minimum TOEFL score of 90 is required. Any student with a score less than 100 will have to prove his/her knowledge of the English language through a Skype interview with two OSE faculty. This requirement is more stringent than the Institute minimum policies (http://www.grad.gatech.edu/international-students-toefl). If the international student has been enrolled in a US university for at least 1 year, he/she is exempt from taking or submitting a TOEFL score.

Each student accepted to the OSE program is admitted to a specific "home unit." Some home units may have some additional requirements beyond those described here. The OSE student handbook includes information concerning such requirements.

Financial assistance and lab space are typically determined by the rules and practices of the home unit.

DOCTOR OF PHILOSOPHY (PHD) DEGREE PROGRAM REQUIREMENTS

The program is designed to provide much flexibility in order to allow students to tailor the program to their individual career objectives under the **Research Themes of OSE** (e.g. Ocean Sustainability, Ocean Technology, Ocean & Climate, Marine Living Resources, Coastal Ocean Systems). The program of study shall be defined by the student with the approval of the student's dissertation advisor, the home unit coordinator and the chair of the OSE **GSC**. Each student will put together an Essential Knowledge List (EKL) that will articulate the core topic and minimum course requirement for the OSE Ph.D. degree.

OSE Essential Knowledge List (EKL)

Students enrolled in the OSE program are expected to be trained and knowledgeable in core ocean science and engineering areas, which reflect the interdisciplinary nature of the program. This training is available through the courses provided in the different schools participating in the program, and include a selection of core topics, one for each of the participating schools:

CEE:

- **Coastal & Ocean Mechanics**
- **Environmental Biotechnology**

BIOL:

- **Marine Ecology & Conservation**
- **Biological & Microbial Oceanography**

EAS:

- **Physical and Chemical Oceanography**
- **Ocean & Climate**

The knowledge required for each of these core topics, along with the list of course work, is articulated in the OSE Essential Knowledge List (EKL), which will provide the common foundation for the Comprehensive Exam for all Ph.D. students enrolled in the program. Depending on the student' background, the program of study may require taking additional courses to be knowledgeable in the core OSE topics. An EKL containing the selection of core topics must be completed and approved by the OSE Graduate Studies Committee by the end of the first semester. A copy of the final EKL will be deposited with the Program Coordinator.

In addition to the core topics, the EKL will be expanded to include topics that are relevant to the research area of the student. The expanded EKL must be completed by the end of the second semesters and approved by the **Ph.D. Advising Committee (ACom)** assigned to the student.

Core topics and course work

The Ph.D. degree in OSE requires a minimum of **32 semester hours** of coursework to cover the core topics articulated in the essential knowledge list (EKL). Students will be considered "in good academic standing" if they are making satisfactory progress toward completion of the degree, and have met a cumulative grade point average (GPA) equal or greater to 3.2 for the number of credits that they have attempted.

The course load requirement could be partially lifted for students with proven foundations in any of the research areas (e.g. students with a Master degree). The coursework includes in its core component the OSE seminar offered to incoming students in their first spring semester. The OSE seminar will serve the dual role of introducing OSE students to research advances in the laboratories and groups of participating program faculty, as well as providing a point of contact for matching students and faculty aiding the formation of the Advising Committees.

The program of study is designed to give the student breadth of knowledge in ocean science and engineering. Required coursework includes:

Component	**Courses**	**Hours Required**
	The OSE PhD program requires completion of four 3-hour credit courses between the ones listed below. Student must choose at least one core topic and one class from each school. First year students must also attend the OSE Seminar (2 credit hours).	
OSE Core Courses	<u>OSE Seminar + 4 courses spanning at least three core topics, at least one from each School</u>: OSE Seminar - 2hr (EAS 8802) (Spring, yearly) **CEE** ***TOPIC: Coastal & Ocean Mechanics*** Environmental Fluid Mechanics (CEE 6261) (Fall, yearly) Coastal Mechanics (CEE 8803) (Fall, yearly) ***TOPIC: Environmental Biotechnology*** Microbial Principles in Environmental Engineering (CEE 6311) (Fall, yearly) Biological Processes (CEE 6331) (Spring, yearly) Environmental Microbial Genomics (CEE 6720) (Spring, yearly) **BIO** ***TOPIC: Marine Ecology & Conservation*** Marine Ecology (BIOL 6417) (Spring, odd years) Biological Oceanography (BIOL 6221) (Spring, even years) ***TOPIC: Biological & Microbial Oceanography***	**14**

	Microbial Ecology (BIOL 6410) (Spring, even years) Biological Oceanography (BIOL 6221) (Spring, odd years) **EAS** ***TOPIC: Physical and Chemical Oceanography*** Physical and Chemical Oceanography (EAS 6305) (Fall, yearly) Global Biogeochemical Cycles (EAS 6122) (Spring, even years) Advanced Environmental Data Analysis (EAS 6490) (Fall, yearly) ***TOPIC: Ocean & Climate*** Thermodynamics of Atmospheres & Oceans (EAS 6140) (Fall, yearly) Climate and Global Change (EAS 4410/8803) (Fall, yearly) Ethics/RCR training - pass/fail 0hr	
OSE Specialization	Elective courses that increase depth of understanding in the research Theme chosen by the PhD candidate *(e.g. Ocean Sustainability, Ocean Technology, Ocean & Climate, Marine Living Resources, or Coastal Ocean Systems)*	**9**
Minor	Courses outside the student' selected Themes (equivalent to Institute approved minor)	**9**
	TOTAL	**32**

Students can request to modify one of the classes associated with the core topics pending approval by their PhD Advising Committee. The requirement of at least one course from each School cannot be altered.

Program of Study Approval

The student must file a proposed program of study indicating which courses will be used to fulfill the degree requirements by the end of the second year in the program. The student's dissertation advisor, the home unit coordinator, and the chair of the GSC must approve the proposed program of study.

PhD Advising Committee

Student and advisor prepare together a set of core expertise anticipated to be important in the student preparation for his PhD research. Based on the core expertise the student will select a PhD Advising Committee (ACom). The ACom will initially have at least 4 members. These include the primary advisor, secondary advisor or mentor if assigned, and 2 more faculty from the OSE group. At least one, preferably two faculty in the committee shall be outside the home school. As the student approaches the PhD defense the ACom will be expanded to have at least 5 members according to the GT polices.

OSE Comprehensive Examination

This examination is designed to ensure that the student has achieved sufficient knowledge in at least three core topics of ocean science and engineering as defined by the OSE Essential Knowledge List (EKL). The exam must be attempted by the end of the second year of enrollment in the OSE doctoral program. The exam will be administered by the PhD advising committee and consists of two components.

1. **Written Exam:** This written exam encompasses all core areas of Ocean Science and Engineering as defined in the student' EKL. The EKL is expanded to include knowledge specific to the candidate's research. Examinations will cover each of the core topics regardless of home school.

2. **Oral Exam:** The written exam will be followed within three weeks by an oral one where the candidate will be further tested on his/her in depth knowledge of the EKL material. The oral examination will include a 15 min presentation of the student's research progress and goals followed by an open discussion with the examining committee. The goal of this last component is for the Ph.D. advising committee to provide feedbacks on the material to be included in the Thesis Proposal.

Each part of the Comprehensive Examination will be rated separately from poor to excellent (according to the sequence poor, fair, good, very good and excellent), and all ratings will be collected and assessed. The outcome of the examination will be Pass, Conditional Pass, or Fail. A minimum rating of Good in each part is required to pass the Comprehensive Exam.
Students who fail the Comprehensive Exam may pursue a Terminal Master Degree choosing between those offered in their home unit. A conditional pass will require retaking part of the examination no later than the drop date of the Fall semester in the third year.

OSE Thesis Proposal

No later than 3 months after the comprehensive exam, and no later than the end of the second year, the student will present to the Ph.D. advising committee a Thesis Proposal and will deliver a presentation on its content to the OSE seminar, followed by a close door discussion with the Ph.D. advising committee.

OSE Doctoral Dissertation

The doctoral dissertation (thesis) forms a central component of the OSE PhD program. The student must demonstrate the ability to perform independent research in collaboration with a faculty advisor that can be defended to a committee of faculty. it is therefore expected that all students will publish a minimum of one paper based on their thesis research and that such paper will be at least submitted and reviewed with a positive outcome before their public presentation and defense.

PhD students must make a public presentation and defense of their thesis. The thesis defense consists of a public seminar followed by an oral examination by the student's the expanded ACom, which will serve as the Final Examination Committee. In accordance with university guidelines, the final defense must be administered by a committee of five faculty members, composed of the student's advisor, three members of the academic faculty of OSE program and one additional member (who must be external to the OSE program).

OSE PROGRAM TIMELINE

Ph.D. candidates are typically admitted in the Spring Semester and begin their training in the Fall Semester. Below is a list of milestones to accomplish assuming a start in the Fall. An academic year begins in the Fall (e.g. 2017) and ends in the following Summer (e.g. 2018).

YEAR - 1

- Develop core Essential Knowledge List (EKL) approved by advisor and the Graduate Student Committee (GSC) (by end of Fall)
- Establish a Ph.D. Advising Committee (Acom) (by end of Summer)
- Take core courses

YEAR - 2

- Finalize EKL in preparation for Comprehensive Exam (by end of Fall)
- Complete core courses (by end of Spring)
- Take Comprehensive Exam (by end of Summer)
- Present Ph.D. proposal (by end of Summer)

YEAR - 3 to 5

- Complete any additional courses and research
- Defend Ph.D. thesis (by end of Summer year 5)

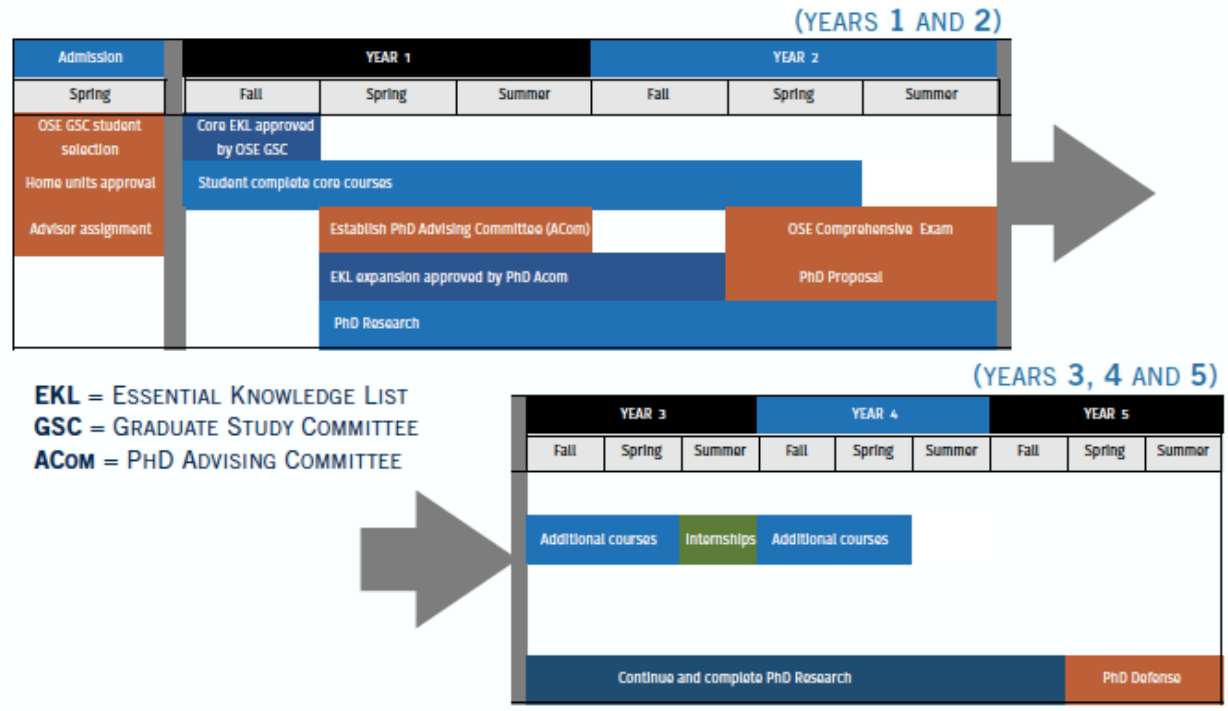


Table: Timeline for OSE PhD Students

Exceptions to this timeline may be requested by a student and will have to be approved on a case by case basis by the **OSE Graduate Studies Committee**.

Internships and/or field experience will not be required but strongly encouraged. Internships can indeed play a crucial role in graduate student professional development as they provide valuable experience for graduate students. The program offers links and opportunities with industrial partners and national laboratories and aims at guaranteeing at least one internship opportunity to all of its graduate students during the summer of their third year. Field experience opportunities are also amply provisioned by numerous faculty in the program.