COASTAL AND MARINE SYSTEM SCIENCE, PHD

Program Description

Coastal and Marine System Science studies the interactions within the coastal and marine environment, which includes most of the critical physical and biological systems that support life on Earth. The mission of the Coastal and Marine System Science (CMSS) program is to support interdisciplinary research and scholarship on the biotic and abiotic components of this zone, as well as quantitative investigation of socio-economic and political processes. The program addresses this mission by integrating the tools of Earth System Science: biogeochemistry, geographic information science, ecosystem dynamics, and quantitative modeling. Students who earn PhD degrees in the sciences are typically employed in teaching or research positions in universities, or in pure research applications at specialized institutions or governmental agencies.

With the increasing efficiency of real-time data collection, transfer, and processing, aided by autonomous observation systems such as satellite sensors, oceanic buoys, and remotely controlled or autonomous submersibles, Coastal and Marine System Science is at the forefront of extracting meaningful scientific results from large data sets in near real time. Graduates of the CMSS program will demonstrate proficiency in understanding and applying the concepts and principles of all of the natural sciences as well as a working competence in mathematical modeling and geospatial analysis.

All students share a core of five interdisciplinary courses that cover the foundations of mathematical modeling, environmental policy, and case studies in system science. Topical specialized coursework (determined by the graduate advisory committee of each individual student) provides grounding in the specific scientific disciplines needed to effectively manage the coastal and marine system. After the completion of any required leveling courses and all core classes (with the exception of the seminar class, CMSS 6102) students must successfully complete a comprehensive examination for advancement to doctoral candidacy. This examination should be scheduled no later than 24 months after initial enrollment. The required dissertation involves an independent, detailed research project of importance to the international scientific community. The graduate advisory committee of each student will guide them through the conception, design, construction, and execution of a systems-based inquiry.

Student Learning Outcomes

As part of their progression through the Coastal and Marine System Science program, the students will:

- acquire the skills required for system science studies applied to coastal and marine topics such that they are prepared to conduct CMSS original research
- perform original and hypothesis-driven quantitative analyses that will lead to comprehensive verifiable models of natural systems
- emphasize mathematical and/or analytical skills to generate new data and critically evaluate models that will aid in our understanding of dynamic natural systems, become a resource capable of answering environmental “what if” questions by providing comprehensive interpretation
- develop the skills necessary to present and publish their work at national and international venues
- develop the skills necessary to effectively teach effectively a college-level class in the area of sciences and technology
- develop a skill set and research record such that they can secure employment at universities, federal agencies, private companies, or non-governmental organizations where they can apply the skills and knowledge acquired during their time in the program

For Additional Information

Website:
http://cmss.tamucc.edu/

Campus Address:
Natural Resource Center, Room 3500
Phone: (361) 825-2814 (Alessandra Garcia)

Mailing Address:
Coastal and Marine System Science Program, Unit 5850
College of Science and Engineering
Texas A&M University-Corpus Christi
6300 Ocean Drive
Corpus Christi, Texas 78412-5850

Admission Requirements

Applicants seeking admission to the CMSS Program must apply through the Office of Recruitment and Admissions. In addition to the documents required by the Office of Admissions and Recruitment, applicants must submit GRE general test scores, an essay of no more than 1,000 words describing their educational background, career interests, goals and challenges, a curriculum vitae, and three letters of evaluation from persons knowledgeable about their potential for success in graduate studies. Applicants seeking admission to the PhD Program in CMSS should first contact the program faculty and identify a faculty member willing to serve as their graduate advisor. In addition, applicants will not be admitted to the program without a graduate advisor. Applicants may optionally submit other relevant materials, e.g., copies of published works or reports of past scientific research. All materials submitted will be considered. A campus visit with personal interviews involving prospective faculty mentors is highly recommended. Completed applications must be received by the Office of Recruitment and Admissions by the deadlines posted on Admissions website.

- Fall Semester-December 1
- Spring Semester-August 1 (June 1 for international applicants)
- Summer Semester-December 1

Incomplete applications are not considered. The applicant will be notified of acceptance or rejection by letter.

Students accepted into the degree program must demonstrate proficiency in the natural sciences, mathematical modeling, and geospatial technology. This proficiency can be demonstrated by the successful completion of undergraduate classes in these topics, or by presentation of satisfactory evidence to the CMSS Program Coordinator. Students who are unable to demonstrate proficiency in the natural sciences, mathematics, or geospatial technology may be required to take undergraduate or graduate leveling courses in these areas. These courses will not apply towards the required credit hours for the PhD degree.

Teaching assistantships, graduate research assistantships, and fellowship positions are available to admitted degree-seeking students who maintain full-time graduate student status (9 credit hours per long semester and 3 credit hours during the summer).

Program Requirements

Each student accepted to the CMSS Ph.D. degree program must complete a minimum of 90 hours beyond the bachelor's degree or 60 hours beyond the master's degree, including the 15-hour CMSS Core Curriculum. If any of the core courses have been previously taken by the student, up to 9 hours can be replaced with elective courses or research courses at the discretion of the graduate advisory committee. The majority of credit hours will be in formal research, but the program requires a minimum of 18 credit hours (for students with an M.S. degree) or 30 credit hours (for students without an M.S. degree) of regular graded coursework on a Ph.D. degree plan. Justification for exceptions to this rule should be prepared by the student and advisor(s), endorsed by the advisory committee, and attached to the degree plan when submitted for the department head's signature. A student's advisory committee must approve the program degree plan. All students must pass a final dissertation defense, to be administered by their advisory committee, during their last semester before graduation.

Admission from a Bachelor's Degree Option

Students accepted into the Coastal and Marine System Science PhD Program with only a bachelor's degree (i.e., without an MS degree) must complete a minimum of 90 semester hours of coursework and research.

Code	Title	Hours
CMSS 6312	Communicating Science Seminar	3
Elective Coursework		15
Research Coursework		51-57
CMSS 6999	Dissertation Defense (3-9 hrs)	9
Core Coursework		
Core: Multidisciplinary Course Choices		
Select two of the following:		6
CMSS 6307	Coastal and Marine Systems	
GSEN 6330	Spatial Systems Science	
CMSS 6359	Marine Ecosystem Dynamics	
CMSS 6370	Coastal Management and Ocean Law	
Core: Math and Statistics Course Choices		
Select two of the following:		6
MATH 6315	Statistical Methods in Research I	
MATH 6316	Statistical Methods Research II	
CMSS 6323	Experimental Design	
CMSS 6352	Environmental Forecasting	
CMSS 6360	Computer Programming in Earth System Sciences	
Total Hours		**90-96**

Admission from a Master's Degree Option

Students accepted into the Coastal and Marine System Science PhD Program with a master's degree (i.e., with a MS degree) must complete a minimum of 60 semester hours of coursework and research.

Code	Title	Hours
CMSS 6312	Communicating Science Seminar	3
Elective Coursework		6
Research Coursework		30-36
CMSS 6999	Dissertation Defense (3-9 hrs)	9
Core Coursework		
Core: Multidisciplinary Course Choices		
Select two of the following:		6
CMSS 6307	Coastal and Marine Systems	
GSEN 6330	Spatial Systems Science	
CMSS 6359	Marine Ecosystem Dynamics	
CMSS 6370	Coastal Management and Ocean Law	
Math and Statistics Course Choices		
Select two of the following:		6
MATH 6315	Statistical Methods in Research I	
MATH 6316	Statistical Methods Research II	
CMSS 6323	Experimental Design	
CMSS 6352	Environmental Forecasting	
CMSS 6360	Computer Programming in Earth System Sciences	
Total Hours		**60-66**

Elective, Specialized, and Topical Coursework

Elective and Specialized coursework are chosen from among approved biology, chemistry, coastal and marine system science, computer science, environmental science, geographic information science, geology, marine biology, or other course offerings, in consultation with student's advisory committee.

Students admitted with a bachelor's degree must choose two electives with substantial marine content from this list of CMSS courses: Coastal and Marine Systems, Physical Oceanography, Coastal Oceanography, Geological Oceanography, Global Geochemical Cycles and Change, Global Change and its effects on Aquatic Ecosystems, Coastal Geoenvironments and Change, Marine Ecosystem Dynamics. Students admitted to the doctoral program with a master's degree must choose one elective course from this list.

Topical coursework is offered under the heading of CMSS 6590 Advanced Topics (1-5 sch). Classes or research projects designated as part of the elective coursework requirement must receive the approval of a student's graduate advisory committee. Students must demonstrate to the committee that the selection of classes or research projects produces a coherent course of study focused on the student's particular area of emphasis. Depending on the emphasis area, selections may include coastal and marine system science, marine biology, the natural sciences, computer science, geographic information science, mathematics, political science, public administration, business law, or other areas as stipulated by the graduate advisory committee.

Research, Dissertation Research, and Dissertation Defense

Three courses are taken for the main research component of the degree:

Code	Title	Hours
CMSS 6996	Research	1-9
CMSS 6998	Dissertation Research	1-9
CMSS 6999	Dissertation Defense	3-9

During the initial phase of the program, students take CMSS 6996 Research (1-9 sch) with approval of their advisor. Students can also enroll in CMSS 6596 Directed independent Study (1-5 sch), supervised

by their advisor or other faculty members at any stage of the program progression. Once students have passed their qualifying exam and become degree candidates, they must take CMSS 6998 Dissertation Research (1-9 sch) with approval of their advisor. The courses CMSS 6996 Research (1-9 sch) and CMSS 6998 Dissertation Research (1-9 sch) are graded with an S or U, and may be repeated. Finally, students must enroll in CMSS 6999 Dissertation Defense (3-9 sch) during their last semester (see below).

CMSS 6999 Dissertation Defense (3-9 sch) is taken as Credit/No Credit.

Final Dissertation Defense

Each student must pass a final dissertation defense examination during the last semester before graduation, to be administered by the student's graduate advisory committee. The exam will cover topics related to

1. all graduate coursework undertaken for the CMSS program,
2. the student's dissertation research area, and
3. broad concepts of system science, requiring familiarity with the literature and appropriate professional societies.

The student is responsible for scheduling the defense in consultation with his or her graduate committee. A student who fails the defense may repeat it once, but only after an interval of four months or more. If a student fails the second defense, the student will be terminated from the program. Students must enroll in the course CMSS 6999 Dissertation Defense (3-9 sch) during the semester in which they are planning to take the dissertation defense and/or graduate.

Dissertation Format and Style

The dissertation must be prepared in a standard format and style prescribed by the advisory committee. Guidance can be found in the CMSS Student Handbook. For more information about dissertation formatting guidelines, consult Graduate Education.

Upon approval by the student's graduate advisory committee, a copy of the dissertation will be submitted to Graduate Education. For more information, see the Doctoral Student Handbook available from the Graduate Education website. See also "Requirements for Doctoral Programs" in the general section of this catalog.

Courses

CMSS 5392 Thesis I: Thesis Proposal
3 Semester Credit Hours (3 Lecture Hours)
Thesis students must submit a completed proposal for their thesis project. A course section will be created for the student to enroll. Upon successful completion and submission of the proposal signed by the graduate committee of the student, students may then register for CMSS 5393 Thesis Research. Open only to M.S. Thesis Degree Candidates in CMSS.

CMSS 5393 Thesis II: Thesis Research
3 Semester Credit Hours (3 Lecture Hours)
Implementation of the Thesis Proposal, and the production of a rough draft of the thesis submitted to the graduate committee of the student for initial editing and comment. A course section will be created for the student to enroll.
Prerequisite: CMSS 5392.

CMSS 5394 Thesis III: Thesis Submission
3 Semester Credit Hours (3 Lecture Hours)
Completion of the final draft of the thesis, signed by the graduate committee of the student and ready for binding and distribution. A course section will be created for the student to enroll.
Prerequisite: CMSS 5393.

CMSS 5596 Directed Independent Study
1-5 Semester Credit Hours
Study in areas of current interest. A total of six semester hours of Directed Independent Study may be counted towards the CMSS M.S. degree.

CMSS 5940 Thesis Project Research
1-9 Semester Credit Hours
Research related to the CMSS M.S. thesis project. Open only to M.S. students in CMSS with consent of the graduate advisor. Up to six hours may count as credit toward regular graded (non-research, non-variable credit) elective coursework for M.S. degree requirement in Coastal and Marine System Science.

CMSS 6303 Natural Systems Analysis
3 Semester Credit Hours (3 Lecture Hours)
Statistical analysis for data collected in several variables. Topics include sampling from multivariate normal distribution, multivariate analysis of variance, discriminant analysis, principle components, and factor analysis.
Prerequisite: MATH 6315.

CMSS 6305 Natural Systems Modeling
3 Semester Credit Hours (3 Lecture Hours)
Modeling and analysis of deterministic and stochastic dynamical systems, including investigation of model behavior and stability. Theory will be applied to research natural environmental and biological systems such as multi-species systems, carbon circulation in the biosphere, Nutrients-Phytoplankton-Zooplankton models, etc.
Prerequisite: MATH 6315 and 6316.

CMSS 6307 Coastal and Marine Systems
3 Semester Credit Hours (3 Lecture Hours)
Description of coastal and oceanic ecosystems to provide an overview of the fundamental concepts of the abiotic and biotic components, physical-chemical processes, and interactions with environmental and human systems.

CMSS 6308 Coastal Geoenvironments and Change
3 Semester Credit Hours (3 Lecture Hours)
Investigations of the origin, character, and processes of coastal geoenvironments with an emphasis on tracking historical and projecting future changes, including examination of the interactions of geological and biological processes and impacts of human activities on coastal depositional systems.

CMSS 6310 Fundamentals of Remote Sensing
3 Semester Credit Hours (3 Lecture Hours)
Fundamental theory of satellite/airborne remote sensing techniques, sensor performance and calibration, and the scientific applications for land, ocean and atmosphere observations. Topics include physical principles of remote sensing, radiometry, sensors and sensor technology from infrared to microwave sensing, and scientific applications for land, ocean and atmosphere observations. Cross listed with ESCI 6310.

CMSS 6312 Communicating Science Seminar
3 Semester Credit Hours (3 Lecture Hours)
Covers communication topics ranging from proposal writing to professional presentations with a minor emphasis on additional non-traditional communication formats. Must be taken to fulfill degree plan requirements by all Marine Biology graduate students and is recommended in the first spring of the degree.

CMSS 6315 Environmental and Geological Applications of GIS
3 Semester Credit Hours (3 Lecture Hours)
The Geographic Information System (GIS) provides a vehicle for capturing, storing, querying, analyzing, and displaying multidimensional geospatial datasets. This course is designed to introduce students to advanced concepts of GIS and their applications to manage, analyze, and display of multidimensional environmental, geological, and geophysical datasets.
Prerequisite: (PHYS 1401 or 2425) and MATH 2413.

CMSS 6321 Big Data Blitz
3 Semester Credit Hours (3 Lecture Hours)
This course is designed to guide students through the process of preparing and conducting a data mining multi-disciplinary project in the field of coastal and marine system sciences that utilizes big data. The course begins with an introduction to python programming and data search and format manipulation, where students will learn how to locate and collect relevant spatial and/or temporal data from various sources and how to manipulate it into a format that can be easily analyzed and visualized. The course then moves on to experiment design, where students will learn how to design experiments to collect spatial and/or temporal data that can be analyzed using big data and data mining techniques. Artificial intelligence (AI) and machine learning (ML) will also be introduced as a powerful tool for analyzing complex data sets and students will learn how to apply various AI and ML algorithms to real-world problems in coastal and marine system sciences. Finally, students will present their projects identifying their research question, experiment design, the data identified, data used, data processing and manipulation steps, any analyses and visualizations (e.g., summary statistics, maps), and their proposed next steps with their data. Instructor permission.

CMSS 6323 Experimental Design
3 Semester Credit Hours (3 Lecture Hours)
Fundamental concepts of mathematical ecology and the design and analysis of environmental experiments. Students Learn SAS programming and procedures to compute ecological metrics, data management techniques, exploratory analysis, power, sample size, checking assumptions, and analysis of variance models to compute a priori and post hoc hypothesis tests.
Prerequisite: MATH 6315.

CMSS 6327 Physical Oceanography
3 Semester Credit Hours (3 Lecture Hours)
Succinct review of basic concepts of physical oceanography followed by general presentations and discussions in three selected areas: global ocean circulation, circulation along the Gulf of Mexico continental shelf, and ocean-atmosphere interaction and impacts on climate. A significant portion of the class is based on student guided reading assignments.

CMSS 6328 Coastal Ocean using RMT SNS
3 Semester Credit Hours (3 Lecture Hours)

CMSS 6333 Paleo Systems
3 Semester Credit Hours (3 Lecture Hours)
Study of the interrelationships of ancient organisms and their environment through interpretation of the fossil record, analog communities, and oceanographic data, such as carbon and oxygen isotopes. Theories and methods of reconstructing terrestrial, marine and freshwater biotic communities and environments. Review of classic paleoecological and paleoceanographic studies as well as current research.
Prerequisite: BIOL 3428 and GEOL 1401 and (ESCI 3351 or GEOL 4316).

CMSS 6334 Geological Oceanography
3 Semester Credit Hours (3 Lecture Hours)
Integrated examination of the geology and geochemistry of the marine environment. Evolution of ocean basins, continental margins and plate boundaries; geology of oceanic crust; controls on the types, origin, and distribution of marine sediments; and introduction to paleoceanography.
Prerequisite: ESCI 3351 or GEOL 4316.

CMSS 6340 Ocean Resources
3 Semester Credit Hours (3 Lecture Hours)

CMSS 6352 Environmental Forecasting
3 Semester Credit Hours (3 Lecture Hours)
Statistical techniques (classic and Bayesian) and new artificial intelligence based techniques, such as neural networks, for the analysis of environmental systems with large datasets.
Prerequisite: CMSS 6305.

CMSS 6357 Global Geochemical Cycles and Change
3 Semester Credit Hours (3 Lecture Hours)
Integrated examination of global-scale geochemical cycles operating within and between the four components of the Earth system (atmosphere, hydrosphere, biosphere, and solid Earth) and their role in the evolution of our planet.
Prerequisite: CHEM 1411, 1412 and 3411.

CMSS 6358 Ocean and Estuarine Acidification
3 Semester Credit Hours (3 Lecture Hours)
This course focuses on introducing the concept of acidification of marine ecosystems (estuaries and oceans) and biological and ecological responses to the acidification; the geological past will also be examined in the context of current ocean acidification. Numerical simulations using the software CO2SYS and interpretation of open-access global databases on global ocean and estuarine acid-base dynamics will be introduced in this class.
Prerequisite: (CHEM 1411 and 1412).

CMSS 6359 Marine Ecosystem Dynamics
3 Semester Credit Hours (3 Lecture Hours)
Investigation of the interactions between organisms and physical processes that regulate marine ecosystem functions.

CMSS 6360 Computer Programming in Earth System Sciences
3 Semester Credit Hours (3 Lecture Hours)
This course is to enhance the programming skills of graduate students under various scientific programming environments. The focus is on the data analysis and problem-solving using Python, R, MATLAB and IDL. The contents of the course include the basic concepts of the operating systems and high-level programming languages, basics of programming in Python, general data analysis methods and tools, common scientific data formats, publication quality scientific graphics, the critical steps of building a large programming project.

CMSS 6362 Global Change and Its Impact on Aquatic Ecosystems
3 Semester Credit Hours (3 Lecture Hours)
This course will introduce students to the effects of climatic and anthropogenic change on aquatic ecosystem structure and function. Includes readings from the current literature and development of a research proposal. Cross-listed with MARB 6362.

CMSS 6370 Coastal Management and Ocean Law
3 Semester Credit Hours (3 Lecture Hours)
Intensive study of the 1972 National Coastal Zone Management Act and subsequent coastal management programs. The Texas program, which is administered by the General Land Office, will be dealt with in depth as the central focus of the course. Statutory law relating to citizen, state, and federal rights and duties as they impact coastal and maritime law will be studied including applicable Texas real property law. Students will use case law studies relating to those rights and duties and Public Trust Doctrine cases to gain an integral part of understanding the responsibilities of governments and rights of citizens.

CMSS 6372 Environmental Sustainability Economics
3 Semester Credit Hours (3 Lecture Hours)
This course will introduce the fundamental concepts of neoclassical microeconomics and ecological economics and apply them to environmental and sustainability issues.

CMSS 6590 Advanced Topics
1-5 Semester Credit Hours (1-5 Lecture Hours)
An advanced study of an environmental systems topic. May be repeated with full credit in another area of environmental systems.

CMSS 6596 Directed independent Study
1-5 Semester Credit Hours
Study in areas of current interest. A total of six semester hours of Directed Independent Study may be counted towards the Ph.D. degree.

CMSS 6940 Dissertation Project Research
1-9 Semester Credit Hours (1-9 Lecture Hours)
DISSERTATION PROJECT RESEARCH Research related to Ph.D. dissertation project. Open only to degree candidates in Coastal and Marine Systems Science with consent of the graduate advisor. Course is taken as credit/non-credit and may be repeated.

CMSS 6996 Research
1-9 Semester Credit Hours (1-9 Lecture Hours)
Independent research conducted under supervision of an advisor. Open to Coastal and Marine System Science students who have not yet passed the qualifying exam and with consent of their graduate advisor. The course is graded with an S or U, and may be repeated.

CMSS 6998 Dissertation Research
1-9 Semester Credit Hours (1-9 Lecture Hours)
Research related to Ph.D. dissertation project. Open only to degree candidates having passed the qualifying exam in Coastal and Marine System Science with consent of their graduate advisor. The course is graded with an S or U, and may be repeated.

CMSS 6999 Dissertation Defense
3-9 Semester Credit Hours
Open only to degree candidates in Coastal and Marine System Science with consent of their graduate advisor. Students should enroll in this course during the last semester of the CMSS PhD program. To successfully complete this course the student must pass the dissertation defense as well as have a final copy of the dissertation signed by the full graduate committee and approved for binding and distribution. A course section will be created for the student to enroll. A grade of Credit/No Credit will be assigned for the class with the possibility to assign the grade of IP or In Progress. If a grade of IP is assigned, the course must be repeated the following semester(s) until the course is passed.