Coastal and Marine System Science
DOCTOR OF PHILOSOPHY

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 which 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, including 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.

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 which 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, students must successfully complete a comprehensive examination for advancement to doctoral candidacy. This examination must 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. Students who earn Ph.D. 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.

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 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 in universities, federal agencies, private companies or non-governmental organizations where they can apply the skills and knowledge acquired during the program
Admission Requirements

Persons seeking admission to the CMSS Program should apply through the university Office of Graduate Studies and Research. In addition to the documents required by that office, 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 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. The applicant will be notified by letter of acceptance or rejection.

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 most cases, these courses will not apply towards the total required for the Ph.D. 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 semester). For additional information, please contact the CMSS Program Coordinator, College of Science and Technology, Texas A&M University-Corpus Christi, 6300 Ocean Dr., Corpus Christi, Texas 78412-5802.

Degree Requirements

Each student accepted to the Ph.D. in the Coastal and Marine System Science degree program must complete a minimum of 90 hours beyond the bachelor’s degree or 60 hours beyond the master’s degree. No more than one-third of the required hours may be taken at the 5000-level with approval from the student’s graduate advisory committee. The remainder must be taken at the 6000-level. A student’s advisory committee must approve the program degree plan. All students must successfully complete at least nine semester credit hours per long semester to remain in the program. All students must pass a final dissertation defense, to be administered by their advisory committee, during their last semester before graduation.

A. Admission from a Bachelor’s Degree Option (90 semester credit hours)

<table>
<thead>
<tr>
<th>Sem. Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMSS 6102 Seminar in Earth System Science (1 sem. hr. x 3)</td>
</tr>
<tr>
<td>CMSS 6303 Systems Analysis</td>
</tr>
<tr>
<td>CMSS 6305 Natural Systems Modeling</td>
</tr>
<tr>
<td>CMSS 6330 Spatial Systems Science</td>
</tr>
<tr>
<td>CMSS 6370 Coastal Management and Ocean Law</td>
</tr>
<tr>
<td>Topical coursework supporting student’s individual research goals (Item C below)</td>
</tr>
<tr>
<td>Specialized coursework, Advanced Topics, Research or Dissertation Research to be chosen from among approved biology, chemistry, coastal and marine system science, computer science, environmental science, geographic information science, geology, or other course offerings, in consultation with student’s advisory committee.</td>
</tr>
<tr>
<td>CMSS 6699 Dissertation Defense</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

B. Admission from a Master’s Degree Option (60 semester credit hours)

<table>
<thead>
<tr>
<th>Sem. Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMSS 6102 Seminar in Earth System Science (1 sem. hr. x 3)</td>
</tr>
<tr>
<td>CMSS 6303 Systems Analysis</td>
</tr>
<tr>
<td>CMSS 6305 Natural Systems Modeling</td>
</tr>
<tr>
<td>CMSS 6330 Spatial Systems Science</td>
</tr>
</tbody>
</table>
CMSS 6370  Coastal Management and Ocean Law  3
Topical coursework supporting student’s individual research goals (Item C below)  8

Specialized coursework, Advanced Topics, Research or Dissertation Research to be chosen from among approved biology, chemistry, coastal and marine system science, computer science, environmental science, geographic information science, geology, or other course offerings, in consultation with student’s advisory committee.  31

CMSS 6399  Dissertation Defense  6
Total  60

C. Topical and Specialized Coursework
Topical coursework is offered under the heading of CMSS 6590, Advanced Topics. Most students will be required to take at least two of these courses. Classes or research projects designated as part of the specialized 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, 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.

D. Dissertation Format and Style
The dissertation must be prepared in a standard format and style dictated by the advisory committee. Guidance can be found in the CMSS Student Handbook. For more information, consult the Office of Graduate Studies and Research.

Upon approval by a student’s graduate advisory committee, a copy of the dissertation will be sent to the Dean of Graduate Studies. At the time of successful completion of the dissertation exam, committee members will sign the dissertation and return it to the Dean of Graduate Studies for final approval and signature. See also “Requirements for Doctoral Programs” in the general section of this catalog.

E. Research, Dissertation Research, and Dissertation Defense
Three courses are taken for the main research component of the degree: CMSS 6996 Research (1-9 credit hours), CMSS 6998 Dissertation Research (1-9 credit hours), and CMSS 6699 Dissertation Defense (6 credit hours). During the initial phase of the program, students take CMSS 6996 Research (1 - 9 credit hours), with approval of their advisor. Students can also enroll in CMSS 6596 Directed Independent Study (1 - 5 credit hours), 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 should take CMSS 6998 Dissertation Research (1 - 9 credit hours) with approval of their advisor. The courses CMSS 6996 and 6998 are graded with an S or U, and may be repeated. Finally students must enroll in CMSS 6699 Dissertation Defense (6 credit hours), during their last semester (see below). CMSS 6699 is taken as Credit/No Credit.

F. 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) a student’s dissertation research area, and (3) broad concepts of system science, including familiarity with the literature and appropriate professional societies. The student is responsible for scheduling the defense with the faculty involved. 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, he or she will be terminated from the program. Students must enroll in the course Dissertation Defense (CMSS 6699) during the semester in which they are planning to take the dissertation defense and/or graduate.
GRADUATE COURSES

CMSS 6102. 1 sem. hr. (1:0)
SEMINAR IN EARTH SYSTEM SCIENCE
Advanced topic study and presentation by students, faculty, or visiting scientists. Meets one hour weekly. Must be taken three times by all Ph.D. students.

CMSS 6303. 3 sem. hrs. (3:0)
SYSTEMS ANALYSIS
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 5315 Statistical Methods in Research I, undergraduate equivalent, or consent of instructor.

CMSS 6305. 3 sem. hrs (3:0)
NATURAL SYSTEMS MODELING
Parameterization of natural systems through the identification and characterization of input/output pathways, regulators, and sinks. Construction, testing, and use of various types of models: conceptual, ecosystem, and numeric. Prerequisites: MATH 5315 Statistical Methods in Research I and MATH 5316 Statistical Methods in Research II, or permission of instructor.

CMSS 6323. 3 sem. hrs. (3:0)
EXPERIMENTAL DESIGN
Fundamental concepts in the design and analysis of biological experiments. Various analysis of variance models will be introduced beginning with completely randomized designs and factorial treatment structures, and proceeding through block and split-plot designs. Related topics include analysis techniques, power, sample size and checking assumptions. Prerequisite: Math 5315 Statistical Methods in Research I, undergraduate equivalent, or consent of instructor.

CMSS 6325. 3 sem. hrs. (3:0)
GEOLICAL OCEANOGRAPHY
Geology of the marine environment. Topics include: controls on the types, origin, and distribution of marine sediments; geology of oceanic crust; evolution of continental margins and plate boundaries; introduction to paleoceanography. Prerequisites: GEOL 1403 Physical Geology and GEOL 1404 Historical Geology; ESCI 3351 Oceanography recommended.

CMSS 6327. 3 sem. hrs. (3:0)
PHYSICAL OCEANOGRAPHY
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. Prerequisites: Direct interest in physical oceanography, background that includes introductory college physics and basic mathematical knowledge of calculus and simple differential equations, or approval of class instructor.

CMSS 6330. 3 sem. hrs. (3:0)
SPATIAL SYSTEMS SCIENCE
Introduction and advanced usages of mapping datums, coordinate systems, and accuracy requirements for geographic information systems (GIS). Use of GIS tools to investigate statistical patterns and relationships among maps and geo-databases. Derivation of new maps and analysis based on spatial context, patterns, surface configuration, proximity, connectivity and flows. Prerequisites: MATH 5316 Statistical Methods in Research II; a working knowledge of ArcView and/or ArcGIS; or permission of instructor.

CMSS 6333. 3 sem. hrs. (3:0)
PALEOECOLOGY
Study of the interrelationships of ancient organisms and their environment through interpretation of the fossil record and analog communities. Theories and methods in reconstructing terrestrial and aquatic biotic communities. Review of classic paleoecological studies and current research. Prerequisites: BIOL 3428 Principles of Ecology and GEOL 1404 Historical Geology, or BIOL 3428 and GEOL 3441 Invertebrate Paleontology, or GEOL 1404 and BIOL 3413 Invertebrate Zoology.

CMSS 6334. 3 sem. hrs. (3:0)
MARINE GEOCHEMISTRY
Review of the steady-state ocean concept, classification of different constituents according to their involvement in the biological particle cycle, geochemical processes at and near the seafloor, chemical exchanges between sea water and sediment, both at the interface itself and within the sediment. Prerequisites: GEOL 1403 Physical Geology, ESCI 3351 Oceanography, CHEM 1311/1312 General Chemistry I and II, and CHEM 3411 Organic Chemistry I (or equivalent).

CMSS 6343. 3 sem. hrs. (3:0)
TRANSPORT OF POLLUTANTS IN THE ENVIRONMENT
Fate and transport processes in the environment. Pollutant distribution among phases; solubility, volatilization, and absorption. Equilibrium partitioning among different phases; fugacity modeling. Modeling of physical transport mechanisms; advection, molecular diffusion, dispersion. Application of transport processes to surface
waters, the subsurface and the atmosphere. Air-water exchange, non-aqueous phase liquids. Prerequisites: CHEM 1311 General Chemistry I and 1312 General Chemistry II.

CMSS 6352. 3 sem. hrs. (3:0)
ENVIRONMENTAL FORECASTING
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 6355. 3 sem. hrs. (2:2)
AQUATIC ECOTOXICOLOGY
Principles and applications of toxicity testing in the aquatic environment for: water and sediment quality assessment and monitoring; characterization of liquid effluents and treatment procedures; role of water quality criteria; assessment of water quality in aquaculture facilities; assessment of environmental hazard of new chemicals. Prerequisites: BIOL 3413 Invertebrate Zoology and BIOL 3414 Vertebrate Zoology.

CMSS 6357. 3 sem. hrs. (3:0)
GLOBAL GEOCHEMICAL CYCLES AND CHANGE
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. Prerequisites: CHEM 1311/1312 General Chemistry I and II and CHEM 3411 Organic Chemistry I.

CMSS 6361. 3 sem. hrs. (3:0)
ORGANIC AND ISOTOPE GEOCHEMISTRY
Organic compounds of biologic and industrial origin are used to study past sedimentary environments. Applications of oxygen, carbon, hydrogen and nitrogen stable isotope systems are employed to complement information gained from various organic geochemical studies. Prerequisites: CHEM 3411 Organic Chemistry I and GEOL 1403 Physical Geology.

CMSS 6370. 3 sem. hrs. (3:0)
COASTAL MANAGEMENT AND OCEAN LAW
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 6401. 4 sem. hrs. (3:3)
MATHEMATICAL CONCEPTS FOR SYSTEM SCIENCE
Course focused on calculus, linear algebra, and differential equations used in coastal, marine, and environmental settings. The course is designed for entering doctoral students in the CMSS program as well as other interested science graduate students of the College of Science and Technology. Course concepts are approached within the context of coastal and marine systems. Prerequisites: Introductory Math Statistics and Calculus I or equivalents or permission of instructor.

CMSS 6407. 4 sem hrs. (3:3)
DATA ACQUISITION AND INTEGRATION
Principal component, mixing, and quantitative analysis of very large data sets. Database design, filtering and mining. Determination of appropriate sampling densities for multitemporal and multiscale acquisition campaigns. Standard mathematical techniques for resampling, rectification, and transformation. Preparation of normalized data sets for visualization and GIS applications. Prerequisite: CMSS 6305 or permission of instructor.

CMSS 6425. 4 sem hrs. (3:3)
GIS APPLICATIONS IN ECOLOGY
Development of hierarchical spatial and temporal analyses relating to ecological phenomena using geographic information system approaches. Emphasis on identifying and evaluating available databases, incorporating databases at appropriate scales, constructing pertinent geospatial themes, and analyzing spatial and temporal changes with habitats and biological populations. Prerequisite: GIS 1470 Geographic Information Systems I and GISC 3421 Visualization for GIS.

CMSS 6442. 4 sem hrs. (3:2)
ACOUSTIC ECOLOGY
Intended for students working in diverse research areas in which sound conveys information that has significant effects on the systems being studied. Topics include field data collection methods, recording devices and media, spectrographic analysis of acoustic signals using digital techniques, and an introduction to statistical evaluation of acoustic data. Prerequisite or co-requisite: Math 5315 or permission of instructor.

CMSS 6590. 1-5 sem. hrs. (1:0-3:4)
ADVANCED TOPICS
An advanced study of an environmental systems topic. May be repeated with full credit in another area of environmental systems.

CMSS 6596. 1-5 sem. hrs.
DIRECTED INDEPENDENT STUDY
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 6996. 1-9 sem. hrs.
RESEARCH
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. 1-9 sem. hrs.
DISSERTATION RESEARCH
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 6699. 6 sem. hrs.
DISSERTATION DEFENSE
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.