

# MARINE SCIENCE PROGRAM

## MARINE SCIENCE AND OTHER RELEVANT COURSE DESCRIPTIONS

**MarSE 212** Geophysical Fluid Dynamics I (Cross-listed as ErSE 201): Introductory description of the Earth's climate system, governing equations of mass and momentum conservation, equation of state, thermodynamic equation, wave kinematics, dispersion, group velocity, sound waves, gravity waves, effect of rotation, equations of motion in spherical coordinates, primitive equations, Boussinesq approximation, changing vertical coordinate, asymptotic analysis and scaling, geostrophic balance, thermal wind, static instability, boundary layers in atmosphere and ocean.

*Prerequisite: ME 200a and ErSE 203 or consent of instructor.*

**MarSE 217** Marine Genomics and Bioinformatics: Genome science is the study of the structure, content, and evolution of genomes. This course deals with organization of genomes, genome sequencing, genomic variation, gene expression and functional genomics with a particular emphasis on marine organisms and how to apply this field to study marine science.

*Prerequisite: Undergraduate course in molecular biology, genetics, evolution, or bioinformatics. Students from programs other than MarSE must have instructor permission to register for this course*

**MarSE 221** Marine Life: An overview of marine biology that surveys the diversity of marine habitats, major groups of taxa inhabiting those habitats and the general biology of the various taxa. Topics include the production and consumption of organic material in the ocean, as well as factors controlling those processes. Species diversity, structure of marine food webs and the flow of energy within different marine habitats will be detailed and contrasted.

*Prerequisite: Undergraduate course in ecology, zoology, or marine science. Students from programs other than MarSE must have instructor permission to register for this course.*

**MarSE 226** Coral Reef Ecology: This course will cover coral reef distributions, biogeography, and ecological processes important to reefs. Basic coral anatomy and physiology will be discussed. Reef fishes and their interaction with coral communities will be highlighted, along with coral reef fisheries. Modern threats to coral reefs, including thermal bleaching, ocean acidification, and diseases of corals will be examined with particular emphasis on processes affecting the future status of reef communities.

*Marine Life (MarSE 221) is a prerequisite for this course.*

**MarSE 228** Structure and Function of Marine Ecosystems - This course gives an overview of marine ecology. It addresses the global production and distribution of plankton and fish, the vertical distribution of both pelagic and benthic organisms as well as predator-prey interactions among organisms in different habitats. It describes ecosystems from the intertidal zone to the deep sea and outlines ecological principles governing the distributions of organisms and their adaptations to be successful in the different environments.

*Marine Life (MarSE 221) is a prerequisite for this course.*

**MarSE 229** Marine Microbial Ecology: This course covers recent developments in the field of marine microbial ecology and will give an overview on structure and function of microbial communities in the oceans including discussions on novel methods, results and hypotheses. Among the topics covered are: Photoheterotrophic bacteria, marine bacteria and the carbon cycle, UV radiation effects on microbes and microbial processes, uptake and regeneration of inorganic nutrients by marine heterotrophic bacteria, bacterivory: interactions between bacteria and their grazers, symbiosis and mixotrophy among pelagic microorganisms, marine viruses and their ecological impact, the Global Ocean Survey of Marine Metagenomics, single cell activity in marine bacterioplankton.

*Environmental Microbiology (EnSE 203) is a prerequisite for this course.*

**MarSE 230** Ecological Genomics: Ecological genomics describes the application of genomic tools (high throughput sequencing, microarrays, quantitative PCR, etc.) to solve questions of ecology. Its purpose is to increase understanding of the responses and interactions of organisms to the environment and to one another by analyzing genomic sequences, gene expressions and genome evolution. This course will give an overview over the methods utilized and the questions asked by ecological genomics with a particular emphasis on marine ecological genomics.

**MarSE 235** Introduction to Physical Oceanography: This course provides an introduction to oceanography and includes the following topics: Ocean basins, major currents and water property distributions; properties of seawater: equation of state, temperature and salinity analysis; basic dynamical ideas: hydrostatic balance, Coriolis force, geostrophy, turbulence; forcing of the ocean: solar radiation, winds, heat and freshwater fluxes; Ekman transport; the observed ocean: major currents, gyres, meridional overturning, eddies, sill flows, upwelling, monsoons, equatorial motions, El Niño, marginal seas; time dependence: inertial oscillations, long gravity waves, Rossby waves; tides: astronomical forcing, basin modes, local resonances, tidal mixing.

**MarSE 243** Ecology and Management of Marine Fisheries: Reviews basic ecological principles applied to fisheries management with the aim of promoting sustainable fisheries and marine conservation. Topics include fish life history and population dynamics and the community and ecosystem-level responses to fishing and natural variability, with special emphasis on coral reef fisheries.

**MarSE 245** Special Topics in Marine Science: Reviews current topics in marine science, particularly relying on scientific journal publications to provide case studies, illustrative examples, classic studies, and controversial findings pertinent to specific fields within marine science. The course will feature an emphasis on primary literature searches, reading and assessment of primary literature, and presentation skills.

**MarSE 297** Thesis (increments of 3 units): Masters-level research leading to a formal written dissertation and oral defense thereof.

**MarSE 298** Marine Science Seminar Series: Seminar series focusing on special topics within the field, highlighting work and studies presented by faculty, staff, visiting scientists, or students.

**MarSE 299** Directed Research: Masters-level supervised research.

**MarSE 317** Advanced Marine Genomics and Bioinformatics: Genome science is the study of the structure, content, and evolution of genomes. This course deals with organization of genomes, genome sequencing, genomic variation, gene expression and functional genomics with a particular emphasis on marine organisms and how to apply this field to study marine science. As a PhD level course, assessment of students and participation expectations will be commensurate with the level of student experience.

*Prerequisites?*

**MarSE 323** Advanced Topics in Pelagic Ecology: The course will address one or a few central topics in pelagic ecology in-depth. It will primarily be based on seminars in which the students will present and discuss scientific papers. The aims are to acquire knowledge of the state-of-the-art of current research questions, as well as to train communication skills and the ability to critically read research papers. Assessment includes a final oral exam.

*Prerequisite: Undergraduate course in marine science. Students from programs other than MarSE must have instructor permission to register for this course.*

**MarSE 326** Advanced Coral Reef Ecology: This course will cover coral reef distributions, biogeography, and ecological processes important to reefs. Basic coral anatomy and physiology will be discussed. Reef fishes and their interaction with coral communities will be highlighted,

along with coral reef fisheries. Modern threats to coral reefs, including thermal bleaching, ocean acidification, and diseases of corals will be examined with particular emphasis on processes affecting the future status of reef communities. As a PhD level course, assessment of students and participation expectations will be commensurate with the level of student experience.

*Marine Life (MarSE 221) is a prerequisite for this course, or consent of instructor.*

**MarSE 329** Advanced Marine Microbial Ecology: This course covers recent developments in the field of marine microbial ecology and will give an overview on structure and function of microbial communities in the oceans including discussions on novel methods, results and hypotheses. Among the topics covered are: Photoheterotrophic bacteria, Marine Bacteria and the Carbon Cycle, UV radiation effects on Microbes and Microbial Processes, Uptake and Regeneration of Inorganic Nutrients by Marine Heterotrophic Bacteria, Bacterivory: Interactions between Bacteria and their Grazers, Symbiosis and Mixotrophy Among Pelagic Microorganisms, Marine Viruses and their ecological impact, Global Ocean Survey of Marine Metagenomics, Single cell activity in marine bacterioplankton. As a PhD level course, assessment of students and participation expectations will be commensurate with the level of student experience.

*Environmental Microbiology (EnSE 203) is a prerequisite for this course, or consent of instructor.*

**MarSE 330** Advanced Ecological Genomics: Ecological genomics describes the application of genomic tools (high throughput sequencing, microarrays, quantitative PCR etc.) to solve questions of ecology. Its purpose is to increase understanding of the responses and interactions of organisms to the environment and to one another by analyzing genomic sequences, gene expressions and genome evolution. This course will give an overview over the methods utilized and the questions asked by ecological genomics with a particular emphasis on marine ecological genomics. As a PhD level course, assessment of students and participation expectations will be commensurate with the level of student experience.

**MarSE 331** Symbiotic Microbial Associations in Marine Systems: Many marine eukaryotes developed symbiotic associations with microbes to gain a fitness advantage over their competitors. This class reviews principles of symbiosis in marine and terrestrial systems and discusses in detail associations of microbes with sponges, squids, plankton, fish, tubeworms, mussels and clams, leaf slugs, algae, corals, and zooplankton.

*Environmental Microbiology (EnSE 203) is a prerequisite for this course, or consent of instructor.*

**MarSE 343** Advanced Ecology and Management of Marine Fisheries: Reviews basic ecological principles applied to fisheries management with the aim of promoting sustainable fisheries and marine conservation. Topics include fish life history and population dynamics and the community and ecosystem-level responses to fishing and natural variability, with special emphasis on coral reef fisheries. As a PhD level course, assessment of students and participation expectations will be commensurate with the level of student experience.

**MarSE 345** Advanced Special Topics in Marine Science: Reviews current topics in marine science, particularly relying on scientific journal publications to provide case studies, illustrative examples, classic studies, and controversial findings pertinent to specific fields within marine science. The course will feature an emphasis on primary literature searches, reading and assessment of primary literature, and presentation skills. As a PhD level course, assessment of students and participation expectations will be commensurate with the level of student experience.

**MarSE 389** PhD Transfer Course: Credit may be awarded at the discretion of the academic advisor and thesis supervisor in cases where a student has taken a suitable PhD-level course at another institution. The subject of the course should be highly relevant to the student's proposed area of research. A student planning to take such a course while enrolled as a KAUST PhD student must obtain prior approval of the supervisor and academic advisor.

**MarSE 397** Thesis

PhD Dissertation (increments of 3 units): PhD-level research leading to a formal written dissertation and oral defense thereof.

**MarSE 398** Marine Science Seminar Series: Seminar series focusing on special topics within the field, highlighting work and studies presented by faculty, staff, visiting scientists, or students. As a PhD level course, assessment of students and participation expectations will be commensurate with the level of student experience.

**MarSE 399 Directed Research**  
Doctoral-level supervised research.

Other relevant course descriptions:

**ErSE 301** Geophysical Fluid Dynamics II - Climate and climate change, large-scale atmospheric and oceanic motions, fine-scale processes. Quasigeostrophic motion of a stratified fluid on a sphere, the equations of motions in spherical coordinates, scaling and asymptotic analysis, potential-vorticity equation. Rossby waves in a stratified fluid. Theory of instability, baroclinic instability, barotropic instability, instability of flows with horizontal and vertical shear. Energy and enstrophy. Numerical models of general circulation of atmosphere, pressure vertical coordinate, linear and nonlinear numerical instabilities.  
*ErSE 201 is prerequisite, or consent of instructor*

**ErSE 253** Data analysis in Geosciences - Time Series (filtering, correlation, deconvolution, spectral analysis, regression), processing of multidimensional data, spatial statistics including variogram, covariance analysis and modeling, multipoint estimation, spatial interpolation including statistical methods (kriging) and dynamical methods (Kalman filter), uncertainty assessment, cross validation, multivariate analysis including principal component analysis and canonical analysis.  
*Prerequisite: Background in linear algebra, probability theory, statistics, and programming in Matlab*

**ErSE 306** Ocean Physics and Modeling - This course will introduce the theory and numerical modeling of ocean circulation. This includes the theory of steady and time-dependent large-scale circulation, effects of earth's curvature, wind-driven Sverdrup circulation, western boundary currents, eastern boundary upwelling, effects of buoyancy forcing, wind- and buoyancy-forced circulation in the thermocline. The course will also review the theoretical models of ocean circulation, including shallow water, barotropic, quasigeostrophic, and primitive equation models; adjustment times, internal length and time scales; the role of advection, bathymetry and coastlines; global models, basin models, regional models.  
*Prerequisite: ErSE 201, ErSE 203, AMCS 252 or consent of instructor*

**ErSE 203** Geophysical Continuum Mechanics - The course provides physical background foundation and overview of mathematical continuum models of geophysics. The goal of the course is to allow students to learn modeling ideas and utilize them in simulation. The course will include a basic introduction to finite difference and finite element methods and their application to continuum modeling and simulation. Topics discussed include: brief introduction to Cartesian tensors, their calculus and algebra; deformations and strain measures; balance laws and equations of motion; thermodynamical relations and constraints; mixture theory and phase change.  
*Prerequisite: AMCS 231 or consent of Instructor*

**ErSE 324** Parallel Scientific Computing in Earth Science - Introduction to the basics of modern parallel computing: parallel architectures, message passing, data and domain decomposition, parallel libraries, programming languages, data management and visualization and parallel numerical algorithms. Applications to scientific computing problems in earth sciences and engineering.  
*Prerequisite: AMCS 252, ErSE 203 or consent of instructor*