1st semester

Introduction to Biological Oceanography

Historical review. Marine environment division. Abiotic parameters. Biological interactions. Biodiversity. Food webs. Primary production. Plankton. Nekton. Benthos. Protected marine organisms. Invasive species in the Mediterranean Sea. Divisions, adaptations, migrations. Elements of Fishery Biology. Elements of Aquaculture.

Introduction to Geological Oceanography

- Basic concepts of Physical Geography (Tectonic plates - genesis and extinction of oceans - Earthquakes -Volcanoes- Rocks, Geological Time)
- Seabed relief
- Marine sediments (origin, dispersion, deposition)
- Volcanism
- Paleogeography
- Geotectonics
- Geological Maps and sections
- Digital Elevation Models
- Slope Maps
- Horizontal,tilted, ruptures, folded layers of sediments
- Lithoseismic stratigraphy and seismic profiles
- 3D Tectonic Models

Introduction to Physical Oceanography

- Physical properties of sea water.
- Observational and forecasting methods of the ocean circulation and the distribution of physical properties.
- Equations of motion and conservation in the ocean.
- Currents (wind-driven and thermohaline circulation)
- Ocean waves.

Introduction to Chemical Oceanography

- The subject of "Chemical Oceanography".
- Water balance on earth, hydrological cycle.
- Chemical structure of water.
- The impact of pressure, temperature, electrolytes.
- Seawater and its physicochemical properties.

- The Ocean as a chemical system (redox, sorption and complexing processes - balances).
- The parameter of Salinity.
- Speciation of seawater components.
- Dissolved gases (oxygen, nitrogen, carbon dioxide). Carbon, nitrogen, silicon and sulfur cycles in the sea.
- Photosynthesis.
- Dissolved and particulate organic matter.
- Trace elements (distribution, speciation).
- Chemistry of marine sediments.
- Introduction to marine pollution.
- Application of principal chemical laboratory techniques in Oceanography: titrations, spectrometry, chromatography etc.
- Basic techniques for water, sediment and biota sampling.
- In situ and laboratory measurements of principal parameters: salinity, pH, temperature, dissolved oxygen, BOD/COD.

Geographic Information Systems

Projection Systems and Geographic Information Systems (GIS)
Digital Data Banks
Information Layers
Primary and Secondary Information Layers
Thematic Mapping
Maps and Charts of changes and events
Applications in Oceanography

Databases and statistical analysis

- Descriptive statistics
- Grouped data
- Statistical errors
- Statistical description of random processes
- Theoretical distributions and extreme values
- Confidence intervals estimation
- Significance tests
- Regression and correlation
- Cluster analysis

2nd semester

Plankton: Structure, Function, Ecology

PHYTOPLANKTON: Ecological characteristics of the pelagic zone. Phytoplanktonic organisms: Main taxonomic groups of phytoplankton. Systematic features, ecology, cellular structures and reproduction of the main groups. Taxonomic classification, phylogenetic relationships and economic importance of organisms. ZOOPLANKTON: Holoplanktonic and meroplanktonic organisms. Main taxonomic groups of zooplankton (identification keys). Sampling methods. Study of planktonic samples. Rearing protocols.

Benthos: Structure, Function, Ecology

PHYTOBENTHOS: Introduction: Classification of coastal zones and their vegetation. Types of substrates. Main ecological characteristics of coastal ecotypes. Benthic microalgae, Benthic macroalgae, Spermatophyta: Taxonomic traits, ecology, cellular structures and reproduction of the main taxonomic groups. Systematic classification, phylogenetic relationships and economic significance of organisms. ZOOBENTHOS: Introduction. Benthic biodiversity. Functional types of benthic organisms. Substrate-organism relationships. Factors that determine the species distribution and biocommunities composition. Diversity, Stability. Impact of pollution on benthic communities.

Necton: Structure, Function, Ecology

SYNTHESIS OF NEKTON: Diversity and Zoogeography. FISH: Anatomy, physiology and adaptations to the marine environment. Age, growth, reproduction and biological cycles of the major taxonomic groups. Behavior. MAMMALS: Anatomy, physiology and adaptations to the marine environment. Age, growth, reproduction and biological cycles of the major taxonomic groups. Behavior. NEKTON ECOLOGY: Feeding ecology and food webs. Impact of pollution on the necton organisms.

Bioindicators - Ecological Quality of Water.

Definition of the Ecological Quality of Water systems and Biological Data for the Ecological Quality Assessment. Typology, reference conditions and classification of the Ecological Quality. Concepts of physical geography and ecology of water systems. The eco-region of the Mediterranean Sea. Types of water bodies in coastal, transitional, flowing and lake waters. Heavily modified water systems. Adaptations of aquatic organisms in the abiotic environment. Competition. Species as indicators of environmental

disturbance. Biocommumity Dynamic. Biological indicators for the measurement of Ecological Quality. Indicators based on the biological elements "zoobenthos", "phytobenthos", "phytoplankton", " ichthyofauna ".

Fisheries Biology and Inventory Estimation

The global fisheries production. Fisheries exploitation standards. Fishing gear and technology. Fishing effort and methods of calculating the effort. Distribution, Abundance and Population Characteristics of the most important commercial species of Osteichthyes, Chondrichthyes, Mollusk and Crustacean in the Mediterranean Sea. Impact of fisheries on populations and bio-communities. By-catches and discards. Control and monitoring of fisheries and stocks. Methods of estimating stocks. Elaboration and analysis of research data. Fisheries management. Objectives, strategy, technical measures and actions.

Marine Microbiology

Morphology and functions of marine prokaryotic microorganisms (Bacteria, Cyanobacteria, Archaea). Metabolic diversity - intake of energy and nutrients, growth. Methods for studying the aquatic microorganisms. Measuring productivity - biomass. Biodiversity. Marine viruses. Structure and life cycles of the phaga. Diversity of "species", abundance and biogeography. The fungi in marine environment. Ecology. The microbial trophic web of the water column. Photosynthetic microbial populations in plankton. Biogeography of aquatic microorganisms. Sediment geomicrobiology. Influence of bio-disturbance by the endofauna on the bacterial processes of transgenesis. The role of microorganisms in the sediment trophic webs.

Biodiversity Estimation and conservation

Definition of biodiversity. Importance of measuring biodiversity. Types of biodiversity. Principles of sampling design. Formulation of the zero hypothesis. Sampling schedules in space and time. Selecting of samples and collection methods. Data types – Data transformations. Creating a database. Species-abundance distributions. Patterns of species abundance distribution. Statistical patterns of distribution. Biological patterns of distribution. Standards of Habitat/Resources Division. Parametric and non-parametric methods of estimating the species abundance. Indicators of species abundance. Curves of species accumulation. Taxonomic diversity. Functional diversity. Methods of comparing biodiversity in space and time. Grouping methods. Sorting methods. Methods of linking biotic and abiotic data.

Sedimentation Marine environments

- Sedimentology: the carbon cycle
- Climate and sedimentary processes
- Sediment accumulation rates
- Tectonics and sedimentation
- Marine sedimentary processes
- Sea floor sampling systems and tools
- Shallow and deep sea clastic, carbonate and evaporative marine systems, specific depositional environments
- Sedimentary analysis proxies
- Stratigraphic principles on sedimentary sequences, and their correlation to the depositional environments
- Seismic stratigraphy of marine clastic, carbonate and evaporite deposits
- Sedimentary environments and paleogeography

Coastal hydrodynamics, morphodynamics and sediment dynamics

Coastal relief, shoreline morphological characteristics and natural processes for the formation of coastal features, coastal hydrodynamics (waves, currents), fundamental principles of sediment dynamics, coastal sediment transport, coastal erosion, coastal vulnerability indices, introduction to coastal engineering and technical works, causes and effects of climate change.

Methods of Seabottom exploration

- Underwater acoustics
- Bathymetric survey: Equipment and methodology
- Side-scan survey: Equipment and methodology
- High- and low-frequency single-channel seismic-reflection survey: Equipment and methodology
- High- and low-frequency multi-channel seismic-reflection survey: Equipment and methodology
- Post-processing, analysis and interpretation of marine geophysical prospection data
- Software training: MB-System, Teledyne RESON PDS2000, HYPACK 2020, Chesapeake Technology SonarWiz, CodaOctopus
- Gravity methods
- Magnetometry
- Electrical prospecting methods
- Performance of a hydrographic survey
- Submarine installations and seabed exploration

- Seafloor instability and mass wasting processes

Underwater morphology,Volcanicity and Geodynamics

- Methods of seafloor mapping
- Analysis of underwater geomorphological features
- Submarine volcanism, volcanosedimentary environments
- Passive and Active margins
- Oceanic basins
- Orogenic Arcs
- Fore Arc basin, Back Arc Basin, Internal Basins
- Anaysis of seismic profiles
- Morphotectonic Analysis of the seabed
- Tectonic grabens and horsts
- Uplift and subsidence of the tectonic blocks

Paleoceanography- Climatic changes

Concepts of Paleoceanography-Paleoceanographic indicators. Climatic changes/cyclicity. Times of stratified conditions, increased productivity, green house effects in the paleo-ocean. Mediterranean Paleoceanography. Climatic variability and triggering factors. Proxy data and CO2 measuring techniques. Global climate change and major impacts-ocean acidification.

Dynamical Physical Oceanography

- Introductory principles and turbulence.
- The effect of the Earth's rotation in ocean circulation.
- Wind-driven circulation theory.
- The effect of stratification in the ocean dynamics and the thermohaline circulation.
- Equatorial ocean dynamics.
- Quasi-geostrophy.

Marine Meteorology and its interaction with the ocean

- Fluxes and forces in the atmosphere and the basic equations of fluid motion
- Geostrophic winds
- Fronts formation and evolution in the atmosphere
- Thunderstorms, weather in synoptic scale
- Basics of climatic variations (El Nino effect)
- Basics of the Greenhouse effect and the role of the ocean

- The marine atmospheric boundary layer and the ocean mixing layer
- Dynamic interactions/transfer laws near the ocean-atmosphere interface
- Wind waves and their role in atmospheric – ocean interaction
- Deep convection and deep water formation
- Bio-geo-chemical cycles in the ocean

Introduction to Numerical Modeling in Oceanography

- Introduction to finite difference methods.
- Time-stepping.
- Equations of one independent variable.
- Equations of multiple independent variables.
- 3D models of ocean circulation.
- Sub-grid scale parameterisation.
- Other oceanographic models.

Methods of data analysis

- Time series analysis
- Filtering time series
- Statistical significance tests
- Fourier analysis
- Trend analysis
- Principal component analysis
- Canonical Correlation analysis
- Computer-based laboratory exercises

Marine pollution

- Main pollutants sources in the marine environment. Classification of marine pollution.
- Mechanisms of pollutants influx and circulation in the sea.
- Nutrients – eutrophication.
- Heavy metals (Hg, Pb, Cu, Zn etc).
- Petrochemicals.
- Synthetic toxic organic compounds.
- PCBs.
- Pesticides.
- Organotin compounds.

- Nuclear isotopes.
- Litter.
- Secondary pollution.
- Impact, monitoring and elimination of marine pollution.
- Antipolluting technologies.

Analytical Chemical Oceanography

- Analytical techniques in Chemical Oceanography.
- Precision – sensitivity of chemical analyses.
- Good laboratory practice, quality control of laboratory measurements.
- Determination of chemical oceanographic parameters in seawater, sediments and biota: organic carbon, nutrients, chlorophyll, trace elements, metals, petrochemicals, detergents, phenols, pesticides etc.
- Statistical treatment and presentation of results, charts, distributions.

Marine ecotoxicology

- Principles of ecosystems functioning and structure.
- Health of ecosystems, ecological-environmental indices.
- Population ecology.
- Matter-energy flow charts.
- Principles of ecosystems analysis.
- Ecological research methods.
- Biological mechanisms of toxic, carcinogenic and dangerous chemicals.
- Endocrine disruptors.
- Toxicity tests.
- Oxidative stress of organisms.
- Main principles of ecology, environmental toxicology and ecotoxicology.
- Ecological risk assessment.
- Legal framework for the protection against toxic substances.
- Ecotoxicological methodologies and environmental impact assessment.
- Demonstration of basic toxicological tests in aquatic organisms.

Specific chapters in chemical Oceanography

- *In situ* experiments. Laboratory simulations (microcosms-macrocosms).
- Magnetic measurements.
- The marine surface microlayer.
- Pore water.
- Radio dating.
- Speciation research in the sea.
- Sequential extraction of sediments.
- Bioaccumulation studies in higher organisms.
- Study of dissolved gases in the sea.
- Biomarkers and bioindicators.

Natural products from marine organisms and their use

- Metabolites from marine organisms and their potential uses. Factors affecting the chemical diversity characterizing the metabolites of marine macro- and microorganisms. Sources/structures/activity and applications of representative metabolites from various marine organisms (algae, sponges, ascidians, corals mollusks etc). Ecological roles dictating the biosynthesis of marine metabolites and their importance for the detection/isolation of bioactive compounds. Raw materials from marine organisms. Presence of biotoxins produced by marine organisms and their potential for beneficial applications.
- Drugs from the sea.
- Secondary marine metabolites approved as commercial drugs and marine natural products that have applications in the cosmetics sector and the prevention of biofouling.

3rd semester

Management of the marine Environment

- Basic principles, definitions, concepts of environmental management (Sustainable development, Blue growth, Biodiversity, Ecosystem Approach).
- Necessity of environmental management and sustainable development.

- Management types, planning, schemes, techniques and concepts.
- Historical evolution of environmental management.
- Environmental studies on which management is based.
- Management tools (institutional, technological, financial, social).
- Management of marine protected areas.
- Protection of endangered species.
- Minimum sustainable population.
- Integrated Coastal Zone Management.
- Sustainable management of wetlands and deltaic systems.
- National – European legislation for the protection, management and exploitation of the marine environment.
- International conventions.
- Marine Strategy Framework Directive, Marine Spatial Planning.
- Dealing with marine pollution, remediation measures, monitoring alternatives.
- Management of swimming areas.
- Water from the sea – desalination.
- Salt production.
- Energy from renewable marine sources.
- Minerals from the sea bottom.
- Marine phosphorites.
- Manganese and iron nodules.
- Methane hydrates.
- Introduction to Operational Oceanography.
- The technological component of operational oceanography.
- The forecasting component of operational oceanography.
- Applications in the Greek seas.