Integral Modelling of Marine Systems (250577)

General Information

School	ETSECCPB
Departments	Departament d'Enginyeria Civil i Ambiental (DECA)
Credits	6.0 ECTS
Programs	GRAU EN CIÈNCIES I TECNOLOGIES DEL MAR (pla 2018)
Course	2024/25

Main teaching language at each group

- Group 10CA2 Catalan (Q2)

Faculty

Responsible Faculty: Marc Mestres Ridge
Faculty: Marc Mestres Ridge, Juan Pablo Sierra Pedrico

Objectives of Education

This subject will show students the most relevant aspects of numerical modeling in the marine environment, with the aim of prediction and operational management. Emphasis will be placed on the modeling of ocean circulation, waves, ecosystems and dispersion of substances in the sea, with practical applications. It will also be shown how evaluations are made of the quality of the results obtained, and of the impacts of the changing conditions of the marine environment on the coast and on port facilities in the face of different management and climate scenarios.

1.- Establish the comprehensive conceptual framework of mechanisms that interact in marine and coastal natural systems.
2.- Determine the numerical experimental approach that allows to address the integral modeling of marine and coastal systems, including the role of physical, geological and ecological aspects.
3.- Make a critical analysis of the results of the conceptual and numerical modeling, assessing the role of the boundary conditions, and performing sensitivity analyzes of the models.

This subject is focused on showing, familiarizing and training students in numerical modeling techniques, which will allow them to characterize a large part of the real problems they will have to address in their professional practice and which will allow students to complete a generic training cycle but with advanced and transversal knowledge in Marine Sciences and Technologies.

Competencies

Especific

To know and apply the lexicon and concepts of the Marine Sciences and Technologies and other related fields.
Establish a good practice in the integration of common numerical, laboratory and field techniques in the analysis of any problem related to the marine environment.
Address the most relevant processes and their interactions related to their physical / chemical / biological / geological components, applying technical and scientific knowledge and criteria.
To set, evaluate and propose solutions to the different conflicts of use and exploitation in the marine and coastal environment resources based on scientific and technical criteria.
Carry out environmental impact, management and protection studies of the marine environment and adjacent coastal areas, including the corresponding infrastructures and their related impacts.
Apply spatial and cartographic representation techniques for different environments and scales.

Develop a conceptual framework to address the sustainability of the marine environment and the related socio-economic activities at different scales, explaining the effects of climate change.
Set, plan and execute basic and applied research in the field of Marine Sciences and Technologies.
Carry out calculations, assessments, surveys and inspections in coastal and marine environments, as well as the corresponding technical documents.
Write technical reports and disseminate knowledge about the different components of the marine system, considering the applicable legal framework.
Apply the necessary tools to analyze the economic and legal aspects of human actions and the related impacts on the marine environment, including technical advice and representation of companies and administrations.

Generic

Apply state-of-the-art methods and techniques in oceanography and marine climate, jointly covering the physical, chemical, geological and biological aspects.
Develop a conceptual framework that links the scientific-technological and management aspects for marine resources, explaining the interactions with marine infrastructures and management plans in coastal areas.
Encompass and teach studies in the different research lines that converge in Marine Sciences and Technologies.
Combining preservation with economic activity within the framework of current legislation promoting the development of a social and environmental awareness.

Total hours of student work

		Hours	Percentage
Supervised Learning	Large group	30.0 h	50.00 %
	Medium group	15.0 h	25.00 %
	Laboratory classes	15.0 h	25.00 %
	Guided Activities	0.0 h	0.00 %
Self Study		90.0 h	

Contents

Introduction

- Introduction to the subject, approach, evaluation methodology - Motivation / need for modeling - Physical, mathematical, numerical models

Construction of a numerical model

Domain and dimensions. Structured and unstructured meshes. Z and sigma coordinates. Boundary conditions (surface, bottom, lateral, open). Initial conditions, spin-up, cold and hot start. Data assimilation. Validation of a model, sources of error, validity and limitations.
Problems

Wave models

Relevant equations. Types of models. Forcings. Application examples.
Problems
There will be a practical wave modeling exercise using the SWAN model, to assess the importance of the boundary conditions and of the general quality of data used to feed numerical models.

Hydrodynamic models

Relevant equations. Types of models. Forcings; atmosphere-ocean interaction. Simple models (tides, storm surges ...). Complex models (eg, ROMS). Application examples
Problems
Programming of a simple hydrodynamic model using Matlab.

Ecosystem modeling

Ecologicla models. Types and characteristics.
Simple case using a ecosystem model

Dispersion models

Relevant equations. Types of models and characteristics.
Simulation using a simple transport model

Modelling in coastal areas

Particularities of modeling in coastal areas: boundary problems, asymmetries, shallow-depth, density

Teaching Methodology

The course consists of 4 hours per week of classroom activity.

Throughout the course, theoretical classes, in which the teachers will explain the basic concepts and materials of the subject, present examples and do exercises, will be combined with practical classes aimed at the use of numerical models and at accompanying the students in carrying out their course work

The teaching language of the subject will, in general, be Catalan, although occasionally some of the sessions may be held in Spanish or English.

Support material available through the ATENEA virtual campus is used: contents, assessment activities, presentations and other materials.

Grading Rules

(*) The evaluation calendar and grading rules will be approved before the start of the course.

The qualification of the subject is obtained from a system of continuous assessment that includes the realization of two partial examinations and a set of numerical assignments.

The partial exams will cover the theoretical component of the subject, and will consist of a number of quiz-type questions..

The practical assignments will consist of the realization of different activities of an additive and formative character, so much individual as in group, done both inside and outside the classroom. The completion of the assignments and the presentation of the corresponding reports will be a necessary condition to be able to pass the course.

The final mark of the course will be obtained by weighting the average mark of the partial exams (65%) and that of the assignments (35%).

Criteria for re-evaluation qualification and eligibility: students that failed the ordinary evaluation and have regularly attended all evaluation tests will have the opportunity of carrying out a re-evaluation test during the period specified in the academic calendar. Students who have already passed the test or were qualified as non-attending will not be admitted to the re-evaluation test. The maximum mark for the re-evaluation exam will be five over ten (5.0). The non-attendance of a student to the re-evaluation test, in the date specified will not grant access to further re-evaluation tests. Students unable to attend any of the continuous assessment tests due to certifiable force majeure will be ensured extraordinary evaluation periods.

These tests must be authorized by the corresponding Head of Studies, at the request of the professor responsible for the course, and will be carried out within the corresponding academic period.

Test Rules

The partial tests will be carried out individually, with test-type questions, with 4 possible options of which only one is correct. Correct answers add X points, incorrect answers subtract X / 4. The questions can be either theoretical or simple problems.

Office Hours

After the lectures, or to be agreed via email

Bibliography

Basic

- Nihoul, J.C.J. (ed.). Modelling of marine systems. Amsterdam: Elsevier Scientific, 1975. ISBN 0444412328.
- Fennel, W.; Neumann, T. Introduction to the modelling of marine ecosystems. 2nd ed. Amsterdam: Elsevier, 2015. ISBN 9780444633637.

Complementary

- Chassignet, E.P.; Verron, J. (eds.). Ocean weather forecasting: an integrated view of oceanography. Dordrecth: Springer, 2006. ISBN 1402039816.