Course guides
250577 - MODINTSIMA - Integral Modelling of Marine Systems

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.

Degree: BACHELOR'S DEGREE IN MARINE SCIENCE AND TECHNOLOGY (Syllabus 2018). (Compulsory subject).

Academic year: 2020 ECTS Credits: 6.0 Languages: Catalan

LECTURER

Coordinating lecturer: MARC MESTRES RIDGE

Others: MARC MESTRES RIDGE, JUAN PABLO SIERRA PEDRICO

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
13388. To know and apply the lexicon and concepts of the Marine Sciences and Technologies and other related fields.
13390. 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.
13394. Address the most relevant processes and their interactions related to their physical / chemical / biological / geological components, applying technical and scientific knowledge and criteria.
13395. 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.
13397. Carry out environmental impact, management and protection studies of the marine environment and adjacent coastal areas, including the corresponding infrastructures and their related impacts.
13401. Apply spatial and cartographic representation techniques for different environments and scales.
13403. 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.
13404. Set, plan and execute basic and applied research in the field of Marine Sciences and Technologies.
13405. Carry out calculations, assessments, surveys and inspections in coastal and marine environments, as well as the corresponding technical documents.
13406. Write technical reports and disseminate knowledge about the different components of the marine system, considering the applicable legal framework.
13407. 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.

Generical:
13382. Apply state-of-the-art methods and techniques in oceanography and marine climate, jointly covering the physical, chemical, geological and biological aspects.
13383. 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.
13386. Encompass and teach studies in the different research lines that converge in Marine Sciences and Technologies.
13387. Combining preservation with economic activity within the framework of current legislation promoting the development of a social and environmental awareness.
TEACHING METHODOLOGY

The course consists of 2.3 hours per week of classroom activity (large size group) and 1.2 hours weekly with half the students (medium size group).

The 2.3 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

The 1.2 hours in the medium size groups is devoted to solving practical problems with greater interaction with the students. The objective of these practical exercises is to consolidate the general and specific learning objectives.

The rest of weekly hours devoted to laboratory practice.

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of learning and assessment activities conducted and literature.

LEARNING OBJECTIVES OF THE SUBJECT

This course will show the students the most relevant aspects of meteo-oceanographic research through numerical modeling, for operational forecasting and management. Emphasis will be placed on ocean circulation modeling using the ROMS model (Regional Oceanic Model System), wave modeling using the SWAN (Simulating Waves Nearshore) model and pollutant transport modeling with the LIMIX model. It will be shown how evaluations of the impacts on the coast and on port facilities of changing marine environment conditions are carried out for different management and climate scenarios.

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

This subject is focused on showing, familiarizing and training students with techniques of observation, monitoring, acquisition and treatment of marine data, as well as modeling techniques, physical and numerical, which allow to characterize practically all of the real problems that will have to address in the professional practice and that will allow the students to finish a generic training cycle but with advanced and transversal knowledge in Sciences and Technologies of the Sea.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<tr>
<td>Self study</td>
<td>84,0</td>
<td>56.00</td>
</tr>
<tr>
<td>Hours medium group</td>
<td>15,0</td>
<td>10.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>15,0</td>
<td>10.00</td>
</tr>
<tr>
<td>Guided activities</td>
<td>6,0</td>
<td>4.00</td>
</tr>
</tbody>
</table>

Total learning time: 150 h
## CONTENTS

### Introduction

**Description:**
- Introduction to the subject, approach, evaluation methodology
- Motivation / need for modeling
- Physical, mathematical, numerical models
- Initial boundary value problems

**Full-or-part-time:** 7h 11m
Theory classes: 3h
Self study : 4h 11m

### Basic concepts of numerical methods

**Description:**
- Approximation of differential equations with different schemes (explicit, implicit, leap-frog predictor)
- Finite elements, finite differences
- Consistency, convergence and stability of numerical schemes

**Problems**

**Full-or-part-time:** 9h 36m
Theory classes: 3h
Practical classes: 1h
Self study : 5h 36m

### Construction of a numerical model

**Description:**

**Full-or-part-time:** 14h 23m
Theory classes: 6h
Self study : 8h 23m

### Wave models

**Description:**

**Problems**
There will be a practical wave modeling exercise using the SWAN model, starting from scratch and following all the steps necessary to run the model (domain selection and bathymetry construction, definition of initial, boundary and forcing conditions, model setup files, model execution and analysis of results)

**Full-or-part-time:** 43h 12m
Theory classes: 6h
Practical classes: 4h
Laboratory classes: 8h
Self study : 25h 12m
### Hydrodynamic models

**Description:**
Relevant equations. Types of models. Forcings; atmosphere-ocean interaction. Simple models (tides, storm surges ...). Complex models (e.g., ROMS). Application examples

**Problems**
Programming of a simple hydrodynamic model using Matlab.

**Full-or-part-time:** 40h 48m
- Theory classes: 7h
- Practical classes: 4h
- Laboratory classes: 6h
- Self study: 23h 48m

### Ecosystem modeling

**Description:**

**Problems**
Practice related to any of the models corresponding to this field

**Full-or-part-time:** 24h
- Theory classes: 6h
- Practical classes: 4h
- Self study: 14h

### Modelling in coastal areas

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

**Full-or-part-time:** 4h 48m
- Theory classes: 2h
- Self study: 2h 48m

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### GRADING SYSTEM

The mark of the course is obtained from the ratings of continuous assessment and their corresponding laboratories and/or classroom computers.

Continuous assessment consist in several activities, both individually and in group, of additive and training characteristics, carried out during the year (both in and out of the classroom).

The teachings of the laboratory grade is the average in such activities.

The evaluation tests consist of a part with questions about concepts associated with the learning objectives of the course with regard to knowledge or understanding, and a part with a set of application exercises.

### EXAMINATION RULES

If any of the continuous assessment activities (practices, exams, problems) is not performed in the scheduled period, it will be considered as a zero score.
BIBLIOGRAPHY

Basic:

Complementary: