Course guide
250574 - ACOESOLINT - Computational Analyses and Smart Solutions Tools

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: 2022 ECTS Credits: 6.0 Languages: Catalan

LECTURER

Coordinating lecturer: MARÍA ISABEL ORTEGO MARTÍNEZ
Others: AGUSTIN MEDINA SIERRA, MARÍA ISABEL ORTEGO MARTÍNEZ

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.
13391. Participate and eventually lead multidisciplinary work teams in the field of Marine Sciences and Technologies to respond to the social challenges related to this field.
13394. Address the most relevant processes and their interactions related to their physical / chemical / biological / geological components, applying technical and scientific knowledge and criteria.
13405. Carry out calculations, assessments, surveys and inspections in coastal and marine environments, as well as the corresponding technical documents.

General:
13380. Develop a professional activity in the field of Marine Sciences and Technologies.
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.
13385. Apply knowledge and academic experience to the biotic and abiotic resources of the marine environment, explaining their interactions with the socio-economic activities that take place in it.
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

The objective of this subject is to provide the theoretical bases and advanced techniques of computational simulation, data science and Big Data. These tools will be applied to the treatment and analysis of data in marine sciences. Resources will also be provided for the presentation and dissemination of results.

1.- Solve PDEs and eigenvalue problems by computer methods (PDEs using the Finite Element Method (FEM), eigenvalues using direct vector iteration (DVI) and inverse (IVI) methods). Critical analysis of the results.
2.- Identify the different types of problems in Marine Sciences (direct, optimal design, optimal identification and optimal control); as well as their formulation and resolution by numerical methods (e.g. Levernberg-Marquardt).
3.- Incorporate the notion of uncertainty in the data (external actions and properties of the system). Develop stochastic smart solutions and statistically treat the results.

This subject is oriented to a high-level interdisciplinary training, by addressing in depth all the major areas of the Marine Sciences (Physical, Geological, Chemical and Biological Oceanography), as well as providing a solid foundation in programming and problem solving methods through the use of computer calculation programs that allow a comprehensive understanding of the marine environment, its problems and the possible solutions to them.

STUDY LOAD

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

Total learning time: 150 h
### Statistical modeling

**Description:**
Basics of statistical modeling  
Modeling: some basics  
Basics of statistical modeling  
Monte Carlo Methods  
Monte Carlo methods

**Full-or-part-time:** 36h  
Theory classes: 8h  
Practical classes: 2h  
Laboratory classes: 5h  
Self study : 21h

### Generalized regression methods

**Description:**
Generalized linear models  
Generalized linear models  
Generalized linear models

**Full-or-part-time:** 21h 36m  
Theory classes: 4h  
Practical classes: 3h  
Laboratory classes: 2h  
Self study : 12h 36m
Generalized regression methods

Description:
Generalized linear models
Generalized linear models
Generalized linear models

Full-or-part-time: 21h 36m
Theory classes: 4h
Practical classes: 3h
Laboratory classes: 2h
Self study : 12h 36m

Modeling of dependence between variables

Description:
Modeling phenomena over time

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

Classification methods

Description:
Classification methods
Classification methods
Classification methods

Full-or-part-time: 16h 48m
Theory classes: 4h
Practical classes: 2h
Laboratory classes: 1h
Self study : 9h 48m
## Classification methods

**Description:**
Classification methods  
Classification methods  
Classification methods

**Full-or-part-time:** 16h 48m  
Theory classes: 4h  
Practical classes: 2h  
Laboratory classes: 1h  
Self study: 9h 48m

## Comprehensive project 1

**Full-or-part-time:** 9h 36m  
Laboratory classes: 4h  
Self study: 5h 36m

## Dimension reduction methods

**Description:**
Dimension reduction methods: PCA and beyond  
Dimension reduction methods: ACP and beyond  
Dimension reduction methods: ACP and beyond

**Full-or-part-time:** 21h 36m  
Theory classes: 4h  
Practical classes: 3h  
Laboratory classes: 2h  
Self study: 12h 36m
**Response models**

**Description:**
Response surface models and surrogate models
Response surfaces and surrogate models
Response surfaces and surrogate models

**Full-or-part-time:** 21h 36m
Theory classes: 4h
Practical classes: 3h
Laboratory classes: 2h
Self study: 12h 36m

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**Comprehensive project 2**

**Full-or-part-time:** 9h 36m
Laboratory classes: 4h
Self study: 5h 36m

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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.
BIBLIOGRAPHY

Basic:

Complementary: