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 is taught on the basis of 4 hours of class per week. These hours of classes comprise theory sessions, problems and laboratories, with no strict difference between them, alternating large and medium-sized groups according to the teaching schedule. Course projects (to be completed with dedication inside and outside the classroom) are carried out to consolidate the general and specific learning objectives.

The subject has an eminently applied and computational component. Therefore, it is advisable to follow the practical classes with a personal computer. Specific software (R, Stan and others) is used.

It is advisable that students use the support material for the face-to-face classes, which will be available on the campus ATENEA virtual: updated information on the organisation of the subject, contents, programme of assessment and directed learning activities and bibliography.

The main language of instruction is Catalan. Spanish and English will also be used. Reference materials may be written in any of the three languages.

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

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>
</tr>
</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

## 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
### 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

### Comprehensive project 2

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

The global mark is obtained from the marks of continuous assessment activities.

Continuous assessment is performed through several activities, both individual and in group, of additive and training characteristics, carried out during the year (both in and outside of the classroom).

The global mark is obtained as a weighted average of the marks of the assessment activities.

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.

BIBLIOGRAPHY

Basic:

Complementary: