Course guide
250569 - MATCIENMAR - Mathematics in Marine Science

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: Spanish

LECTURER
Coordinating lecturer: ALBERTO GARCIA GONZALEZ
Others: PEDRO DIEZ MEJIA, ALBERTO GARCIA GONZALEZ

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.

General:
13380. Develop a professional activity in the field of Marine Sciences and Technologies.
13381. Address in a comprehensive manner the analysis and preservation of the marine environment with sustainability criteria.

TEACHING METHODOLOGY
Theoretical, problem solving and practical classes will be given, and the classes may be taught indistinctly in Spanish and Catalan, thus improving the transversal capacities of the students. The subject is face-to-face and the work in class will be evaluated, in addition to the exams proposed for the course. Participation in class will be highly valued. Class attendance will not be sufficient to pass the subject, which implies that the student must devote an average of 4 hours per week to study outside of class. Support material is used in the format of a detailed teaching plan through the ATENEA virtual campus: contents, programming of evaluation activities and directed learning and bibliography.

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

In this subject, advanced tools for fluid mechanics, such as partial differential equations, will be presented to study physical phenomena of interest in marine sciences. An introduction to numerical techniques to solve systems of differential equations will also be given, such as the finite element method.

1.- Program numerical analysis algorithms to carry out a sensitivity analysis of a problem that is solved by ordinary differential equations (ODEs).
2.- Solve boundary problems in fluid mechanics by means of differential equations in partial derivatives, starting from its approach to its numerical solution via Finite Differences (FDM) or the Finite Element Method (FEM).
3.- Solving of modeling problems applied to marine sciences, by means of numerical techniques (systems of equations, zeros of functions, integration, interpolation).

This is where students are expected to obtain a vision of real environmental problems in the marine environment from a perspective that combines, on the one hand, chemistry and biology, as well as the mathematical techniques to address these problems (Marine Ecology, Ecosystems and Productive Processes) and, on the other, the tools of chemistry, biology and physics (Marine Pollution, Origin, Transport and Impacts), which are needed to solve common problems in coastal and platform waters.

This subject also includes applied techniques in the visualization, interpretation and resolution of the problems addressed in this same subject.

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>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>
<tr>
<td>Guided activities</td>
<td>6,0</td>
<td>4.00</td>
</tr>
</tbody>
</table>

**Total learning time:** 150 h

CONTENTS

**Numerical Integration**

**Description:**
Definition of Square
Composite Square
Problem resolution
Calculation of squares with Matlab
Applications of Numerical Integration in Marine Sciences

**Full-or-part-time:** 31h 12m
Theory classes: 6h
Practical classes: 5h
Laboratory classes: 2h
Self study: 18h 12m
### Equations in Partial Derivatives

**Description:**
Definition  
Classification  
Separation of Variables  
Application exercises

**Full-or-part-time:** 31h 12m  
Theory classes: 8h  
Practical classes: 5h  
Self study: 18h 12m

### Numerical resolution of EDP's with Finite Differences

**Description:**
Approach concept for finite differences  
Resolution of diffusion problems  
Programming and simulation  
Resolution of 1D diffusion convection problems

**Full-or-part-time:** 31h 12m  
Theory classes: 6h  
Practical classes: 3h  
Laboratory classes: 4h  
Self study: 18h 12m

### Environmental modeling of problems described by EDPs

**Description:**
Introduction to the finite element method  
General formulation of for simulation by finite elements  
Resolution of environmental problems  
Simulation of environmental problems

**Full-or-part-time:** 38h 24m  
Theory classes: 10h  
Practical classes: 2h  
Laboratory classes: 4h  
Self study: 22h 24m

### Evaluation

**Full-or-part-time:** 12h  
Laboratory classes: 5h  
Self study: 7h
GRADING SYSTEM

The grade for the course will consist of:

- Practical works (NA).
- Two exams (NE1 and NE2).

1. The practical work (NA) will include, among others, the resolution of problems and the performance of directed work.

2. The contents of the NE1 and NE2 exams will be in accordance with all the subject taught from the beginning of the course.
   - The NE1 exam will be taken approximately halfway through the semester and the subject taught so far will enter.
   - The NE2 exam will be a final exam, where the complete subject taught throughout the course will enter.

The note of the exams will be calculated as:

\[ NE = \begin{cases} 
0.3 \times NE1 + 0.7 \times NE2 & \text{if } NE1 \geq 2 \text{ out of 10} \\
0.3 \times NE1 + 0.7 \times NE2 & \text{if } NE1 < 2 \text{ out of 10} 
\end{cases} \]

In other words, it will be the maximum between the grade obtained through the calculation \(0.3 \times NE1 + 0.7 \times NE2\) or the final exam score \(NE2\). In order to be eligible for this scoring criterion, the student must have obtained a minimum score of 2 out of 10 in \(NE1\), otherwise the \(NE\) grade will necessarily be the one obtained by calculating \(NE = 0.3 \times NE1 + 0.7 \times NE2\).

The final grade for the course will be:

\[ \text{Final Note} = 0.25 \times NA + 0.75 \times NE \]

EXAMINATION RULES.

Students suspended to the ordinary assessment that have been submitted regularly to the evaluation tests of the subject suspended will have the option to carry out a reassessment test in the period set in the academic calendar. Students who have already passed the qualification as not yet submitted may not be submitted to the re-evaluation test of a subject. The maximum qualification in the case of re-evaluation will be five (5.0). The non-attendance of a student summoned to the test of re-evaluation, celebrated in the fixed period, will not be able to give rise to the accomplishment of another test with later date. Extraordinary assessments will be made for students who have not been able to complete some of the continuous assessment tests because of their proven accreditation. These tests must be authorized by the corresponding head of studies, at the request of the professor responsible for the subject, and will be carried out within the corresponding teaching period.

Once each exam has been completed, there is the possibility that a student may be called to conduct an oral interview as validation of their written exam, this interview being on the subject of the exam. In case of not obtaining a satisfactory assessment in the interview, the exam will be given as suspended with a grade of zero.

BIBLIOGRAPHY

Basic: