Course guide

250554 - FOMATMEDAM - Fundamentals of Mathematics for Environmental 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: Catalan

LECTURER

Coordinating lecturer: FRANCISCO JAVIER MARCOTE ORDAX
Others: M. ROSA ESTELA CARBONELL, FRANCISCO JAVIER MARCOTE ORDAX

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 classes will be given, solving problems and practices. The subject is face-to-face and the work in class will be evaluated, in addition to the exams proposed for the course. The participation in class will be very positive. Class attendance will not be enough to pass the subject, which means that the student must spend about 4 hours a week on a regular basis outside the classroom. Support material is used in the format of a detailed teaching plan through the ATENEA virtual campus: contents, programming of assessment activities and directed learning and bibliography.
LEARNING OBJECTIVES OF THE SUBJECT

In this course, some basic mathematical aspects will be provided to understand the existing relationships between different environmental parameters. Emphasis will be placed on teaching a block of basic mathematical tools (metric spaces, analysis of functions, matrix operations and solving methods for equation systems) as well as fundamental aspects of Linear Algebra.

1.- Provide ability in the handling of arithmetic operations and algebraic operations and identities. Resolution of linear equation systems, both manually and through computer programming. Ability to geometrically interpret the concepts of vector calculation.
2.- Ability to analyze successions and series in a Science and Technology context.
3.- Interpretation of vector spaces. Calculations with vectors and matrices. Ability to solve linear eigenvalue problems both manually and through computer programing. Ability to operate with tensors.

At the end of the course, the students should have:

a) obtained knowledge and calculus skills on matrices and systems of linear equations, basic linear transformations in the plane and space, differential and integral calculus of real-valued real functions;

b) acquired basic knowledge about the use of Matlab, having had to practice with problems posed in some of the subjects that make up the course program;

c) been initiated in the numerical resolution of some problems.

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 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>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
</tbody>
</table>

Total learning time: 150 h

CONTENTS

**Topic 1: Matrices (I): Systems of linear equations**

**Description:**
Basic definitions and types of matrices. Elemental row operations, Gauss method, rank of an array. Matrix transposed from a matrix; elementary column posts. Systems of linear equations. Elimination of parameters. Determinants. Classroom resolution of some list problems provided to students. Problem solving in class by students, under the supervision of the teacher.

**Specific objectives:**
Learn how to use the matrices to solve certain types of problems. In particular, how to solve systems of linear equations. Use examples to illustrate poorly conditioned systems of linear equations
Learn how to manipulate matrices loosely, and solve the problems for which they are especially useful.
Individual help students in the difficulties that can be encountered when trying to solve a problem.

**Full-or-part-time:** 24h
Theory classes: 5h
Practical classes: 3h
Laboratory classes: 2h
Self study : 14h
## Topic 1: Matrices (I): Systems of linear equations

### Description:
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## Topic 2: Introduction to Matlab

### Description:
Introduction to Matlab. Basic instructions. Resolution of systems of linear equations: large systems that come from real cases; poorly conditioned systems

**Specific objectives:**
Start using Matlab. Practicing the matrix manipulation and the resolution of systems of linear equations

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

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**Full-or-part-time:** 4h 48m  
Laboratory classes: 2h  
Self study: 2h 48m
**Topic 3: Matrices (II): Product of matrices**

**Description:**
Definitions of linear and product combinations of matrices. Transposed matrix, determinant and rank of the matrix product. Relationship between matrix product and elementary operations. Regular matrices Calculation of the inverse matrix by the Gauss method and by determinants. Matrix of a linear application; Rotations and symmetries in the plane and space. Translations Treatment with Matlab.

Problem solving in class by students, under the supervision of the teacher

Solving problems for topic 3, from a list given to students

**Specific objectives:**
Learn the relationship between matrix product and elemental operations. Know how to calculate the inverse of a matrix. Know how to find the matrix associated with a linear application; particular case: rotations and symmetries in the plane and space.

Individual help students in the difficulties that can be encountered when trying to solve a problem

Acquire skills in manipulating matrices, and solve the problems for which they are especially useful

**Full-or-part-time:** 24h

- Theory classes: 5h
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Treatment with Matlab.

Problem solving in class by students, under the supervision of the teacher

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Individual help students in the difficulties that can be encountered when trying to solve a problem

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**Full-or-part-time:** 24h

- Theory classes: 5h
- Practical classes: 3h
- Laboratory classes: 2h
- Self study: 14h
### Topic 4: Real functions of real variable: differential calculus

#### Description:
Solving problems for topic 4, from a list given to students
Resolution of a problem on the part of the students, under the supervision of the professor

#### Specific objectives:
Remember the basics of the differential calculation of a variable. Treatment of functions with Matlab.
Know how to identify when a function is or not differentiable at a point. Solve optimization problems.
Individual help students in the difficulties that can be encountered when trying to solve a problem

#### Full-or-part-time: 24h
Theory classes: 5h
Practical classes: 3h
Laboratory classes: 2h
Self study: 14h
**Topic 5: Real functions of real variable: integral calculation**

**Description:**
The integral defined as an area under a curve. Primitives and Barrow rule. Change of variable. Calculation of areas and volumes of revolution. Comprehensive Numerical Calculus (Trapezium, Simpson). Treatment with Matlab. Solving problems for topic 5, from a list given to students
Resolution of problems on the part of the students, under the supervision of the professor

**Specific objectives:**
Learn to interpret the integral defined as an area under a curve, and the relationship between integrals and primitives. See how the value of an integral can be numerically approximated. Calculate integrals with Matlab. See applications of the integral in the calculation of areas, volumes of revolution, etc.
Learn the utilities of the integral calculation. Know how to calculate integrals defined both analytically and numerically.
Individual help students in the difficulties that can be encountered when trying to solve a problem

**Full-or-part-time:** 28h 47m
- Theory classes: 5h
- Practical classes: 4h
- Laboratory classes: 3h
- Self study: 16h 47m
Topic 6: Introduction to Geometry in the plane and in space

Description:
Affine space concept. Linear varieties: points, straight lines and plans. Straight and plan equations. Relative positions. Perpendicularity Distance between two linear varieties Parameterization of curves.
Problem solving in topic 6, from a list of students
Problem solving in class by students, under the supervision of the teacher

Specific objectives:
Remember the concepts related to geometry in the plane and space. Acquire knowledge about curve parameterization
Solve problems of incidence, relative position and perpendicularity of linear varieties. Know how to perform the parameterization of some curves
Individual help students in the difficulties that can be encountered when trying to solve a problem

Full-or-part-time: 24h
Theory classes: 4h
Practical classes: 3h
Laboratory classes: 3h
Self study: 14h

Exams
Full-or-part-time: 14h 23m
Laboratory classes: 6h
Self study: 8h 23m
**GRADING SYSTEM**

The mark of the subject will consist of:

- Classroom work (mark: NA).
- Two exams (E1 and E2, marks: NE1 and NE2).

1. Classroom work (NA) will contain, among others, problem solving in class. The voluntary participation in class will be valued positively.

2. The contents of the exams E1 and E2 will be in agreement with all the material taught from the beginning of the course.

The final grade of the subject will be:

\[
\text{Final Grade} = 0.35 \times \text{NA} + 0.65 \times \text{NE},
\]

where the exam grades (NE) will be calculated as:

\[
\text{NE} = \max (0.5 \times \text{NE1} + 0.5 \times \text{NE2}, 0.3 \times \text{NE1} + 0.7 \times \text{NE2})
\]

**ADMISSION AND QUALIFICATION CRITERIA FOR REVALUATION:**

Students suspended for regular evaluation that have been submitted regularly to the evaluation tests of the subject will have the option to carry out a reassessment test in the period set in the academic calendar. Students who have already passed the subject cannot carry out re-evaluation exam. The maximum qualification in the case of re-evaluation will be five (5.0). The non-attendance of a student to the test of re-evaluation, celebrated in the fixed period, will not allow 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.

**EXAMINATION RULES.**

For each assessment activity not carried out in the programmed period, a score of zero will be assigned.

Unless expressly authorized by the responsible professor, in assessment activities it is not allowed the use of calculator, mobile phone, notes, book, or any other device (electronic or otherwise) that allows you to store, receive, send or check information about the subject and/or manipulate mathematical expressions.

**BIBLIOGRAPHY**

**Basic:**

**Complementary:**