Course guides
2500201 - FONAMATEMA - Fundamentals of Mathematics

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

Degree: (ANG) GRAU EN ENGINYERIA AMBIENTAL (Syllabus 2020). (Compulsory subject).
Academic year: 2020 ECTS Credits: 6.0 Languages: Catalan

LECTURER
Coordinating lecturer: FRANCISCO JAVIER MARCOTE ORDAX
Others: FRANCISCO JAVIER MARCOTE ORDAX

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
14445. Recognize the biological bases and foundations of the plant and animal field in engineering: notions of genetics, biochemistry and metabolism, physiology, organisms and environment, population dynamics, flows of matter and energy and changes in ecosystems, biodiversity, principles of the kinetics of microbial growth and reactor theory.
14446. Solve mathematical problems that may arise in engineering by applying knowledge about: linear algebra, geometry, differential geometry, differential and integral calculus, optimization, ordinary differential equations.
14447. Obtain basic knowledge about the use and programming of computers, operating systems, databases and basic numerical calculation and applied to engineering.
14448. Manage the basic concepts about the general laws of mechanics and thermodynamics, concept of field and heat transfer, and apply them to solve engineering problems.
14449. Apply the basic principles of general chemistry, organic and inorganic chemistry and their applications in engineering.
14450. Describe the global functioning of the planet: atmosphere, hydrosphere, lithosphere, biosphere, anthroposphere, biogeochemical cycles (C, N, P, S), soil morphology and apply it to problems related to geology, geotechnics, edaphology and climatology.

Generic:
14440. Identify, formulate and solve problems related to environmental engineering.
14441. Apply the functions of consulting, analysis, design, calculation, project, construction, maintenance, conservation and exploitation of any action in the territory in the field of environmental engineering.

TEACHING METHODOLOGY

The course consists of 2 hours per week of classroom activity (large size group) and 1 hour weekly with half the students (medium size group).

The 2 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 hour 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

Mathematical concepts are discussed to understand relationships between different environmental variables. Emphasis is placed on a block of basic mathematical tools: matrix operations, solving linear systems of equations, derivation and integration of one-variable functions, plane and space geometry.

1. Manage trigonometric functions including their derivation and integration. Ability to analyze sequences and series in the context of engineering.
2. Solve maximum and minimum problems using differential calculus related to simple engineering problems.
3. Solve integrals of one variable, looking for a relationship with simple engineering problems.


At the end of the course, the student will have had to: a) achieve knowledge and computational fluency on matrices and systems of linear equations, basic linear transformations in plane and space, differential and integral calculus of real functions of real variable; b) to acquire basic knowledge about the use of Matlab, having had to practice with problems posed in some of the subjects that configure the syllabus of the subject; c) get started in the numerical resolution of some problems.

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>Hours small group</td>
<td>15,0</td>
<td>10.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<tr>
<td>Guided activities</td>
<td>6,0</td>
<td>4.00</td>
</tr>
</tbody>
</table>

Total learning time: 150 h

CONTENTS

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

Description:
Solve in class some problems from a list provided to students.
Problem solving in class by students, under the supervision of the teacher.

Specific objectives:
Learn to use matrices to solve certain types of problems. In particular, how to solve systems of linear equations. Show examples of poorly conditioned systems of equations
Learn to manipulate matrices fluently, and to solve problems for which they are especially useful.
Assist students individually in any difficulties they may encounter in trying to solve a problem.

Full-or-part-time: 26h 24m
Theory classes: 5h
Practical classes: 3h
Laboratory classes: 3h
Self study: 15h 24m
**Topic 2: Introduction to Matlab**

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

**Specific objectives:**
Get started in using Matlab. Practice matrix manipulation and solving systems of linear equations

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

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**Topic 3: Matrices (II): Product of matrices**

**Description:**

Problem solving in class by students, under the supervision of the teacher
Problem-solving in class of Topic 3, from a list provided to students

**Specific objectives:**
Learn the relationship between matrix product and elementary operations. Know how to calculate the inverse of an array. Know how to find the matrix associated with a linear application; particular case; rotations and symmetries in plane and space. Assist students individually in any difficulties they may encounter in trying to solve a problem. Learn to manipulate matrices fluently, and to solve problems for which they are especially useful

**Full-or-part-time:** 24h
Theory classes: 5h
Practical classes: 3h
Laboratory classes: 2h
Self study: 14h

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**Topic 4: Real functions of real variable: differential calculus**

**Description:**

Problem solving in class of Topic 4, from a list provided to students
Class resolution of a problem by students, under the supervision of the teacher

**Specific objectives:**
Remember the basic concepts of the differential calculus of a variable. Function treatment with Matlab. Know how to identify when a function is or is not differentiable at a point. Solve endpoint and optimization problems. Assist students individually in any difficulties they may encounter in 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 calculus**

**Description:**
The integral defined as the area under a curve. Primitives and Barrow's rule. Variable change. Calculation of areas and volumes of revolution. Numerical calculation of integrals (trapezoids, Simpson). Treatment with Matlab.

Problem solving in class of Topic 5, from a list provided to students
Problem solving in class by students, under the supervision of the teacher

**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 approximated numerically. Calculate integrals with Matlab. See applications of the integral to the calculation of areas, volumes of revolution, etc.

Learn the utilities of integral calculus. Know how to calculate definite integrals both analytically and numerically.

Assist students individually in any difficulties they may encounter in 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 space**

**Description:**
Concept of related space. Linear varieties: points, lines and planes. Equations of straight lines and planes. Relative positions. Perpendicularity. Distance between two linear varieties Parameterization of curves.

Problem solving in class of Topic 6, from a list provided to students
Problem solving in class by students, under the supervision of the teacher

**Specific objectives:**
Remember the concepts related to geometry in plane and space. Acquire knowledge about parameterization of curves
Solve problems of incidence, relative position and perpendicularity of linear varieties. Know how to perform the parameterization of some curves
Assist students individually in any difficulties they may encounter in trying to solve a problem

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

**Evaluations**

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

Each assessment activity not performed in the scheduled period will be assigned a score of zero.

Unless expressly authorized by the responsible teacher, a calculator, mobile phone, notes, book, or any other device (electronic or otherwise) that allows storage, reception may not be carried out for the face-to-face assessment tests, send or consult information about the subject and/or manipulate mathematical expressions.

BIBLIOGRAPHY

Basic:

Complementary: