250206 - FONMATEM - Mathematik Fundamentals

Coordinating unit: 250 - ETSECCPB - Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering
Academic year: 2017
Degree: BACHELOR'S DEGREE IN PUBLIC WORKS ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 6 Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: FRANCISCO JAVIER OZON GORRIZ
Others: FRANCISCO JAVIER OZON GORRIZ

Opening hours
Timetable: Each teacher will define the timetable when the course start.

Degree competences to which the subject contributes

Specific:
3096. Ability to solve the types of mathematical problems that may arise in engineering. Ability to apply knowledge of: linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and partial derivatives; numerical methods; numerical algorithms; statistics and optimisation.

Transversal:
591. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 1. Planning oral communication, answering questions properly and writing straightforward texts that are spelt correctly and are grammatically coherent.
597. EFFECTIVE USE OF INFORMATION RESOURCES - Level 1. Identifying information needs. Using collections, premises and services that are available for designing and executing simple searches that are suited to the topic.
600. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.
250206 - FONMATEM - Mathematic Fundamentals

**Teaching methodology**

This course consists of 4 attendance classes per week.

2 hour lectures (approximately) where the teacher will describe basic concepts and materials, will give examples and will propose exercises.

1 hour (approximately) of the weekly class time will be devoted to solving problems proposed both in class and in the course's ancillary material. Students are required to actively participate in these classes.

In the remaining 30 minutes, students will be carrying out complementary evaluable activities that are of two types:

(a) Monthly exams. Four exams will be administered during the quarter:
   i. One (first) multiple choice exam aiming to assess the students' synthesis ability and calculating accuracy.
   ii. Two (second and fourth) conventional exams aiming to assess individual performance, writing and problem solving.
   iii. One (third) exam in which students will work in pairs. In this exam, collaboration, concentration, team-work awareness, ability of completing a task in a given time frame and confidence in a partner will be assessed.

   All exams will have to be completed in 100 minutes.

(b) Solving problems classes (work in groups). Two solving problem (in groups) classes are proposed. These classes' structure will be as follows: Please note that groups will be made up of 3 students. Before each session, students will have several available materials. This material consists of class plans, either previously ad hoc developed or from selected books and videos from several Websites, and a series of solved problems related to the subject. Students are required to work on this material prior to the class. During the class they will be asked to solve a collection of problems which must be completed in groups and which will be assessed at a later stage.

   It is intended to teach a certain number of classes by means of a Tablet PC in order to make them more dynamic and to allow the use of new technologies, such as Websites related to the subject or the use of algebraic manipulators, such as Maple.

   Ancillary materials will be available at ATENEA virtual campus: contents, course notes, assessment and learning activities planning, bibliography...

**Learning objectives of the subject**

Students will learn to perform differential and integral calculus of one variable. They will also learn to solve mathematical problems encountered in engineering that involve these concepts.

On completion of the course, students will have acquired the ability to:

1. Use trigonometric functions and derivation and integration techniques;
2. Use differential calculus to solve maxima and minima problems related to simple engineering problems;
3. Solve integrals of one variable and identify how this technique can be applied to simple engineering problems.

Real numbers; Trigonometry; Successions and calculation of limits; Numerical series and convergence; Theory of functions, including analysis of continuity and limits; Differential calculus of functions of a real variable, including maxima and minima problems in simple engineering problems.
## Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 26h</th>
<th>17.33%</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>17h</td>
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<tr>
<td></td>
<td></td>
<td>11.33%</td>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>17h</td>
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<td></td>
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<td>11.33%</td>
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<tr>
<td></td>
<td>Guided activities:</td>
<td>6h</td>
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<tr>
<td></td>
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<td>4.00%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>84h</td>
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<tr>
<td></td>
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<td>56.00%</td>
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</tbody>
</table>
## Content

<table>
<thead>
<tr>
<th>Basic concepts. Sequences and numerical series</th>
<th>Learning time: 38h 24m</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 8h</td>
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<tr>
<td></td>
<td>Practical classes: 5h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 3h</td>
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<tr>
<td></td>
<td>Self study : 22h 24m</td>
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### Description:
- Sets of numbers. Absolute value and distance
- Review of the fundamental trigonometric concepts and their basic properties and relations.
- Definition and properties of open and closed sets and intervals.
- Determination of the interior, the boundary and the closure of simple sets on the n-dimensional Euclidean space.
- Session 5. Group work on conics
- Session 6. Sequences
- Session 7. Indeterminations and computing limits
- Series with positive terms. Convergence criteria: comparison, quotient and root.

### Specific objectives:
- Introduce the sets of numbers on which the subject will be developed. Review the concepts of absolute value and proximity
- To facilitate the use of the trigonometric identities in the applications. To introduce the basic trigonometric functions.
- The student should be able to determine the interior, the adherence and the boundary of a set and distinguish between different types of intervals.
- Formalize the concept of approximation

<table>
<thead>
<tr>
<th>Study of functions and its continuity</th>
<th>Learning time: 33h 36m</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 7h</td>
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<tr>
<td></td>
<td>Practical classes: 4h</td>
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<tr>
<td></td>
<td>Laboratory classes: 3h</td>
</tr>
<tr>
<td></td>
<td>Self study : 19h 36m</td>
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</tbody>
</table>

### Description:
- Session 10. Concepts and basic operations with functions.
- Session 11. Trigonometric and other basic functions
- Session 12. Limit of a function at a point. Definition of continuity
- Session 13. Computing limits
- Session 14. Solving problems on quadrics (work in group)
- Session 15. Weierstrass and Bolzano’s theorems. The bisection method
- Session 16. Continuity problems and application of the bisection method
### Differential calculus of one variable functions

**Learning time:** 38h 24m  
- Theory classes: 7h  
- Practical classes: 6h  
- Laboratory classes: 3h  
- Self study: 22h 24m

**Description:**  
Session 18. Derivative concept. Algebraic properties  
Rolle and Mean Value theorems. L'Hopital Rule. High order derivatives. Taylor polynomial  
Session 22. Problem solving on local approximation of functions (work in group)  
Session 23. Extreme values of one variable functions  
Session 24. Computing maximum and minimum values

### Integral calculus

**Learning time:** 33h 36m  
- Theory classes: 4h  
- Practical classes: 2h  
- Laboratory classes: 8h  
- Self study: 19h 36m

**Description:**  
Session 26. Riemann Integral definition  
Session 27. Computations of integrals  
Session 28. Barrow's Rule and change of variable  
Session 29. Problem solving on integral computation  
Session 31. Applications:
Qualification system

The grade (T) is calculated as follows:

\[ T = \frac{T_1 + T_2}{2}, \]

where Ti with i=1,2 is the grade from each group work.

Two exams (Ei, i=1,2) will be administered throughout the quarter. Each one corresponds to a content block.

If all Ei grades are greater than or equal to 3, the final grade will be:

\[ N = 0.7 \times \frac{E_1 + E_2}{2} + 0.3 \times T \]

If N is greater than or equal to 5, the student will pass the course.

If N is less than 3, students will have to make up those parts corresponding to Ei grades in the additional testing period (ERi).

If we call EEi = max (Ei, ERi), and ERi is greater than or equal to 3, i = 1,2, the final grade will then be calculated as follows:

\[ N = 0.7 \times \frac{EE_1 + EE_2}{2} + 0.3 \times T \]

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.

Regulations for carrying out activities

It is mandatory to do the exams and their corresponding make up tests (where appropriate); otherwise the student will fail the course and will get an NP (Incomplete) final grade.

Bibliography

Basic: