## Course file

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| **Study cycle** | BACHELOR IN CIVIL ENGINEERING | | |
| **Course** | Calculus I | Mandatory | ☒ |
| | | Optional | ☐ |
| **Course scientific area** | CIVIL ENGINEERING | Category | B |

Course category: B - Basic; C - Core Engineering; E - Specialization; P - Complementary.

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| Year: 1st | Semester: 1st | | ECTS: 5,5 | | Total: 148 |
| Contact time | T: | TP: 67,5 | PL: | S: | OT: |

T - Lectures; TP - Theory and practice; PL - Lab Work; S - Seminar; OT - Tutorial Guidance.

| **Course Director** | **Title** | **Position** |
|---|---|---|
| Ricardo Enguiça | Doutor | Professor Adjunto |

**Learning objectives (knowledge, skills and competences to be developed by students)**

(max. 1000 characters)

1. To master the basic real-valued functions.
2. To master the concepts of calculus required in the study of real-valued functions of one variable.
3. To know how to approximate functions by polynomials.
4. To understand the concepts of nature and sum of a series and to know the convergence tests.
5. To understand and be able to apply the concepts of integral calculus and, in particular, the fundamental theorem of calculus.
6. To know how to use the antiderivatives methods.
7. To be able to formulate a mathematical problem and to identify and implement the appropriate strategies and tools to its analytical and/or computational solution.
8. To be able to apply the key concepts and techniques of differential and integral calculus in IR in the context of the various engineering-related courses of the program.
9. To have analysis, algebraic, and deductive reasoning skills.
10. To have reflection and criticism capabilities.

| **Syllabus**<br>(max. 1000 characters) |
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| I. Differentiation.<br><br>Concept of derivative. Derivation rules.<br><br>Lagrange's Theorem. Local extrema. Optimization.<br><br>Taylor's formula. Concavities.<br><br>Cauchy's rule. Indeterminate forms.<br><br>Infinite series. Convergence tests. Power series.<br><br>Taylor series. Power series expansion.<br><br>Antiderivatives.<br><br>I. Integration.<br><br>Concept of integral. Integrable functions. Properties of the definite integral. Mean value theorem.<br><br>Indefinite integral. Properties. Fundamental theorem of calculus.<br><br>Barrow's rule. Computation of integrals.<br><br>Improper integrals.<br><br>First order linear differential equations and separate variable equations.<br><br>6. Applications to engineering. |

| **Demonstration of the consistency between the syllabus and the course objectives**<br>(max. 1000 characters) |
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| Goals 1 to 6 are met within the contents of the syllabus, in which also analysis, algebra and deductive reasoning skills are widely developed (goal 9). In addition to the applications studied in chapter II, the systematic use of applied, computational and contextual problems yields an increase of motivation, efficiency and spectrum of learning, since they enable:<br><br>• to convey the fact that differential and integral calculus in IR are an indispensable tool in the study of engineering;<br><br>• to practice the mathematical formulation of problems, their solution and criticism (goals 7 to 10); |

• to enable computational experiments in the direct mathematical formalization of problems and their solution, to formulate conjectures and to construct, evaluate, modify, and interpret algorithms (goals 7, 9 and 10);

• to help students recognize the concepts and techniques studied when they are met in the study of other courses (goal 8).

**Teaching methodology (evaluation included)**

(max. 1000 characters)

Lectures based on applied examples and practical classes in which theoretical, practical, and computational problems are solved. Special emphasis is given to problems connecting the tools developed with concepts which are important in engineering-relates courses. Exercises sheets are available for an effective monitoring and strengthen of the knowledge presented.

The assessment comprises two alternative components, continuous assessment and exam assessment. Continuous assessment consists of two tests during the classes, complemented by assignments, either individual or in group, or summative tests, whose influence on the final grade should not exceed 25%. Assessment by examination consists entirely on a written examination.

**Demonstration of the consistency between teaching methodology and the course learning objectives**

(max. 3000 characters)

Lectures are essential to a correct and comprehensive coverage of all topics of the syllabus, while in-class solution of exercises allows for a successful application of the theoretical knowledge to practical problems.

By their organization, contents and diversity of difficulty degree, the exercises sheets provided allow students to closely monitor all topics of the syllabus and are the main tools regarding individual study. The exercises that constitute them are particularly well-suited for the development of algebra skills and deductive reasoning.

Given that success in mathematics is not compatible with pre-assessment study alone, it is essential to implement processes to avoid this inclination. The use of group work or summative tests requires students to closely monitor the progress of the syllabus.

Group work, in particular, is of great advantage. When confronted with less straightforward problems, students are led to question and deepen their knowledge while acquiring work and independence skills. This type of problems is also the most suitable for the development of analysis, reflection and criticism skills. Furthermore, group dynamics encourage debate and support between students, which lead to better results

than those achieved solely by classes and individual study. Occasionally, either individual or group checks may take place.

The considerable weight of this component in the final grade is due to the two-fold intention of not being easily neglected and to reward the student for his or her effort. (In addition, significant higher attendance rates have been observed, since students evidence some concern about wasting the effort that has already been developed.)

**Main Bibliography**

(max. 1000 characters)

D. Hughes-Hallet, et al., Calculus: Single Variable, John Wiley & Sons (Reference book), 2008.

J. Marsden, A. Weinstein, Calculus I, Springer (Reference book), 1985.

J. Marsden, A. Weinstein, Calculus II, Springer (Reference book), 1985.

P. Kent, P. Ramsden, J. Wood, Experiments in Undergraduate Mathematics – A Mathematica-Based Approach, Imperial College Press (Reference book), 1996.

G. Bluman, Problem Book for First Year Calculus, Springer (Reference book), 1984.

H. J. Keisler, Elementary Calculus: An Infinitesimal Approach, disponível online em: http://www.math.wisc.edu/~keisler/calc.html (Reference book), 2012.

C. Sarrico, Análise Matemática, Gradiva (Reference book), 2000.

J. S. Guerreiro, Curso de Análise Matemática, Escolar Editora (Reference book), 1989.