

Course guides

250202 - CÀLCUL - Calculus

Last modified: 01/10/2021

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

Degree: BACHELOR'S DEGREE IN PUBLIC WORKS ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2021 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: FRANCISCO JAVIER OZON GORRIZ

Others: FRANCISCO JAVIER OZON GORRIZ

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:

588. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 1. Analyzing the world's situation critically and systemically, while taking an interdisciplinary approach to sustainability and adhering to the principles of sustainable human development. Recognizing the social and environmental implications of a particular professional activity.

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.

598. EFFECTIVE USE OF INFORMATION RESOURCES - Level 2. Designing and executing a good strategy for advanced searches using specialized information resources, once the various parts of an academic document have been identified and bibliographical references provided. Choosing suitable information based on its relevance and quality.

TEACHING METHODOLOGY

This course consists of 4 compulsory attendance classes per week.

Teaching methodology:

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

- 1 ½ 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 activities which will become part of the final assessment.

Assessment:

(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 problems (in groups) classes are proposed. These classes' structure will be as follows: Three one hour sessions (first, second and third) and a one two hour session (fourth). Please note that groups will be made up of 3 students. Before each session, students will have available ancillary materials, so that they can design their class. 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 developing their classes. 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 several variables and how they these techniques can be used to solve mathematical problems encountered in engineering.

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

1. Relate ordinary differential equations to engineering problems, solve ODEs in simple conditions, and conduct analyses such as parametric studies to validate the solutions;
2. Solve engineering problems that require minimisation, integration and analysis of functions of several variables.

Differential calculus of functions of several variables; Integral calculus of several variables; Directional derivatives; Gradient vector; Chain rule; Tangent plane; Inverse function theorem; Implicit functions; Higher-order partial derivatives; Taylor's theorem; Free extrema; Conditional extrema; Fourier systems and their application to civil engineering problems

Ability to solve first order linear ordinary differential equations and equation with separated variables. Ability to implement these techniques to solving scientific-technical problems. Ability to solving high order linear ordinary differential equations and its application to engineering problems such as vibration with and without damped

STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	10.00
Hours medium group	15,0	10.00
Self study	84,0	56.00



Type	Hours	Percentage
Guided activities	6,0	4.00
Hours large group	30,0	20.00

Total learning time: 150 h

CONTENTS

Differential calculus of several variables functions

Description:

Parametric curves
Parametrization, curvature and torsion of remarkable curves
Partial and directional derivatives and differential
Study of known curves
Computing partial derivatives
Jacobian matrix. Gradient. Chain rule.
Applications of the chain rule

Full-or-part-time: 33h 36m

Theory classes: 6h
Practical classes: 5h
Laboratory classes: 3h
Self study : 19h 36m

Implicit and inverse Theorems. Optimization of several variables functions

Description:

Implicit function and inverse function theorems
Curves and surfaces implicitly defined
Higher derivatives. Taylor polynomials
Necessary and sufficient conditions for free extrema
Computation of maximum and minimum values of a function
Optimization of implicit functions
Extrema in compact sets
Constrained optimization
Assessment Item 2

Full-or-part-time: 38h 24m

Theory classes: 7h
Practical classes: 6h
Laboratory classes: 3h
Self study : 22h 24m



Riemann multiple integral

Description:

Basic Properties

Iterated integral. Integration on pseudointervals

Change of variable in multiple integration

Integration in polar and spherical coordinates

Computing areas and volumes

Full-or-part-time: 33h 36m

Theory classes: 4h

Practical classes: 7h

Laboratory classes: 3h

Self study : 19h 36m

Introduction to ordinary differential equations

Description:

First order linear ordinary differential equation

Differential equations with separated variables

Modelization with first order ODE

Logistic equation

Linear ordinary differential equations of higher order

Application of Lagrange's formula

Vibratory movements

Full-or-part-time: 38h 24m

Theory classes: 6h

Practical classes: 2h

Laboratory classes: 8h

Self study : 22h 24m

GRADING SYSTEM

The grade (T) is calculated as follows:

$$T = (T_1 + T_2) / 2,$$

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

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

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

$$N = 0.8 * (E_1 + E_2) / 2 + 0.2 * T$$

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 E_i grades in the additional testing period (ER_i).

If we call $EE_i = \max(E_i, ER_i)$, and ER_i is greater than or equal to 3, $i = 1,2$, the final grade will then be calculated as follows:

$$N = 0.8 * (EE_1 + EE_2) / 2 + 0.2 * T$$

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.

EXAMINATION RULES.

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:

- Apostol, T.M. Calculus. 2a ed. Barcelona: Reverté, 1972. ISBN 8429150013 (O.C.).
- Salas, S.L.; Hille, E.; Etgen, G. Calculus. 4a ed. Reverté, 2002. ISBN 8429151567.
- Rogawski, J. Cálculo, Una variable. 2a ed. Barcelona [etc.]: Reverté, 2012. ISBN 9788429151664.
- Rogawski, J. Cálculo, Varias Variables. 2a ed. Barcelona [etc.]: Reverté, 2012. ISBN 9788429151749.

Complementary:

- Nagle, R.K; Saff, E.B. Fundamentos de ecuaciones diferenciales. Argentina: Addison Wesley, 1992. ISBN 0201518368.