

Course guide

330502 - CAL1 - Calculus 1

Last modified: 16/05/2023

Unit in charge: Manresa School of Engineering
Teaching unit: 749 - MAT - Department of Mathematics.

Degree: BACHELOR'S DEGREE IN AUTOMOTIVE ENGINEERING (Syllabus 2017). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: Bastardas Ferrer, Gemma

Others: Rossell Garriga, Josep Maria

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

CE1. Ability to solve mathematical problems that may arise in engineering. Ability to apply knowledge about: linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and partial derivatives; numerical methods; numerical algorithms; statistics and optimization.

Generical:

CG3. Knowledge of basic and technological subjects that will enable students to learn new methods and theories and that will endow them with the versatility needed to adapt to new situations.

Transversal:

1. 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.
2. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.

Basic:

CB1. Students will be able to demonstrate their knowledge of a field of study that builds on secondary education and is usually found at a level that, while supported by advanced textbooks, also includes aspects that involve knowledge of the latest developments in the field of study.

CB2. Students will be able to apply their knowledge to their work or vocation in a professional manner and demonstrate that they possess the competencies that are typically demonstrated by elaborating and defending arguments and solving problems in the field of study.

TEACHING METHODOLOGY

- MD1 Master class or lecture (EXP)
- MD2 Problem solving and case study (RP)
- MD5 Small-scale project, activity or assignment (PR)
- MD6 Large-scale project or assignment (PA)
- MD7 Assessment activities (EV)

LEARNING OBJECTIVES OF THE SUBJECT

To learn basic mathematical principles and methods of single-variable calculus.

The general aim is twofold: on one hand, students must acquire the knowledge required to understand, set up and solve basic mathematical engineering problems. On the other hand, the learning process should also help increase their ability to understand new methods and theories.

At the end of the Calculus 1 course, students should be able to do the following:

1. Set up and solve basic mathematical problems related to calculus of single-variable functions.
2. Apply the theoretical knowledge necessary for solving specific engineering problems and correctly interpreting the results.
3. Make elementary use of MATLAB for numeric and symbolic computations.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Hours small group	30,0	20.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Topic 1: Single-variable differential calculus

Description:

Basic functions in engineering.
Limits and continuity. Theorems on continuous functions.
Derivation of single-variable functions.
Linear approximations.
Theorems on differentiable functions.
Relative and absolute extremes. Optimisation problems.
Zeros of functions: the bisection and Newton-Raphson methods.

Specific objectives:

At the end of this part students should be able, with the assistance of MATLAB in non-elementary cases, to do the following:

Identify domains of functions and represent them graphically. Understand the concept of limits. Calculate limits of functions.
Understand the concepts of continuity and differentiability.
Identify whether a function is continuous or differentiable at one point.
Calculate derivatives of functions defined either explicitly or implicitly.
Write the equation of the tangent and the normal lines to a curve at a point.
Write the linear approximation of a function at a point and use it to calculate approximately the function at nearby points.
Understand the main theorems on continuous and differentiable functions, and apply them in concrete examples.
Calculate relative and absolute extremes of a function.
Set up and solve elementary optimisation problems.
Understand and know how to use the bisection and Newton-Raphson methods for approximate calculation of roots of equations.

Related activities:

1,2,3,4,5

Full-or-part-time: 50h

Theory classes: 10h
Laboratory classes: 10h
Self study : 30h



Topic 2: Single-variable integral calculus

Description:

Riemann sums. The concept of definite integrals.

The fundamental theorem of calculus.

Calculation of primitives: immediate, by change of variable, by parts and rational.

Calculation of areas of flat regions and volumes of revolution.

Numerical integration: trapezoid and Simpson methods.

Improper integrals.

Specific objectives:

At the end of this part students should be able, with the help of MATLAB in non-elementary cases, to do the following:

Understand the concept of Riemann sums as a tool for defining magnitudes in engineering.

Calculate primitives and definite integrals.

Decompose a rational function into a sum of simple fractions.

Calculate areas of flat regions by integration.

Calculate volumes of solids generated by rotating a flat region around an axis that does not cut it.

Understand and know how to use the trapezium and Simpson methods for the approximate calculation of definite integrals.

Understand the concept of improper integrals and know how to calculate them in elementary cases.

Related activities:

1,2,3,4,5

Full-or-part-time: 50h

Theory classes: 10h

Laboratory classes: 10h

Self study : 30h



Topic 3: Series

Description:

Numerical series. Convergence tests.
Power series. Intervals of convergence.
Representing functions with power series.
Fourier series. Calculation of coefficients.
Dirichlet's theorem.
Complex expression of the Fourier series.

Specific objectives:

At the end of this part students should be able, with the help of MATLAB in non-elementary cases, to do the following:

Understand the concept of numerical series.
Identify the character of a numerical series.
Calculate the sum of particular series such as geometric or telescoping series.
Understand the concept of power series.
Find the interval of convergence of a power series.
Represent a function with a power series.
Understand the concept of Fourier series.
Calculate the trigonometric Fourier series of a periodic function.
Know the Dirichlet's conditions for convergence of a Fourier series.
Represent functions defined in a finite interval with a Fourier series.
Write the complex form of a Fourier series.

Related activities:

1,2,3,4,5

Full-or-part-time: 50h

Theory classes: 10h

Laboratory classes: 10h

Self study : 30h

ACTIVITIES

Activity 1: Theory sessions

Description:

Presentation of the theory and applications of the various topics.

Specific objectives:

Those of topics 1, 2 and 3.

Material:

Documents in the Atenea virtual campus.
Compulsory reading list.

Full-or-part-time: 54h

Theory classes: 27h

Self study: 27h



Activity 2: Practice sessions

Description:

Setting up and solving problems.

Specific objectives:

Those of topics 1, 2 and 3.

Material:

Exercise statements.
Solved exercises (to be seen after students have attempted to solve them).
Documents in the Atenea virtual campus.
Online quizzes.
Compulsory reading list.

Full-or-part-time: 50h

Laboratory classes: 21h

Self study: 29h

Activity 3: Lab sessions

Description:

Getting acquainted with the basic use of MATLAB.

Specific objectives:

Those of topics 1, 2 and 3.

Material:

Computer with MATLAB software.
Exercise statements.
Solved exercises (to be seen after students have attempted to solve them).
Documents in the Atenea virtual campus.
Compulsory reading list.

Full-or-part-time: 26h

Laboratory classes: 7h

Self study: 19h

Activity 4: Written partial tests

Description:

Student learning tests, one for each of the three topics.

Specific objectives:

Those of topics 1, 2 and 3.

Material:

Test questions.

Delivery:

Individual answers.

Full-or-part-time: 12h

Theory classes: 3h

Self study: 9h



Activity 5: Lab partial tests

Description:

MATLAB knowledge assessment, one for each of the three topics.

Specific objectives:

Those of topics 1, 2 and 3.

Material:

Practice questions.

Delivery:

Individual answers.

Full-or-part-time: 8h

Laboratory classes: 2h

Self study: 6h

Activity 6 (additional): Final exam

Description:

A final exam including all topics.

Specific objectives:

Those of contents 1, 2 and 3.

Material:

Exam paper.

Delivery:

Individual answers.

Full-or-part-time: 3h

Theory classes: 3h

GRADING SYSTEM

The course mark, between 0 and 10, is obtained from the test results.

The marks for the written partial tests (P1, P2 and P3) have a weighting of 25% each.

The score of the lab partial tests (L) has a weighting of 25%. Thus, the course mark N is calculated as follows:

$$N=0.30(P1+P2)+0.25P3+0.15L$$

Students may additionally take a final exam to improve their mark in the written partial tests. The mark obtained from this test, G, gives rise to a new mark, NG:

$$NG=0.85G+0.15L$$

The final mark is the highest between the course mark N and the mark NG.

EXAMINATION RULES.

Activities 1, 2, 3, 4 and 5 are compulsory for all students.

Failure to do any of the tests in activities 4 or 5 will lead to a mark of zero for this test in calculating the values of N and NG.



BIBLIOGRAPHY

Basic:

- Hartman, Gregory Neil. APEX calculus: versión 3.0 [on line]. [Consultation: 19/11/2020]. Available on: <https://drive.google.com/file/d/0B2Pdq3LqVNPmkiScTZQOU5aMVE/view>.
- Bradley, Gerald L.; Smith, Karl J. Cálculo. Madrid: Prentice Hall, 1998. ISBN 848966076X.
- Hsu, Hwei P.; Mehra, Raj. Análisis de Fourier [on line]. Argentina: Addison-Wesley Iberoamericana, 1987 [Consultation: 03/04/2024]. Available on: <https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=6118465>. ISBN 0201029421.
- Pérez López, César. Matlab a través de ejemplos. Madrid: Ibergarceta, 2011. ISBN 9788492812431.