Universidad de Alcalá

TEACHING GUIDE

Calculus II

Degree in
Telecommunication Technologies Engineering (GITT)
Electronic Communications Engineering (GIEC)
Telematics Engineering (GIT)
Telecommunication Systems Engineering (GIST)

Universidad de Alcalá

Academic Year 2025/2026

1st Year - 2nd Semester (GITT+GIEC+GIT+GIST)

Approved by the EPS School Board on June 16th, 2025

TEACHING GUIDE

Course Name:	**Calculus II**
Code:	**350006 (GITT+GIEC+GIT+GIST)**
Degree in:	**Telecommunication Technologies Engineering (GITT)** **Electronic Communications Engineering (GIEC)** **Telematics Engineering (GIT)** **Telecommunication Systems Engineering (GIST)**
Department and area:	**Física y Matemáticas** **Physics and Mathematics**
Type:	**Basic (GITT+GIEC+GIT+GIST)**
ECTS Credits:	**6.0**
Year and semester:	**1st Year - 2nd Semester (GITT+GIEC+GIT+GIST)**
Teachers:	See website: https://www.uah.es/es/estudios/estudios-oficiales/grados/asignatura/Calculo-II-350006/
Tutoring schedule:	Consultar al comienzo de la asignatura
Language:	English

1. COURSE SUMMARY

This subject focuses on the study of real functions of several real variables, and is a natural continuation of Calculus I. Here, we generalize notions and results related to functions ofone real variable to the case of several variables, and we introduce some new concepts and phenomena that appear, precisely, as a consequence ofhaving extra variables. Additionally, this subject provides our students with indispensable mathematical tools for understanding many fundamental notions in Telecommunication Engineering, as well as the physical lawslying at the foundations of Telecommunication Engineering, like Electromagnetism,Newtonian Mechanics or Thermodinamics. In particular, Vector Analysis and integral theorems are studied and related to several notions and results in Physics.

Prerequisites and recommendations:

In order to face this subject successfully it is recommendable to previously have studiedCalculus I and Linear Algebra.

2. SKILLS

Basic, Generic and Cross Curricular Skills.

This course contributes to acquire the following generic skills, which are defined in the Section 3 of the Annex to the Orden CIN/352/2009:

en_TR2 - Knowledge of basic subjects and technologies that enables to learn new methods and technologies, as well as to provide versatility that allows adaptation to new situations.

en_TR3 - Aptitude to solve problems with initiative, decision making, creativity, and to communicate and to transmit knowledge, skills and workmanship, comprising the ethical and professional responsibility of the activity of the Technical Engineer of Telecommunication.

en_TR4 - Knowledge for the achievement of measurements, calculations, evaluations, appraisals, examinations, studies, reports, planning of tasks and other similar works in its specific ambience of the telecommunication.

en_TRU1 - Capacity of analysis and synthesis.

Professional Skills

This course contributes to acquire the following professional skills, which are defined in the Section 5 of the Annex to the Orden CIN/352/2009:

en_CB1 - Capacity for the resolution of the mathematical problems that could appear in the pathway of an engineer. Aptitude for applying the knowledge on: linear algebra; geometry; distinguishing geometry; differential and integral calculus; distinguishing equations and in partial derivatives; numerical methods; numerical algorithms; statistics and optimization.

Learning outcomes:

RA1. Describing correctly the behavior of a scalar or vector function.

RA2. Using differential calculus to solve geometric problems and optimization problems involving functions of several variables.

RA3. Using double and triple integrals to solve geometric problems and in problems related to Engineering and Physics.

RA4. Distinguishing and using properly the different types of integrals related to planar and space regions, planar and space curves, and surfaces in 3-space.

RA5. Solving geometric problems in the plane and in 3-space using techniques of differential and integral calculus.

3. CONTENTS

Contents Blocks	Total number of hours
Lesson 1: Real functions of several real variables:examples and definitions. Graphs and level sets. Limits and continuity.	• 4 hours theory • 4 hours practice
Lesson 2: Derivation. Partial and directional derivatives. Gradien, geometric meaning and applications. Chain rule and implicit derivation.	• 4 hours theory • 4 hours practice
Lesson3. Maxima and minima: Higher order derivatives. Taylor polynomial. Critical points, characterization and classification. Restricted critical points of functions with constraints. Lagrange multipliers. Absolute extrema in compact sets.	• 4 hours theory • 4 hours practice
Lesson4. Multiple integrals: Double integral on a rectangle.Double integral on general regions. Triple integral, definition and methods. Change of variables in double and triple integrals. Orthogonal and general systems of coordinates.	• 5 hours theory • 4 hours practice
Lesson5. Line integrals: Parametrized curves. Derivationand tangent vector. Arc length. Vector fields and line integrals. Line integral of conservative fields. Green theorem.	• 3 hours theory • 4 hours practice
Lesson6. Surface integrals: Parametrized surfaces. Area of a surface. Surface integrals of scalar functions. Surface integrals of vector flows. Application: Gauss Theorem.	• 4 hours theory • 4 hours practice
Lesson7. Vector Analysis: The nabla operator. Basic identities of vector analysis. Integral theorems of Vector analysis. Flow and electric charges. Stokes Theorem. Rotational and flow. Applications.	• 4 hours theory • 4 hours practice

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	58 hours (56 hours on-site +2 exams hours)
Number of hours of student work:	92
Total hours	150

4.2. Methodological strategies, teaching materials and resources

Lectures	Lectures to present and/or review a concept, and also to make conclusions. Problem solving lectures by the teacher and/or by the student.
Resources and didactic materials	The material enumerated in the references will be used. Sheets of activities and additional material will be also provided.

5. ASSESSMENT: procedures, evaluation and grading criteria

Preferably, students will be offered a continuous assessment model that has characteristics of formative assessment in a way that serves as feedback in the teaching-learning process.

5.1. PROCEDURES

The evaluation must be inspired by the criteria of continuous evaluation (Learning Assesment Guidelines, LAG, art 3). However, in compliance with the regulations of the University of Alcalá, an alternative process of final evaluation is made available to the student in accordance with the Learning Assesment Guidelines as indicated in Article 10, students will have a period of fifteen days from the start of the course to request in writing to the Director of the Polytechnic School their intention to take the non-continuous evaluation model adducing the reasons that they deem convenient. The evaluation of the learning process of all students who do not apply for it or are denied it will be done, by default, according to the continuous assessment model. The student has two calls to pass the subject, one ordinary and one extraordinary.

ASSESSMENT PROCEDURES

Ordinary call:

1. Continuous evaluation system:

On one hand the students will do two partial exams, accounting for 40% of the final grade each. One will be in the middle of the semester (PEI1) and the other at the end of the semester (PEI2). These exams will include both theoretical questions and exercises.
On the other hand, the work of the students on the practical lessons will be evaluated, accounting for 20% of the final grade.
Besides, another edition of PEI1 will be held at the end of the semester that the sudents can take regardless of whether thy took the first edition of such exam or not. The grade obtained by a student taking the PEI1 exam twice will be the maximum of the two grades obtained.

2. Final evaluation system: the students will take one exam, which may contain both theoretical questions and exercises.

Extraordinary Call:

The students will take one exam, which may contain both theoretical questions and exercises.

5.2. EVALUATION

EVALUATION CRITERIA

The assessment criteria measure the skills acquired by the student. In order to do that, we consider the following criteria:

CE1. The student understands the concepts.

CE2. The student uses properly the mathematical tools.

CE3. The student is able to formulate geometric probles, related to regions and objects of the plane and 3-space, in terms of differential and integral calculus.

CE4. The student reasons and argues correctly.

GRADING TOOLS

The work of the student is graded according to the evaluation criteria above, by using the following tools:

1. Ordinary call

   a) Continuous assessment: two written exams (PEI1, PEI2) and the work of the students on the practical lessons, as it was indicated in Section 5.1.

   b) Final assessment: one exam (PEF).

2. Extraordinary Call: one exam (PEF).

GRADING CRITERIA

Ordinary call. Continuous assessment

Skill	Learning Outcomes	Evaluation criteria	Assessment tool	Marking Criteria
TR2, TR3, TR4,TRU1, CB1	RA1, RA2, RA5	CE1-CE4	PEI1	40%
	RA1-RA5	CE1-CE4	PEI2	40%
	RA1-RA5	CE1-CE4	Work of the students on the practical lessons	20%

In this case, the qualification of "Not presented" will be applied to those students who have taken, at most, the first test (PEI1).

Ordinary call. Final assessment

Skill	Learning Outcomes	Evaluation criteria	Assessment tool	Marking Criteria
TR2, TR3, TR4,TRU1,CB1	RA1-RA5	CE1-CE4	PEF	100%

In this case (Final assessment), the qualification of "Not presented" will apply to those students who have missed the exam.

Skill	Learning Outcomes	Evaluation criteria	Assessment tool	Marking Criteria
TR2, TR3, TR4,TRU1,CB1	RA1-RA5	CE1-CE4	PEF	100%

In this case, the qualification of "Not Presented" will apply to those students who have missed the exam.

The teaching-learning methodology and the assessment process will be adapted as needed, in accordance with the guidelines of the Diversity Support Unit, to implement curricular adaptations for students with specific needs.

6. BIBLIOGRAPHY

6.1. Basic Bibliography

- Calculus, one and several variables, Vol. 2, S.L. Salas, E. Hille & G.J. Etgen, Ed. Reverté.
- Calculus II. Theory and problems of functions of several variables, A. Garcia; A. Lopez ; G.Rodriguez ; S. Romero ; A. De La villa, Ed.Clagsa.
- Vectorial Calculus, Marsden J.E. Tromba A.J. ,.Ed. Addison Wesley.
- Calculus of several variables (Volume 2). G.L.Bradley, K.J.Smith. Ed.Prentice Hall.
- Calculus, Vol II , Larson R. Hostettler, Edwards B.H.. Ed. McGraw-Hill.
- Calculus. Concepts and settings, J. Stewart, Ed Thomson. Mexico.

6.2. Additional Bibliography

- Superior Calculus, M. Spiegel, Ed. Mc Graw-Hill.
- Calculus II, T.M. Apostol, Ed. Reverté.

Disclosure Note

During the evaluation tests, the guidelines set out in the Regulations establishing the Rules of Coexistence of the University of Alcalá must be followed, as well as the possible implications of the irregularities committed during said tests, including the consequences for committing academic fraud according to the Regulation of Disciplinary Regime of the Students of the University of Alcalá.