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

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**Academic Year 2019/2020**

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

# TEACHING GUIDE

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| Course Name: | **Calculus II** |
| Code: | **350006 (GITT+GIEC+GIT+GIST)** |
| Degree in: | **Telecommunication Technologies Engineering (GITT)**<br>**Electronic Communications Engineering (GIEC)**<br>**Telematics Engineering (GIT)**<br>**Telecommunication Systems Engineering (GIST)** |
| Department and area: | **Física y Matemáticas**<br>**Physics and Mathematics** |
| Type: | **Basic (GITT+GIEC+GIT+GIST)** |
| ECTS Credits: | **6** |
| Year and semester: | **1st Year - 2nd Semester (GITT+GIEC+GIT+GIST)** |
| Teachers: | David Orden Martín |
| 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<br>• 4 hours practice |
| **Lesson 2: Derivation.** Partial and directional derivatives. Gradien, geometric meaning and applications. Chain rule and implicit derivation. | • 4 hours theory<br>• 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<br>• 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<br>• 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<br>• 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<br>• 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<br>• 4 hours practice |

# 4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

## 4.1. Credits Distribution

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| 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

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| Lectures | Lectures to present and/or review a concept, and also to make conclusions.<br><br>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 (Regulations for the Regulation of Teaching Learning Processes, NRPEA, 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 Regulations for the Evaluation of Apprenticeships (approved by the Governing Council on March 24, 2011 and modified in the Board of Directors). Government of May 5, 2016) 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: the students will do three written exams, one of them in the middle of the semester (PEI1) and two of them at the end of the semester(PEI2 and PEI3). The first exam

will take up 40% of the final grade, and the two other exams will take up 30% of the final grade each. Besides, whenever the student has done the first exam PEI1, he/she will have the option of taken this same exam again at the end of the semester. The grade obtained in this exam will replace, regardelss of whether it is better or not, the grade obtained in the exam PEI1 in order to compute the final grade.

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: three written exams (PEI1, PEI2, PEI3).

   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 | CE1, CE2 | PEI1 | 40% |
| | RA2, RA4 | CE2, CE4 | PEI2 | 30% |
| | RA1,RA2,RA3,RA4, RA5 | CE1, CE2, CE3, CE4,CE5 | PEI2 | 30% |

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-CE5 | 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-CE5 | PEF | 100% |

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

# 6. BIBLIOGRAPHY

## 6.1. Basic Bibliography


- Calculus, one and several variables, Vol. 2, S.L. Salas, E. Hille & G.J. Etgen, (10th. ed.)Wiley.
- Calculo II. Teoría y problemas de funciones de varias variables, A. Garcia; A. Lopez ; G.Rodriguez ; S. Romero ; A. De La villa, Ed.Clagsa.
- Cálculo Vectorial, Marsden J.E. Tromba A.J. ,.Ed. Addison Wesley.
- Cálculo de varias variables (Volumen 2). G.L.Bradley, K.J.Smith. Ed.Prentice Hall.
- Cálculo, Vol II , Larson R. Hostettler, Edwards B.H.. Ed. McGraw-Hill.
- Cálculo. Conceptos y contextos, J. Stewart, Ed Thomson.Méjico
- Additional material for Vector Calculus, J.E. Marsden & A.J. Tromba, available athttp://bcs.whfreeman.com
- CALCULUS, G. Strang, MIT, Wellesley-Cambridge Press
- Vector Calculus, M. Corral, Schoolcraft College, 2008. GNU Free DocumentationLicense V1.2 or latter.


## 6.2. Additional Bibliography


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