

**COURSE DATA****DATA SUBJECT****Code:** 36584**Name:** Vector Calculus**Cycle:** Undergraduate Studies**ECTS Credits:** 6**Academic year:** 2025-26**STUDY (S)**

Degree	Center	Acad. year	Period
1928 - Double Degree Program Physics-Mathematics	Facultat de Ciències Matemàtiques	1	Second quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1928 - Double Degree Program Physics-Mathematics	Primer Curso (Obligatorio)	COMPULSORY

COORDINATION

SEGURA DE LEON SERGIO

SUMMARY

This subject aims at the early introduction of the basic aspects of calculus of functions of several variables. More specifically, functions of several variables, limits and continuity, line and surface integrals, and integral theorems (Gauss and Stokes). This is essential for the study of other more advanced subjects, both in the mathematical and physical aspects of double degree. Most of the contents will be revisited in Mathematical Analysis II, where they will be studied with more rigor and detail. This early introduction is necessary in double degree owing to the wide variety of applications of calculus to physics, which makes it essential to learn its fundamental concepts and results in the first course. The purpose is for students to acquire these basic tools and to be used with ease.

PREVIOUS KNOWLEDGE**RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE**

There are no specified enrollment restrictions with other subjects of the curriculum.

OTHER REQUIREMENTS

As requirements for studying this subject, it is assumed that the student knows the contents of HIGH



SCHOOL MATHEMATICS I and II. In addition, students who study this subject must have the basic knowledge of the first semester of Mathematical Analysis I.

COMPETENCES / LEARNING OUTCOMES

DESCRIPTION OF CONTENTS

1. Functions of several variables. Differentiation.

Functions of several variables. Graphical representation: level sets. Limits and continuity. Partial derivatives and the differential. Paths and curves. Derivatives of compose functions: The chain rule. Implicit derivation. Directional derivatives and gradient. Gradient and level sets.

2. Higher order derivatives. Extreme values.

Higher order derivatives: Taylor's formula in several variables. Extreme values and saddle points. Hessian matrix. Conditioned extremes: Lagrange multiplier method.

3. Vector fields.

Vector fields: definition, graphic representation and flow lines. Gradient fields. Differential operators and their properties: gradient, divergence, rotational and Laplacian. Curvilinear coordinates: vectors and operators.

4. Multiple integration

Double integrals on a rectangle. Double integrals over elementary regions. Change of variable in the double integral. Polar coordinates. Triple integrals. Change of variable in the triple integral. Cylindrical and spherical coordinates. Applications of multiple integrals: mass centers and moments of inertia.

5. Line and Surface integrals.

Curvilinear integrals. Circulation of vector fields. Surface integrals. Green's theorem in the plane. The Stokes and Gauss-Ostrogradski theorems.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
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Theory	30,00
Other activities	7,50
Classroom practices	22,50
Total hours	60,00

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	5,00
Independent study and work	75,00
Preparation of lessons	0,00
Preparation for assessment activities	10,00
Resolution of case studies	0,00
Total hours	90,00

TEACHING METHODOLOGY

Face-to-face teaching (40%):

- Theoretical-practical classes: The conceptual and formal aspects of the subject are addressed, as well as the resolution of problems or cases as an application of theoretical concepts. They are mainly based on participatory master class and the use of teaching tools such as graphic representation of solutions, projection of presentations, computation programs, etc.

- Seminar sessions: focused on the student's work and their active participation: resolution of doubts arising when facing theoretical concepts and problem solving, reinforcement in aspects of greater difficulty, conceptual questionnaires, experimental proofs relevant to the study cases and, associated with a continuous evaluation component, verification of the student's progress in the subject.

Student personal work (60%):

- Study of the theoretical foundations.

- Solving exercises and problems, individually and in groups.

- Individual tutorials: personal consultations from the student to the teacher about doubts and difficulties arising in the study and in problem solving or discussion on topics of interest, bibliography, etc.

EVALUATION

Evaluation will consist of the following three items:

1) Item 1: Written exams, of problems and questions. On the one hand, the comprehension of the



theoretical-conceptual aspects and the formalism of the subject will be evaluated, both through theoretical questions and through conceptual questions or cases simple individuals. On the other hand, the application of formalism will also be evaluated, through problem solving and critical capacity regarding the results obtained. In any case, a correct argument and an adequate justification will be valued. To pass the course, a minimum score of 4 points out of 10 must be achieved on Item 1.

2) Item 2: Participation in tasks or tests proposed by the teacher will be valued. This item has a weight of 10% in the final grade.

3) Item 3: Participation in the seminars will be evaluated. This item has a weight of 10% in the final grade.

The activities described in items 2) and 3) are considered non-recoverable, that is, the scores obtained in the corresponding blocks will be kept in the two calls of the academic year in which they have been carried out.

REFERENCES

- CÁLCULO VECTORIAL, J.E. Marsden y A.J. Tromba, Pearson/Addison Wesley, 5ª Edición, 2004.
- CÁLCULO. VARIAS VARIABLES, G. B. Thomas, Pearson/Addison Wesley, 13ª Edición, 2015.
- CÁLCULO, L.E. Larson, R.P. Hostetler y B.H. Edwards, McGraw-Hill, 8ª Edición, 2006.
- PROBLEMAS DE CÁLCULO VECTORIAL E. Aranda y P. Pedregal, 3ª Edición, 2013. Disponible en descarga gratuita en http://matematicas.uclm.es/earanda/?page_id=152

Additional Bibliography

- ANÁLISIS MATEMÁTICO, T.M. Apostol, Editorial Reverté, 1977.
- VECTOR ANALYSIS VERSUS VECTOR CALCULUS, A. Galbis y M. Maestre, Springer, 2012.
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- CÁLCULO EN VARIAS VARIABLES, I. Uña, J. San Martín, V. Tomeo, 1ª Edición, Garceta, 2011.
- PROBLEMAS DE ANÁLISIS MATEMÁTICO, Vol. 1 y 2, F. Bombal, L. Rodríguez, G. Vera, 1ª Edición, Electrolibris, 2017.