COURSE DATA

DATA SUBJECT

Code: 34239
Name: Calculus II
Cycle: Undergraduate Studies
ECTS Credits: 6
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1105 - Degree in Physics	Facultat de Física	1	Second quarter
1929 - Double Degree Program in Physics and Chemistry	Facultat de Física	1	Second quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1105 - Degree in Physics	Mathematics	BASIC
1929 - Double Degree Program in Physics and Chemistry	Primer Curso (Obligatorio)	COMPULSORY

COORDINATION

OLMO ALBA GONZALO

MARTINEZ GARCIA DOMINGO

SUMMARY

Mathematics is the language of physics, so it is necessary to know the appropriate "grammar" to use it. With this premise, the aim of the course is to familiarize the students with a part of this language, referring to differential and integral calculus with real functions of several real variables. Much of the power of calculus and the need for their studies steems from a wide variety of practical applications in physics but also in other more applied sciences. Within the first degree course the course "Calculus II" provides mathematical tools of differential and integral functions of several variables used in the subjects included in the field "Physics". Within the degree, the concepts developed in the course are useful in almost all subjects.

Descriptors in the curriculum (for Calculus I and II):

Elementary functions of one variable, limits and continuity, differentiation, numerical and power series, Taylor series, integration, functions of several variables, limits and continuity, line and surface integrals, integral theorems (Gauss and Stokes).

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

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

OTHER REQUIREMENTS

Students taking the course should have basic knowledge in calculus with real functions of a real variable. That is, should be familiar with the concepts of derivative and integral and its use and applications in elementary functions. The background required by the student may be acquired in studying the subjects of mathematics and physics which are taught in high school, in addition to the Calculus I course taught in the first term.

COMPETENCES / LEARNING OUTCOMES

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Be able to understand and master the use of the most commonly used mathematical and numerical methods.

Communication Skills (written and oral): Being able to communicate information, ideas, problems and solutions through argumentation and reasoning which are characteristic of the scientific activity, using basic concepts and tools of physics.

Foreign Language skills: Have improved command of English (or other foreign languages of interest) through: use of the basic literature, written and oral communication (scientific and technical English), participation in courses, study abroad via exchange programmes, and recognition of credits at foreign universities or research centres.

Modelling & Problem solving skills: be able to identify the essentials of a process / situation and to set up a working model of the same; be able to perform the required approximations so as to reduce a problem to an approachable one. Critical thinking to construct physical models.

Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.

Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.

Students must have acquired knowledge and understanding in a specific field of study, on the basis of general secondary education and at a level that includes mainly knowledge drawn from advanced textbooks, but also some cutting-edge knowledge in their field of study.

Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.

To know how to apply the knowledge acquired to professional activity, to know how to solve problems and develop and defend arguments, relying on this knowledge.

DESCRIPTION OF CONTENTS

1. Differential Calculus in Rn

Paths in Rn. Differentiation of composite functions: chain rule. Directional derivatives and gradient. Geometric interpretation. Implicit function theorem. Inverse function theorem.

2. High-order derivatives. Extrema

High-order derivatives. Taylors formula in Rn. Extrema values and saddle points. Hessian matrix. Constrained extrema and Lagrange multipliers.

3. Multiple integrals

Double integral over a rectangle. Double integral over an elementary region. Change of variable for double integrals. Polar coordinates. Triple integrals. Change of variable for triple integrals. Cylindrical and spherical coordinates. Applications of multiple integrals.

4. Vector fields

Vector fields. Field lines. Differential operators and its properties: gradient, divergence, curl and Laplacian. Geometric interpretation of divergence and curl. Curvilinear coordinates: vectors and operators.

5. Integrals over paths and surfaces

Path integrals for scalar functions. Applications. Line integrals for vector fields. Conservative fields. Integrals of scalar functions over surfaces. Applications. Surface integral of vector fields. Greens theorem in the plane. Stokess and Gauss-Ostrogradski theorems.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Tutorials	15,00
Theory	45,00
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

Classroom teaching (40%):

Theoretical and practical classes: they address the conceptual and formal aspects of the subject, and resolution of problems or cases as the application of theoretical concepts. They are based mainly on lectures and the use of teaching tools as graphical representation of solutions, slide presentations, calculation software, etc.

Group tutorials or small group work sessions: focus on active student participation and their work: resolution of doubts arising when facing theoretical concepts and problem solving, reinforcement in aspects of greater difficulty, conceptual quizzes, experimental demonstrations relevant to the cases studied and, associated with an ongoing evaluation, verification of the student's progress in the subject.

Student's personal work (60%):

- Study of the theoretical concepts.

- Resolution of exercises and problems, individually and in groups.

- Individual tutorials: occasional queries from the student to the teacher about doubts and difficulties encountered in the study and in the resolution of problems or discussion on topics of interest, bibliography, etc.

EVALUATION

The evaluation systems are the following:

1) Written exams: on the one hand, the understanding of the theoretical-conceptual aspects and the formalism of the subject will be evaluated, both through theoretical questions and through conceptual and numerical questions or simple particular cases. 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 adequate justification will be valued.

2) Continuous evaluation: assessment of work and problems presented by students, questions proposed and discussed in the classroom, oral presentation of solved problems or any other method that involves an interaction between teachers and students. The average of the two types of evaluation, written exams and continuous evaluation, will be obtained, using a maximum of 30% for continuous evaluation, provided that a minimum of 4 out of 10 is obtained in the written exam. The final grade will be the maximum value of the exam grade and the average with the continuous evaluation.

These evaluation criteria will be applied to the two evaluation calls available during an academic year.

In total, the grade necessary to pass the course is 5 out of 10.

NB: It is possible to pass the subject via compensation with other subjects of the same branch, if the criteria for compensation are fulfilled.

REFERENCES

Basic:

- CÁLCULO VECTORIAL, J.E. Marsden y A.J. Tromba, Pearson/Addison Wesley, 5ª Edición (2004) o 6ª Edición (2018)
- CÁLCULO. VARIAS VARIABLES, G. B. Thomas, Pearson/Addison Wesley, 12ª Edición (2010) o 13ª Edición (2015).

Additional:

- MATHEMATICAL METHODS FOR PHYSICS AND ENGINEERING, K.F. Riley, M.P. Hobson, S.J. Bence, 3rd edition, Cambridge University Press, 2006.
- CALCULUS. EARLY TRANSCENDENTALS, J. Stewart, 6th edition, Thomson, 2008.
- CALCULUS. UNA Y VARIAS VARIABLES, Vol. II. S.L. Salas, E. Hille, G.J. Etgen, 4ª edición, Reverté, 2002.
- CALCULO. VARIAS VARIABLES. J. Rogawski, 2ª edición, Reverté, 2012.
- CÁLCULO EN VARIAS VARIABLES, I. Uña, J. San Martín, V. Tomeo, 1ª Edición, Garceta, 2011.
- 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
- PROBLEMAS Y EJERCICIOS DE ANÁLISIS MATEMÁTICO, B. Demidovich, Paraninfo, 1982.
- CALCULUS, Vol. II, Tom M. Apostol, 2ª Edición, Reverté, 1980.