

**COURSE DATA****Data Subject**

<b>Code</b>	34239
<b>Name</b>	Calculus II
<b>Cycle</b>	Grade
<b>ECTS Credits</b>	6.0
<b>Academic year</b>	2021 - 2022

**Study (s)**

<b>Degree</b>	<b>Center</b>	<b>Acad. year</b>	<b>Period</b>
1105 - Degree in Physics	Faculty of Physics	1	Second term
1929 - D.D. in Physics-Chemistry	Double Degree Program Physics and Chemistry	1	Second term

**Subject-matter**

<b>Degree</b>	<b>Subject-matter</b>	<b>Character</b>
1105 - Degree in Physics	2 - Mathematics	Basic Training
1929 - D.D. in Physics-Chemistry	1 - Primer Curso (Obligatorio)	Obligatory

**Coordination**

<b>Name</b>	<b>Department</b>
HERRERO GARCIA, JUAN ANDRES	185 - Theoretical Physics
MARTINEZ GARCIA, DOMINGO	175 - Applied Physics and Electromagnetism

**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 student 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 stems 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 Mathematics II and Physics, which are taught in high school, in addition to the Calculus I course taught in the first term.

## OUTCOMES

### 1105 - Degree in Physics

- 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.
- Be able to understand and master the use of the most commonly used mathematical and numerical methods.
- 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.
- 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.
- 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.
- 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 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 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.
- Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.
- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

## LEARNING OUTCOMES

- Understand the concepts of limit, derivative and integral. Become familiar with differential calculus and integral functions of several variables.
- Calculate derivatives of functions of several variables. Understand and use the concepts of partial derivatives obtain Taylor expansions of functions of several variables and study of critical points. Using curvilinear coordinate systems and become familiar with the use of operators differential (gradient, divergence and curl) in polar coordinates, cylindrical and spherical.
- Learning to solve integrals of functions of several variables, line integrals and integrals surface. Know and apply the change of variable theorem, Green, Stokes, and Gauss-Ostrogradski. Knowing how to solve problems and applications that require the use of integrals (lengths, areas, volumes, centers of gravity, moments of inertia, etc.).
- Use software to calculate derivatives and integrals.

## DESCRIPTION OF CONTENTS

### 1. Differential Calculus in $R^n$

Paths in  $R^n$ . 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  $R^n$ . 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. Stokes and Gauss-Ostrogradski theorems.

**WORKLOAD**

ACTIVITY	Hours	% To be attended
Theory classes	45,00	100
Tutorials	15,00	100
Development of individual work	5,00	0
Study and independent work	75,00	0
Preparation of evaluation activities	10,00	0
<b>TOTAL</b>	<b>150,00</b>	

**TEACHING METHODOLOGY**

Contact 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 dialogued teaching tools as graphical representation of solutions, design presentations, spreadsheet Programs, etc.

Group tutoring sessions in small groups or work: focus on active student participation and their Work: Resolving Doubts in Theoretical concepts and problem solving, reinforcement in areas of greatest Difficulty, Questionnaires conceptual, relevant experimental Demonstrations and case studies, and, associated With A Ongoing evaluation of component, monitoring of student progress in the field.



Student's Personal work (60%):

- Study of the Theoretical concepts.
- Resolution of exercises and Problems, Individually and in groups.
- Individual tutorials: querying of the teacher on student questions and Difficulties Encountered in the study and 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.

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

## 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](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.

## **ADDENDUM COVID-19**

**This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council**

### **TEACHING METHODOLOGY:**

In case that health situation requires blended teaching, the teaching model approved by the Academic Degree Committee on July 23, 2020 will be adopted, consisting of 100% student attendance in all activities, with 50% capacity in classrooms for lectures.

If a total reduction in attendance is necessary, classes will be broadcast by synchronous videoconference at their regular schedule, along the period determined by the Health Authority.