# COURSE DATA

| Data Subject | |
|---|---|
| **Code** | 34239 |
| **Name** | Calculus II |
| **Cycle** | Grade |
| **ECTS Credits** | 6.0 |
| **Academic year** | 2020 - 2021 |

**Study (s)**

| Degree | Center | Acad. year | Period |
|---|---|---|---|
| 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**

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

**Coordination**

| Name | Department |
|---|---|
| MARTINEZ GARCIA, DOMINGO | 175 - Applied Physics and Electromagnetism |
| RIUS DIONIS, NURIA | 185 - Theoretical Physics |

# 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 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 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.
- Capacity to communicate information, ideas, problems and solutions to a specialist and a general audience.
- Developing learning skills so as to undertake further studies with a high degree of autonomy.
- 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.
- Destrezas Generales y Específicas de Lenguas extranjeras: Mejorar el dominio del inglés científico-técnico mediante la lectura y acceso a la bibliografía fundamental de la materia.
- Comunicación oral y escrita: Ser capaz de transmitir información, ideas, problemas y soluciones mediante la argumentación y el razonamiento propios de la actividad científica.

## 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 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

| 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 |
| **TOTAL** | **150,00** | |

## 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 dialogic teaching tools as a 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 assessment system is as follows:

1) Written exam: One part will assess the understanding of the theoretical-conceptual and formal nature of the subject, both through theoretical questions, conceptual questions and numerical or simple particular cases. Another part will assess the applicability of the formalism, by solving problems and critical capacity regarding the results. Anyway, proper argumentations and adequate justifications will be taken into account.

In the case of separate theory and problem exams, the minimum grade to average between them is 3,5 out of 10.

2) Continuous assessment: assessment of exercises and problems presented by students, questions proposed and discussed in classroom, oral presentation of problems solved or any other method that involves an interaction with students.

The final grade will be obtained from the average of the two types of written and continuous assessment, using a maximum of 30% for continuous assessment, provided that a minimum grade of 4 out of 10 is achieved on the written exam. The final grade needed to pass the subject will be 5 out of 10.

COMMENTS: Subject to compliance with the compensation criteria established for this purpose, note this course can be averaged with other belonging to the same subject (Calculo I), so as to pass the course.

## 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.

## ADDENDUM COVID-19

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

## English version is not available

METODOLOGÍA DOCENTE:

Durante el mes de febrero 2021, la docencia de teorías y seminarios-trabajos tutelados, pasan a modalidad de videoconferencia síncrona impartida en el horario fijado por la asignatura y el grupo.

A partir del 1 de marzo, se seguirá la modalidad docente indicada en la Guía Docente y a las modalidades docentes aprobadas en las Comisiones Académicas de Título de los meses de julio 2020 y noviembre 2020, respectivamente, salvo que las autoridades sanitarias y Rectorado indican una nueva reducción de presencialidad, en cuyo caso se volvería a la modalidad de videoconferencia síncrona.