Bachelor in Physics
(Academic Year 2025/26)

Calculus II		Code	808256	Year	1st	Sem.	2nd
Module	Basic Core	**Topic**	Mathematics			**Character**	Obligatory

	Total	Theory	Exercises
ECTS Credits	7.5	4.5	3
Semester hours	70	40	30

Specific course contents

Limits, partial derivatives, and Taylor expansions in several variables. Analysis of functions of several variables. Gradient, divergence, and curl. Line integrals. Surface and volume integrals. Fundamental theorems.

Prerequisites

It is necessary to have knowledge of differential and integral calculus of real functions of a single variable. The student must understand the meaning, and be able to calculate, the limits, derivatives and integrals of real functions of a single variable, as well as their Taylor's series expansion and characterize their extremes.

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Theory/Problems – Schedule and Teaching Staff

Group	Lecture Room	Day	Time	Professor	Period/ Dates	Hours	T/E	Dept.
B	7	Tu We Th	10:30 – 12:00 11:00 – 13:00 9:30 – 11:00	Joaquín López Herráiz	January - March	42	T/E	EMFTEL
				Alberto Domínguez Díaz	March-May	28	T/E	EMFTEL

T: Theory, E: Exercises

Office hours

Group	Professor	Schedule	E-mail	Location
B	Joaquín López Herráiz	1er. semestre X:11:00-14:00 J:11:00-14:00 2º semestre X:14:00-17:00 J: 11:00-14:00	jlopezhe@ucm.es	03.235.0

	Alberto Domínguez Díaz	J:13:00-19:00 V: 9:00-12:00	alberto.d@ucm.es	03.219.0

Syllabus

1. **Differential calculus.**
   - Functions with real values: graphs and level curves.
   - Limits and continuity.
   - Partial derivatives and differentiability. Chain rule.
   - Gradient and directional derivatives.
2. **Maximum and minimum.**
   - Higher order derivatives. Taylor's theorem.
   - Extrema of a function with real values.
   - Restricted extrema: Lagrange multipliers.
   - Implicit function theorem.
3. **Functions with vector values.**
   - Trajectories, speed, acceleration.
   - Vector fields. Divergence and curl.
   - Vector differential calculus.
4. **Double and triple integrals.**
   - Double integral over rectangular regions. Integrability.
   - Double integral over more general regions.
   - Triple integrals.
   - Change of variables.
5. **Integrals over curves and surfaces.**
   - Integral of a function (scalar or vector) along a curve.
   - Parameterized surfaces. Area of a surface.
   - Integral of a function (scalar or vector) over a surface.
6. **Integral theorems of vector calculus.**
   - Green's theorem.
   - Stokes' theorem.
   - Conservative vector fields.
   - Gauss's theorem.

Bibliography

Basic:

- J.E.Marsden and A.J.Tromba, Vector Calculus, W. H. Freeman; Sixth edition, 2012.
- R.Larson, R.P.Hostetler and B.H.Edwards, *Calculus II. H*oughton Mifflin Company; 8th edition (2005).

Complementary:

- James Stewart, Multivariable Calculus, Cengage Learning; 8th edition, 2015.
- Ron Larson and Bruce H. Edwards, Multivariable Calculus, Cengage Learning; 11th edition (2017)

Online Resources

Virtual Campus: Documents (pdf), Exercises, Forum

Online Classes: Microsoft Teams (within the Virtual Campus). Alternatively: Google Meet

Computation Online: Matlab Online (available using the UCM email account) and Google Colab (Python)

Other: Kahoot (for short exercises) and Google Drive (for sharing large videos).

Methodology

Theory lectures will focus on the main concepts, including examples and applications and many problems will also be solved. Classes will be taught using the blackboard and sometimes with a computer and a projector.

Students will receive in advance a set of exercises to be discussed in class.

Students will receive exam copies from previous years.
All the materials will be available on the Virtual Campus.

Evaluation Criteria

Exams	Weight:	75%

Midterm Exam: Yes Eliminatory: No Weight of the midterm exam: 40%

Final mark for the Exams section: $N_{Exam} = \max \{ N_{Final}, 0.4\, N_{Partial} + 0.6\, N_{Final}\}$

where $N_{Partial}$ is the mark obtained on the midterm exam and N_{Final} is the mark obtained on the final exam, both between 0 and 10.

Minimum mark on the final exam for weighting: $N_{Final} \geq 4$. If this condition is not met, the course will not be passed.

According to the faculty board's agreement, at least 60% of the first-year midterm and final exams must be shared by all groups.

Other Activities	Weight:	25%

In the “Other Activities” section some of the following activities may be evaluated:

• Delivery of problems and exercises, individual or in groups, which may be done or be solved during the classes.

• Additional tests, written or oral, always as a voluntary basis.

The grade obtained in this section will also be taken into account in the extraordinary call.

The final mark for this section will be $N_{OtherActiv}$ and will range from 0 to 10.

Final Mark

Final mark:

$$C_{Final} = \max \{0.75 N_{Exam} + 0.25 N_{OtherActiv}, N_{Exam}\}$$

Minimum mark on the final exam for weighting: $N_{Final} \geq 4$

The final mark criterion, as well as the mark corresponding to other activities, will be maintained in the exam of the extraordinary call.

Learning and Training Outcome (according to the Degree's Verification Document)
● CON01: Identify the physical, mathematical, experimental and computational basis of the different fields in Modern Physics. ● HD04: Develop models to describe physical phenomena through well-defined approximations. ● HD05: Apply mathematical methods to problem solving in Physics. ● HD06: Apply critical thinking to problem analysis and resolution. ● HD08: Organize time and resources autonomously to acquire new knowledge.