Bachelor in Physics
(Academic Year 2022-23)

Calculus		Code	800493	Year	1st	Sem.	2nd
Module	Basic Core	Topic	Mathematics			Character	Obligatory

	Total	Theory	Exercises
ECTS Credits	7.5	4.5	3
Semester hours	69	39	30

Learning Objectives (according to the Degree's Verification Document)

1. Develop the ability to calculate and manage limits, partial derivatives, and multivariable Taylor's series expansion.
2. Learn how to analyze functions of several variables and characterize their extrema.
3. Learn how to calculate and manage the gradient of a function, as well as the divergence and the curl of a vector field.
4. Learn how to calculate curvilinear, surface, and volume integrals, as well as how to apply the fundamental theorems that relate them.

Brief description of contents

Differential and integral calculus with several variables.

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.

Coordinator	Miguel Ángel Rodríguez González		Dept.	FT
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Theory/Exercises – Schedule and Teaching Staff

Group	Lecture Room	Day	Time	Professor	Period/ Dates	Hours	T/E	Dept.
B	8	Tu We Th	10:30-12:00 11:00-13:00 9:30-11:00	Joaquín López Herraiz	Januari - April	41	T/E	EMFTEL
				Raúl González Jiménez	April & May	28	T/E	EMFTEL

T: Theory, E: Exercises

Office hours

Group	Professor	Schedule	E-mail	Location
B	Joaquín López Herraiz	Tu: 15:00-17:00 Th: 11:00-13:00	jlopezhe@ucm.es	235. 3rd floor
	Raúl González Jiménez	Mo: 10:00-12:00 We, Th: 14:00-16:00	raugon06@ucm.es	3rd floor, central- north no office number

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. **Double and triple integrals.**
   - Double integral over rectangular regions. Integrability.
   - Double integral over more general regions.
   - Triple integrals.
   - Functions from $\mathbf{R}^2$ to $\mathbf{R}^2$. Change of variables.
4. **Functions with vector values.**
   - Trajectories, speed, acceleration.
   - Vector fields. Divergence and curl.
   - Vector differential calculus.
5. **Integrals over curves and surfaces.**
   - Integral of a function (scalar or vector) along a curve.
   - Arc length
   - 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

The following formative activities will be developed:

• Theory lectures, which will focus on the main concepts, including examples and applications (approximately 3 hours per week)

• Practical classes of exercises (2 hours per week on average)

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.

For questions or more thorough explanations, students will be able to visit the professor during the specified office hours. It is highly recommended the use of these tutoring classes for a better use of the course.

Students will receive exam copies from previous years.

All the materials will be available on the Virtual Campus.

Evaluation Criteria

Exams	Weight:	75%

A partial exam will be held approximately at mid-semester, in addition to the final exam. The contents evaluated in the partial exam will be subject to evaluation also in the final exam, regardless of the grade that the student may have obtained in the partial exam.

If the score obtained in the partial exam is “P”, and the score obtained in the final exam is “F”, both on a scale of 0-10, then the total exam grade is obtained by applying the following formula:

$$E=\max(F, 0.4*P+0.6*F)$$

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 in September.

Final Mark

A grade greater than or equal to 4 in the final exam (F) and greater or equal to 5 in the final mark (FM) is required to pass the course.

The final mark is the best score of the options as follows:

$$FM = \max (E, 0.75*E + 0.25*A)$$

where A corresponds to the score obtained in Other Activities, and E to the exam score. The final mark in the extraordinary call will be obtained following exactly the same assessment procedure.