Bachelor in Physics
(Academic Year 2021-22)

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	67.5	37.5	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.

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Theory/Exercises – Schedule and Teaching Staff

Group	Lecture Room	Day	Time	Professor	Period/ Dates	Hours	T/E	Dept.
B	2	Tu We Th	10:30-12:00 11:00-13:00 9:30-11:00	Joaquín López Herraiz	February, March & April	40	T/E	EMFTEL
				Raúl González Jiménez	April & May	27.5	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

On-campus teaching 100% (Scenario 0)

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.

Semi-online teaching (Scenario 1)

In this group (Calculus in English) we will use Modality B (Modalities A and B are described in the document approved by the Faculty Board on June 26, 2020). This way it will be easy to switch to fully online education if needed, and the face-to-face interactions will be focused on the topics more difficult to address online.

In this scenario, presence classes will be carried out with a reduced number of students. The group of students attending the presence classes will rotate, so that all students have the same number of these sessions. These face-to-face classes will be focused on answering questions and solving exercises. The Virtual Campus will be used to share documents with the theory of each chapter in pdf format and videos with detailed explanations of the main concepts of each topic and solutions of some exercises. These materials will be connected with the topics seen in the presence classes.

Additionally, other resources of the Virtual Campus (such as the Forum for answering questions and making them available for all students) will be extensively used. Tutoring will be answered by email whenever possible.

Online teaching (Scenario 2)

The teacher will extensively use the Virtual Material Campus with explanations of each subject recorded in advance or broadcasted synchronously using Microsoft Teams.

This material will guarantee the same competences acquisition as the presence theoretical classes.

Teaching material will be made available to students via the Virtual Campus and Google Drive.

Tools will be used for live collective communication such as Microsoft Teams and Google Meet.

The use of the Virtual Campus forums will be encouraged for student questions and the subsequent answers will be used by the rest of the students.

The resources of the Virtual Campus (Forum for answering questions and making them available for all students, and Microsoft Teams for Online Classes) will be extensively used.

Tutoring will be answered by email whenever possible.

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. A grade greater than or equal to 4 out of 10 in the final exam is required to pass the course.

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

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 in July will be obtained following exactly the same assessment procedure.