Bachelor in Physics
(Academic Year 2024/25)

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	Luis Antonio Fernández Pérez		**Dept.**	FT
	Room	03.320.0	**e-mail**	lsntnfp@ucm.es

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	41	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	M: 15:00-17:00 J: 11:00-13:00	jlopezhe@ucm.es	03.235.0
	Alberto Domínguez Díaz	L: 10:00-12:00 X,J: 14:00-16:00	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%
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:		

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

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.