Bachelor in Physics
(Academic Year 2021-22)

Mathematical Methods II	**Code**	800505	**Year**	2nd	**Sem.**	2nd
Module	General Core	**Topic**	Mathematical Methods in Physics	**Character**	Obligatory	

	Total	**Theory**	**Exercises**
ECTS Credits	6	3.5	2.5
Semester hours	54	29	25

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

- To use basic partial differential equations in Physics, to know their scope and to dominate fundamental techniques to obtain solutions.
- To learn Fourier analysis methods and its applications to differential equations.
- To get knowledge of most of the special functions used in Physics and their physical properties.

Brief description of contents

Partial differential equations. Fourier series and transformations. Boundary problem resolution. Special functions.

Prerequisites

Calculus on one and various variables functions. Linear ordinary differential equations.

Coordinator	Piergiulio Tempesta		**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	7	Mo Th	12:00-14:00 10:00-12:00	Manuel Mañas Baena	Full semester	42	T/E	FT
				Mindaugas Karciauskas	Full semester	12	E	

T: Theory, E: Exercises

Office hours

Group	Professor	Schedule	E-mail	Location
B	Manuel Mañas Baena	Tu, We, Fr: 12:00 - 13:00 (+ 3 h online)	manuel.manas@ucm.es	Office 10 2nd floor West
	Mindaugas Karciauskas	We: 14:00-17:00 + 3 h online	mindaugas.k@ucm.es	234.0 3ª planta, oeste

Syllabus

1. Introduction to partial differential equations (PDEs). First order PDEs. Second order linear PDEs. Boundary and initial value problems. The equations of Mathematical-Physics. The wave equation.

2. Series solutions for second order linear ODEs and special functions. Regular point and regular singular points. Hermite, Legendre and Bessel equations.

3. Boundary value problems for ODE. Fourier series and Fourier transform. Eigenvalues and eigenfunctions. Sets of orthogonal functions. Eigenfunction series expansions. Fourier trigonometric series. Convergence. Inhomogeneous problems. Fourier transforms.

4. EDP: method of separation of variables and eigenfunction expansion method. Homogeneous and non-homogeneous problems for the equations of Mathematical Physics (heat, wave, Laplace, Schrödinger, ...). Cartesian, polar, cylindrical and spherical coordinate problems.

Bibliography

Basic:

- Partial Differential Equations: An Introduction, Walter A. Strauss. John Wiley & Sons
- Introduction to Partial Differential Equations, Peter Olver. Sringer 2016.
- *Applied Partial Differential Equations with Fourier Series and Boundary Value Problems.* Richard Haberman. Pearson Education Limited (2013).
- *Boyce's Elementary Differential Equations and Boundary Value.* William E. Boyce, Richard C. DiPrima, Douglas B. Meade. John Wiley & Sons Inc (2017).

Complementary:

- *Partial Differential Equations*, Peter J. Olver, Springer
- *Fourier Series.* Georgi Tolstov. Dover
- *Ecuaciones Diferenciales II*. Manuel Mañas Baena y Luis Martínez Alonso. (http://eprints.ucm.es/31464/1/Manuel.pdf

Online Resources

We will use the UCM's Moodle facility (Campus Virtual)

Methodology

On-campus teaching 100% (Scenario 0)

We will follow the material uploaded to the Moodle platform. In particular, The professor lecture notes. The classes will be divided in theoretical and practical, solving in these last ones' exercises from the professor lecture notes.

Semi-online teaching (Scenario 1)

All groups, in at least part of the course, will follow modality A with semi-face-to-face theory and problem classes, live broadcasting the audio and the standard or digital blackboard or transparencies that are used, as well as solving the doubts raised in the classroom and through the internet in the other subgroup.

Throughout the course, some group may pass to modality B, publishing in advance recorded videos on theoretical content and / or practical material in audiovisual or written format and dedicating the face-to-face hours to additional theoretical explanations and, above all, to solving more problems. Classe, in essence, would be repeated the following week for the other half of students.

Tutorials sessions will be carried out in person if the conditions allow it, or remotely by email or in Microsoft Teams/Google Meet sessions at the established times.

Online teaching (Scenario 2)
Theoretical classes and problems taught through videos posted on the Moodle facility, or streaming through the use of online tools that will broadcast during class time and will be available to students on Moodle. Written and audiovisual material will be provided to complement the classes. Questions will be resolved by email and through online tutoring at the corresponding time.

Evaluation Criteria		
Exams	**Weight:**	65%
The final exam (ordinary or extraordinary in July) consists in the resolution of a number or practical problems that the student must solve using the knowledge learned throughout the course. The mark of the exam, say *E,* will vary from 0 to 10. A score *E* bigger than 5 means that the student has passed the subject. In other to apply the marks obtained in other activities the mark *E* must be bigger than 3.5.		
Other Activities	**Weight:**	35%
Continuous evaluation activities of any of these types will be carried out: • Delivery of problems throughout the course individually or in groups. • Individual realization of evaluable problems during class hours. The final grade *A* of other activities will be a number between 0 and 3.5 points. This note will be considered in the extraordinary call for July.		
Final Mark		
If *E* is the score of the final exam and *A* the final grade of other activities, the final grade C_F will be given (if $E \geq 3.5$) by the following formula $$C_F = \text{Max}\ (A + 0.65 * E,\ E)$$		