Bachelor in Physics
(Academic Year 2021-22)

Mathematical Methods I		**Code**	800504	**Year**	2nd	**Sem.**	1st
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 analyze and solve ordinary differential equations and linear systems of ordinary differential equations
- To understand the concept of complex variable analytic function and to learn its fundamental properties. To learn to use the residue theorem for integral calculus.

Brief description of contents

Ordinary differential equations. Systems of ordinary differential equations. Complex variable functions.

Prerequisites

Calculus of one and various real variables functions. Linear algebra.

Coordinator	Federico Finkel Morgenstern		**Dept.**	Theoretical Physics
	Room	Office 20, West wing, 2nd floor.	**e-mail**	ffinkel@fis.ucm.es

Theory/Exercises – Schedule and Teaching Staff

Group	Lecture Room	Day	Time	Professor	Period/ Dates	Hours	T/E	Dept.
B	10	Tu, Wed Fr	12:00-13:00 12:00-13:30 11:00-12:30	Luis J. Garay Elizondo Valentín Boyanov Savov	Whole semester	49,0 5,0	T/E E	Theoretical Physics

T: Theory, E: Exercises

Office hours

Group	Professor	Schedule	E-mail	Location
B	Luis J. Garay Elizondo	We: 9:00-12:00 Fr: 9:00-11:00 & 12:30-13:30	luisj.garay@ucm.es	Office 16, West wing, 2nd floor.
	Valentín Boyanov Savov	Tu, Th: 14:00-15:00 on site Fr: 12:00-13:00 online	vboyanov@ucm.es	Office 15, West wing, 2nd floor

Syllabus

ORDINARY DIFFERENTIAL EQUATIONS

1. **Introduction** to ordinary differential equations and systems of ordinary differential equations. Solutions. Basic integration methods for first order equations. Existence and uniqueness of solutions.
2. **Linear equations.** Second order linear equations. Homogeneous equations. Nonhomogeneous equations. Method of variation of constants. Equations with constant coefficients. Higher order linear equations.
3. **Linear systems.** Homogeneous systems. Nonhomogeneous systems. Method of variation of constants. Systems with constant coefficients. Matrix exponential.

COMPLEX VARIABLE

1. **Analytic functions.** Definition and algebraic properties of complex numbers. Elementary functions. Differentiability. Cauchy–Riemann equations.
2. **Cauchy theorem.** Contour integrals. Cauchy theorem. Cauchy integral formula and its consequences.
3. **Series.** Power series. Taylor theorem. Laurent series. Laurent theorem. Classification of isolated singular points.
4. **Residues.** Residue theorem. Methods for calculating residues. Definite and improper integrals using the residue theorem.

Bibliography

- Boyce, W.E., DiPrima, R.C., Elementary Differential Equations and Boundary Value Problems, 11th ed., Wiley, 2016.
- Marsden, J.E. y Hoffman, M.J., Basic Complex Analysis, 3rd ed., Freeman, 1999.
- Simmons, G.F., Differential Equations with Applications and Historical Notes, 3rd ed., Chapman and Hall/CRC, 2016
- Spiegel, M.R., Schaum's Outline of Complex Variables, 2nd ed., McGraw-Hill, 2009

Online Resources

- https://sites.google.com/site/luisjgaray/

Methodology

On-campus teaching 100% (Scenario 0)

• Theory lectures to present and explain the basic concepts, examples and apllications (2.5 hours per week approx.)

• Problem-solving sessions (1.5 hours per week approx.)

Both types of sessions will be carried out mostly in the blackboard although the lecturer may also use other tools including, for instance, computer presentations.

• Tutorials for individual students or small groups with the aim of explaining and solving doubts.

• Handouts will be available in the web page prior to the corresponding problem-solving sessions as well as other teaching material

Semi-online teaching (Scenario 1)

I will follow "Modalidad A" according to the "Documento de Medidas extraordinarias de planificación y organización docente para el curso 2020-21" with the methodology proposed for "Escenario 0". The professor will give his lectures as usual ("Escenario 0") but only one subgroup of students will attend in person, rotating every week. The rest of the students will follow the lessons online via Microsoft Teams, Google Meet or a similar tool, together with one of the following methods: slide presentations, traditional blackboard (with image broadcast) or other electronic method.

Besides, the student will have accesss ---via the web page--- additional teaching material which might include lecture notes, solved exercises, etc.

Online teaching (Scenario 2)

I will give online live lectures via Google Meet or Microsoft Teams with the methodology proposed for "Escenario 0". The corresponding recordings will be available to the students in the "Campus Virtual".

Besides, the student will have accesss ---via the web page--- to additional teaching material which might include lecture notes, solved exercises, etc.

The tutorials will take place in the same manner as in "Escenario 0" except they will be online.

Evaluation Criteria

Exams	Weight:	70%
Final exam.		
Other Activities	**Weight:**	30%
Problems and exercises evaluated by means of partial exams or by presenting their solution in the classroom.		

Final Mark

If the final exam score is higher than 3.5, then the final mark FM obtained by the student will be calculated using the following formula:

$$FM = \max(E, 0.7\,E + 0.3\,A),$$

where E and A are the marks in the final exam and in the other activities, respectively, both in the 0-10 scale.