Bachelor in Physics
(Academic Year 2022-23)

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	55	30	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	02.0311.0	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 Álvaro Álvarez Domínguez	Whole semester	42 13	T/E E	Theoretical Physics

T: Theory, E: Exercises

Office hours

Group	Professor	Schedule	E-mail	Location
B	Luis J. Garay Elizondo	1st. semester: We: 9:30-12:30, Th: 9:30-11:30, Fr: 12:30-13:30 2nd. semester: We: 9:30-15:30	luisj.garay@ucm.es	Office: 02.0315.0
	Álvaro Álvarez Domínguez	1st. semester: Tu: 14:00- 15:30, Fr: 12:30-14:00 2nd. semester: We: 11:30-13:00, Th: 11:30-13:00	alvalv04@ucm.es	Office 02.0329.0

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

• 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

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.		