Course guide
230456 - MM1 - Mathematical Methods I

Last modified: 11/04/2025

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 749 - MAT - Department of Mathematics.

Degree: BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: RAFAEL RAMIREZ ROS

Others:

PRIOR SKILLS

Calculus of one variable (derivatives, integrals, and power series), and linear algebra (linear maps and diagonalization).

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Ability to solve math problems that may arise in engineering. Ability to apply knowledge about linear algebra, geometry, differential geometry, differential and integral calculus, ordinary and partial differential equations, probability and statistics.
2. Ability to select numerical and optimization methods suitable for solving physical and engineering problems. Ability to apply the knowledge of numerical algorithms and optimization.

Generical:
3. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

Transversal:
4. EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 1. Identifying information needs. Using collections, premises and services that are available for designing and executing simple searches that are suited to the topic.

TEACHING METHODOLOGY

Five hours per week of class attendance. Realization of an optional work about a free topic.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course, the student should be able: 1) To solve several simple ODEs (first-order linear ODEs, separable ODEs, exact ODEs, n-th order linear ODEs with constant coefficients, etc.); 2) To solve linear ODEs by using the Laplace transform; 3) To solve (and to draw the phase portrait of) 2D and 3D systems of linear ODEs with constant coefficients; 4) To draw local and global phase portraits of 2D and 3D systems of nonlinear ODEs; and 5) To model physical, chemical, biological, and geometrical problems with ODEs.

STUDY LOAD

Type	Hours	Percentage
Hours large group	65,0	43.33
Self study	85,0	56.67

Total learning time: 150 h

CONTENTS

Solving first-order ODEs

Description:
First-order EDOs: separable, linear, Bernoulli, Ricatti, exact, etc. Applications: snow plow, radioactive decay, Newton's law of cooling,Torricelli's law, logistic equation, etc.

Full-or-part-time: 29h
Practical classes: 12h
Self study : 17h

Systems of linear ODEs

Description:
Resolution and classification of systems of linear EDOs to constant coefficients. Applications: Problems of connected deposits, connected spring problems, Wilberforce pendulum, etc.

Full-or-part-time: 41h
Theory classes: 18h
Self study : 23h

Laplace Tranaform

Description:
Definition and computation of Laplace transforms. Application to solving linear ODEs. Dirac's delta.

Full-or-part-time: 16h
Practical classes: 7h
Self study : 9h

Systems of nonlinear ODEs

Description:
Case 1D: Phase portraits and bifurcation diagrams. Case 2D: Isoclines, separatrices, limit cycles, trap regions, etc. 3D case: Chaos. Stability of equilibrium points by linearization and by Liapunov. Applications: Pursuit trajectories, biological models, conservative systems with one degree of freedom, pendulum problems, tennis racket theorem, etc.

Full-or-part-time: 48h
Theory classes: 21h
Self study : 27h

n-th order linear ODEs

Description:
Homogeneous linear EDOs with constant coefficients: The characteristic polynomial. Non-homogeneous linear EDOs with constant coefficients: Indeterminate coefficients and variation of constants. Applications: Oscillations, spring problems, etc.

Full-or-part-time: 16h
Practical classes: 7h
Self study : 9h

GRADING SYSTEM

A partial exam, a final exam, and an optional work. The final grade is

FG = min(10, max(FE , 0.3*PE + 0.7*FE) + 0.1*W),

where PE is the grade of the partial exam, FE is the grade of the final exam, and W is the grade of the work.

If the student shows up for reevaluation, then his/her final grade is

RFG = max(FG, min(10, RE + 0.1*W)),

where RE is the grade of the reevaluation exam and W is the grade of the work.

EXAMINATION RULES.

The student can use a sheet of paper (DIN A4 size) written by hand and a list of Laplace transforms. The use of calculators, cellulars or any programable digital device is forbidden.

BIBLIOGRAPHY

Basic:
- Borrelli, R.L.; Coleman, C.S. Ecuaciones diferenciales: una perspectiva de modelación. México: Oxford University Press, 2002. ISBN 9706136118.
- Tenenbaum, M.; Pollard, H. Ordinary differential equations: an elementary textbook for students of mathematics, engineering, and the sciences. New York: Dover Publications, 1985. ISBN 0486649407.
- Zill, D.G. Ecuaciones diferenciales con aplicaciones de modelado. 11a ed. México: Cengage Learning Editores, 2018. ISBN 9786075266312.

Complementary:
- Beltrami, E.J. Mathematics for dynamic modeling. 2nd ed. Boston: Academic Press, 1998. ISBN 0120855666.
- Braun, M. Differential equations and their applications: an introduction to applied mathematics. 4th ed. New York, NY: Springer-Verlag, 1993. ISBN 0387978941.
- Chicone, C. Ordinary differential equations with applications [on line]. 2nd ed. New York, NY: Springer Science+Business Media, 2006 [Consultation: 10/07/2019]. Available on: HTTP://DX.DOI.ORG/10.1007/0-387-35794-7. ISBN 9780387357942.
- Meiss, J.D. Differential dynamical systems. Revised edition. Philadelphia: Society for Industrial & Applied Mathematics, 2017. ISBN 9781611974638.