

Differential Equations and Vector Calculus

Code: 102425
ECTS Credits: 6

Degree	Type	Year	Semester
2500897 Chemical Engineering	FB	2	1

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Teachers

Xavier Mora Giné

Prerequisites

The subject does not officially require any prerequisite, but it is assumed that the student has completed and passed the subjects of "Algebra" and "Differential and integral calculus" of the first year.

Objectives and Contextualisation

It is a basic subject that introduces two of the most important mathematical tools for modeling and solving real problems that appear in engineering: differential equations and vector analysis. It is intended that the student:

- Be able to use the basic analytical methods to obtain solutions of differential equations.
- Be able to distinguish the differential equations that can be solved with analytical methods from those that require numerical methods.
- Be able to extract qualitative information of the solutions of a differential equation of the first order from the vector field of directions.
- Be able to understand the role of differential equations in the mathematical modeling of real problems and be able to build this model in simple situations.
- Gets familiar dealing with functions of several variables and vector fields.
- Be able to deal with curves and surfaces in space and the equations that describe them.
- Understands the meaning of the basic concepts of vector analysis.
- Learns to use the vector analysis tools to identify and calculate physical magnitudes.

- Understands the theorems of vector analysis and their use in the formulation of some physical theories.

Competences

- Apply relevant knowledge of the basic sciences, such as mathematics, chemistry, physics and biology, and the principles of economics, biochemistry, statistics and material science, to comprehend, describe and resolve typical chemical engineering problems.
- Develop personal work habits.

Learning Outcomes

1. Apply the methods for solving differential equations to the analysis of deterministic phenomena.
2. Develop independent learning strategies.
3. Identify, analyse and calculate magnitudes in the area of engineering using calculation tools in different variables.
4. Manage available time and resources. Work in an organised manner.

Content

A. Ordinary differential equations.

1. First-order differential equations. Solutions and initial value problems. Resolution by elemental methods: separable equations, linear equations, solutions by substitution.
2. Linear equations of order 2 (and higher) with constant coefficients. Homogeneous linear equations. Non-homogeneous linear equations. Method of indeterminate coefficients.
3. Systems of differential equations of first order. Homogeneous and non-homogeneous linear systems.

B. Vector analysis.

1. Vector functions. Curves in space. Tangent and normal vectors.
2. Functions of several variables. Curves and level surfaces. Partial derivatives Gradients and directional derivatives. Chain rule. Tangent planes. Maximum and minimum values.
3. Multiple integration. Double integrals on elementary domains. Iterated integrals. Triple integrals Applications of the double and triple integrals. Change of variables.
4. Line and surface integrals. Vector fields. Rotational and divergence. Integral lines. Theorem of Green. Theorem of divergence

Methodology

In the learning process it is fundamental the own work of the student, who at all times will have the help of the professor.

The hours of class are distributed in:

Theory: The teacher introduces the basic concepts corresponding to the subject, showing examples of their application. The student will have to complement the explanations of the professors with the personal study.

Problems: By completing sets of exercises, the comprehension and application of the concepts and tools introduced in the theory class is attained. The student will have lists of problems, a part of which will be solved in the problem classes. Students should work on the remaining ones as part of their autonomous work.

Seminars: to reach a deeper understanding of the subject the students work on in group on more complex practical problems. Some seminars will deal with computer-aid approach to solving problems.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Solving problems class	15	0.6	1, 2, 3
Theory class	30	1.2	1, 3
Type: Supervised			
Seminars	5	0.2	1, 2, 3
Type: Autonomous			
Personal Study	30	1.2	1, 2, 3
Solving problems	62	2.48	1, 2, 3

Assessment

A continuous assessment is performed based on five controls:

- Two written tests combining theory and problems, one P1 related to part A, another P2 related to part B.
- One related to work done during the seminars, with grade S.
- Submission of two sets of exercises, one LL1 on part A, another LL2 on part B, assessed through an interview. Can be completed at home and uploaded to Campus Virtual. Their mean is LLP

Submissions in b) c) are mandatory, with no resit assesment.

If both $P1, P2 > 3,5$, a grade C1 is generated according to $C1 = (0,15)S + (0,15)LLP + (0,35)(P1 + P2)$. If C1 is at least 5, the final grade is C1.

Students with $C1 < 5$ and having submitted b),c), and students willing to improve their grade, may attend a resit exam, with grade R.

The final grade C2 after the resit exam is $C2 = (0,15)S + (0,15)LLP + (0,70) R$.

For students improving their grade, the final score is $MAX(C1, C2)$.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Mid-term exam combining theory and problems of part A	30%	2	0.08	1, 3
Mid-term exam combining theory and problems of part B	30%	2	0.08	1, 3
Seminar test	10%	1	0.04	1, 2, 4, 3
Submission of exercise sets part A, graded by interview	15%	1.5	0.06	1, 2, 4, 3
Submission of exercise sets part B, graded by interview	15%	1.5	0.06	1, 2, 4

Bibliography

Main:

Dennis G. Zill, Michael R. Cullen. Ecuaciones diferenciales con problemas de valores en la frontera (séptima edición). International Thompson editores, México 2006.

S. L. Salas, E. Hille. Cálculo de una y varias variables. Ed. Reverté, 1994.

Complementary

R.K. Nagle, E.B. Saff, A.D. Snider. Ecuaciones diferenciales y problemas con valores en la frontera (tercera edición). Addison-Wesley. 2001.

R. Martínez. Models amb equacions diferencials. Materials UAB. 2004.