SUBJECT TEACHING GUIDE

G585 - BROAD MATHEMATICS

Degree in Energy Resources Engineering
First Degree in Energy Resources Engineering

Academic year 2024-2025

1. IDENTIFYING DATA					
Degree	Degree in Energy Resources Engineering First Degree in Energy Resources Engineering			Type and Year	Compulsory. Year 2 Compulsory. Year 2
Faculty	School of Mines and Energy Engineering				
Discipline	Subject Area: Advanced Basic Training Module: Training in Common with the Mining Branch				
Course unit title and code	G585 - BROAD MATHEMATICS				
Number of ECTS credits allocated	6	Term		Semester based (2)	
Web					
Language of instruction	Spanish	English Friendly	Yes	Mode of delivery	Face-to-face

Department	DPTO. MATEMATICA APLICADA Y CIENCIAS DE LA COMPUTACION
Name of lecturer	PAULA CAMUS BRAÑA
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Other lecturers	DIEGO RUIZ ANTOLIN

3.1 LEARNING OUTCOMES
- Critically analyse the characteristics of a population from a sample. Apply the fundamental properties of the punctual estimators and confidence intervals.
- Manage the concept of multiple integral of Riemann and its application to problems of Physics and Engineering. Use symbolic calculus software to solve problems of calculation of volumes, areas, centers of gravity.
- Apply the Fourier analysis and express a function by a series of trigonometric functions.
- Classify and solve some types of first-order differential equations.
- Solve differential equations of second order, linear and constant coefficients, homogeneous and not homogeneous. Use of the Laplace transform.
- Know some second order partial differential equations.
- Use of specific software for the resolution of different problems.
- To analyse the importance of quality control and the quality control programmes
- To use symbolic calculus software to solve calculus problems about volume, area and gravity center

4. OBJECTIVES
Familiarize the students in the required statistical tools to apply inference studies from a sample.
Introduce students to statistical quality control and its applications.
Know how to sketch curves, surfaces and volumes, in three-dimensional space, defined by implicit or parametric equations, in rectangular, polar or cylindrical coordinates.
Know how to express a curve as a vector function of a variable and calculate its length from its differential.
Learn to calculate curvilinear integrals, double and triple integrals of curves, surfaces and volumes, respectively, in order to obtain geometric or physical characterizations. Example: calculation of work of a force, mass of a rod, areas, volumes, geometric center and center of mass.
Know the theory and applications of Fourier Analysis.
Learn to solve simple differential equations of first and second order by analytical and numerical methods.
Know the modeling through differential equations of different processes in physics, engineering, economics, biology. Solve these equations and represent and analyze the solution.
Know some equation in partial derivatives of second order.
Deepening into the use of specific software as a basic tool for calculus and statistical analysis.

6. SUBJECT PROGRAM	
	CONTENTS
1	BLOCK 1. CONFIDENCE INTERVALS AND QUALITY CONTROL. TOPIC 1. INFERENCE AND HYPOTHESIS TESTING: Point estimation. Confidence intervals for proportions, means, and variances. Introduction to hypothesis testing. TOPIC 2: LINEAR REGRESSION; TOPIC 3. QUALITY CONTROL: Introduction. Control charts for measurements and attributes.
2	BLOCK 2. INTEGRAL CALCULUS TOPIC 3. CURVES AND SURFACES: Curves in the plane. Surfaces. Some important surfaces. Normal vector and tangent plane to a surface. Parametric equations of a curve on a surface. TOPIC 4. DOUBLE AND TRIPLE INTEGRALS: Concept of double integral. Class of integrable functions and properties. Mean Value Theorem. Calculation of double integrals. Change of variables in double integrals. Calculation of volumes. Triple integrals. Calculation of triple integrals. Change of variables in triple integrals. Applications to problems in Engineering Physics. TOPIC 5. VECTOR FIELD THEORY: Scalar and vector fields. Differential operators. Divergence and curl of a vector field. Line integrals. Circulation of a vector. Work done by a force. Path-independent integrals. Calculation of potential function. Surface area. Surface integrals. Flux of a field through a surface. Integral theorems. Applications.
3	BLOCK III. FOURIER ANALYSIS TOPIC 6. FOURIER SERIES AND TRANSFORMS: Systems of orthogonal functions. Approximation of a function by the sum of terms from an orthogonal system. Trigonometric or Fourier series. General procedure for expanding a function into a Fourier series. Fourier transforms. Definition and properties. Application of the above to problems in Physics and Engineering.
4	BLOCK IV. DIFFERENTIAL EQUATIONS TOPIC 7. FIRST-ORDER DIFFERENTIAL EQUATIONS: Introduction. General solution. Particular solution. Analytical methods (separation of variables, exact equations, linear equations). Integrating factor. Applications to problems in Physics and Engineering. Numerical solution of initial value problems. Euler's method. Runge-Kutta method. TOPIC 8. ORDINARY DIFFERENTIAL EQUATIONS SECOND-ORDER LINEAR EQUATIONS: Initial value problems for second-order ODEs. General solution of the homogeneous equation with constant coefficients, non-homogeneous equations with constant coefficients. Solution methods. Variation of parameters. Method of undetermined coefficients. Numerical solution of initial value problems (generalization of Euler's method), numerical solution of boundary value problems (finite difference method). Systems of linear first-order differential equations. TOPIC 9: INTRODUCTION TO PARTIAL DIFFERENTIAL EQUATIONS: Introduction to partial differential equations.

7. ASSESSMENT METHODS AND CRITERIA				
Description	Type	Final Eval.	Reassessn	%
Computer Lab sessions	Laboratory evaluation	No	No	16,00
Continuous evaluation tests	Written exam	No	Yes	24,00
Written exam 1	Written exam	Yes	Yes	30,00
Written exam 2	Written exam	Yes	Yes	30,00
TOTAL				100,00

Observations

In the case of not exceeding the minimum grades, the global numerical grade will be the lowest value between 4.9 and the weighted average of all the evaluation items, as indicated in the Regulation of the UC Evaluation Processes, article 35.
Only for duly justified causes (e.g. health restrictions) the evaluation tests may be organized remotely, with prior authorization from the Faculty's Board.

Observations for part-time students

Those students enrolled part-time who request it at the beginning of the term, will have the option of doing the laboratory practices individually, in a flexible schedule that adapts to their needs. In addition, the part of the grade corresponding to the continuous evaluation tests will be included in the grade of the exam of the regular exam, thus taking into account the impossibility of regular attendance throughout the term.

8. BIBLIOGRAPHY AND TEACHING MATERIALS

BASIC

Luceño, A.; González, F.J. 2004. "Métodos estadísticos para medir, describir y controlar la variabilidad". Santander : Servicio de Publicaciones de la Universidad de Cantabria. ISBN: 84-8102-375-2.
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Marsden, J.E.; Tromba, A.J. 1998. "Cálculo Vectorial". Wilmington, Delaware: Addison-Wesley Iberoamericana. ISBN: 0-201-04604-0
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O'Neil PV. 1994. "Matemáticas avanzadas para la Ingeniería". 3ª Edición. Cecsa