Universitat Autònoma de Barcelona

2023/2024

Mathematics for Geology

Code: 101045
ECTS Credits: 10

Degree	Type	Year	Semester
2500254 Geology	FB	1	A

Contact

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Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject. Please note that this information is provisional until 30 November 2023.

Teachers

Jaume Aguade Bover

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Maria Merce Corbella Cordomi

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Prerequisites

The subject has no official prerequisites. Due to its content, it should be easily assimilated by students who have a good high school education and have passed the selective examination. But experience tells us otherwise. Geological students have many basic deficiencies in mathematics. So without any criticism they accept that sin(pi)=0.03 if the calculator tells them so. They also have a lot of difficulty in simple algebraic calculation: simplifying, taking out common factors, calculating with roots, etc. People who see that they have these shortcomings should try to overcome them. For example, they could review their high school style books.

1) Simple algebraic calculation. Powers, roots and logarithms.

2) Plane trigonometry with all trigonometric functions and ratios.

3) Combinatorics and powers of a binomial.

4) The direct calculation of derivatives of real functions.

It is also very important that Geology students appreciate that mathematics can be useful in their professional life and may be essential. It must change the mentality of these students towards mathematics.

Objectives and Contextualisation

This subject should be used to consolidate some basic knowledgements of mathematics that will be necessary to address, in higher courses, other more specialized subjects of the Degree in Geology.

Competences

- Learn and apply the knowledge acquired, and use it to solve problems.
- Synthesise and analyse information critically.
- Use mathematical tools to solve geological problems.
- Work independently.

Learning Outcomes

1. Apply mathematical techniques to problems in geology.
2. Calculate determinants and decompositions of matrices.
3. Calculate probabilities in elementary situations.
4. Correctly handle numerical methods with attention to margins of error.
5. Formulate and solve hypothesis contrast problems in one or two populations.
6. Handle random variables and know their usefulness for modelling real phenomena.
7. Interpret the basic properties of point estimators and interval estimators.
8. Learn and apply the knowledge acquired, and use it to solve problems.
9. Make appropriate use of the rules of derivation and integration of functions.
10. Produce and interpret graphic and numerical expressions.
11. Recognise real situations in which the most common probabilistic distributions appear.
12. Resolve and discuss linear equation systems.
13. Solve geometric plane and space problems.
14. Synthesise and analyse information critically.
15. Synthesise and descriptively analyse data sets.
16. Use a statistical package to handle large data sets.
17. Use software packages for numerical and symbolic calculation.
18. Use the basic mathematical language used in geology.
19. Use the concept of independence.
20. Work independently.

Content

Linear algebra and geometry (3 ECTS)

1. Review of basic concepts.

Rational numbers and real numbers. Order relation. Equations, inequalities. i

2. System of linear equations. arrays

Definitions. Elementary operations by rows. Matrix calculation.

inverse matrix Solving linear systems.

3. The vector space R^n. Linear dependence and independence, algebraic bases.

4. Values and eigenvectors.

Definitions. Diagonalization Calculation of powers. applications

5. Plane geometry. Distance between point and line. Triangles and plane trigonometry.

Calculus (3 ECTS)

1. Real functions of real variable.

Review of basic concepts. Function definition. Domain and route. graphics Operations with functions. Inverse function Examples of important functions (polynomial, exponential, ...).

2. Limits and continuity.

Limit of a function at a point. Generalizations of the concept of limit. Calculation of limits of functions.

Continuity of a function at a point and in an interval. Discontinuities of a function. Bolzano's theorem.

3. Derivatives and applications

The derivative of a function at a point. Derivation rules. The chain rule. Mean value theorem. Growth and decrease of a function. Local extremes. Extremes and absolute extreme values. Concavity and turning points. Applications: optimization problems.

4. Integral calculation.

Primitives Definite integral of a continuous function. Fundamental theorem of calculus. Barrow's theorem. Integration techniques. Applications of Integral Calculus

Numerical and graphical calculation (2 ECTS)

1. Errors.

Definitions. Operational errors. Law of propagation of errors. applications

2. Stairs.

Definitions. Construction of stairs. Scales error. applications

3. Representation of curves.

Empirical equations. rectification More common cases. applications

4. Numerical solution of equations.

Bolzano's method, bisection, secant and Newton Raphson. Dimension of the error. applications

5. Interpolation extrapolation

Lagrange's method. The cubic splines.

6. Numerical and graphical derivation.

Derivation formulas. Dimension of the error.

7. Numerical and graphic integration.

The method of trapezoids. Simpson's formula and 3/8 rule. The weighing method.

Statistics (2 ECTS)

1. Probability.

1.1 Basic properties of probability. Conditional probability. Total Probability Formula. Bayes formula.

1.2 Discrete random variables: Bernoulli, Binomial, Hypergeometric.

1.3 The Normal distribution. Approximation of the Binomial by the Normal.

2. Statistics.

2.1 Introduction to Statistics: population and sample, parameters and estimators. Distribution of the sample mean in the normal case with known variance. The Z-statistic. Confidence interval for the normal mean with known variance.

2.2 Student's t distribution. The case of unknown variance: the T-statistic. Confidence interval for the normal mean with unknown variance.

2.3 Introduction to hypothesis testing. Hypothesis tests for the normal mean with known variance. Hypothesis tests for the normal mean with unknown variance.

Methodology

This annual subject has a complicated structure as it consists of four areas of mathematics that are related to each other, but at the same time a certain independence from each other. They are the part of Algebra and Geometry (A), Calculus (C), Numerical Calculus (CN) and Statistics (E), which will receive the generic name of modules and will facilitate the explanations in the guide. Each of them has theory, problems and practices. Specifically, there are 30 hours of theory, 5 problems and 6 practical in (A) and (C), 10 hours of theory, 3 hours of problems and 4 practical hours for (CN) and 10 hours of theory, 3 problems and 3 practices for (E).

In view of the face-to-face hours, it is clear that the constant work of the student throughout the year will be essential in the learning process of this subject. You will have the help of the teaching team at all times and will have online tutoring and consultation times.

The face-to-face hours are distributed in:

Theory: The teacher introduces the basic concepts corresponding to the subject matter showing examples of their application, it will be done in the classroom using the traditional chalk and blackboard method. The student will have material in the Virtual Campus that will help him follow the explanations

Problems: The understanding of the concepts introduced in theory is worked on with the realization of problems and discussion of practical cases. The students will previously have some lists on the Virtual Campus that the student will have to work on on their own. Given the few problem hours available, only model problems can be done in the problem class.

Practices The student will learn to use packages of symbolic, numerical and statistical mathematical calculation programs (Maxima, Excel). The practice classes will be held in the computer rooms. In these classes, the application of mathematical tools to problems that require the use of a computer program will be worked on. The aim of this learning will be for the student to be able to use the computer to address (and be able to solve) any mathematical issue that they may need to consider in the future.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			

Practices	19	0.76	14, 1, 8, 2, 3, 7, 4, 6, 5, 10, 11, 12, 13, 15, 20, 9, 19, 18, 17, 16
Problems in the classroom	16	0.64	14, 1, 8, 2, 3, 7, 4, 6, 5, 10, 11, 12, 13, 15, 20, 9, 19, 18, 17, 16
Theory	50	2	14, 1, 8, 2, 3, 7, 4, 6, 5, 10, 11, 12, 13, 15, 20, 9, 19, 18, 17, 16
Type: Autonomous			
Personal and team work made by the students	153	6.12	14, 1, 8, 2, 3, 7, 4, 6, 5, 10, 11, 12, 13, 15, 20, 9, 19, 18, 17, 16

Assessment

In order to avoid possible confusion and errors of legal interpretation, see the evaluation in the guide made in Catalan

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Parcial exams	70%	12	0.48	14, 1, 8, 2, 3, 7, 4, 6, 5, 10, 11, 12, 13, 15, 20, 9, 19, 18, 17, 16

Bibliography

Basic Bibliographie

1) Linear Algebra and Geometry
- Introducción al Álgebra Lineal, H. Anton,(editorial Limusa), 1986
- Àlgebra Lineal con Aplicaciones. G. Nakos, D. Joyner, International Thomson, Mexico, 1999.

2) Calculus
- Calculus I, S. Salas, E. Hille, editorial Reverté, 1994.

3) Numerical and graphical calculation
- Càlcul numèric, C. Bonet, A. Jorba, Mª T. Martínez-Seara, J. Masdemont, M. Ollé, A. Susin i M. València. Edicions UPC. Barcelona 1994

4) Statistics
- Probabilidad y Estadística para Ciencias e Ingenierías, R. Delgado, Publicaciones Delta 2008.

Complementary bliographie

- Mathematics in Geology, J. Ferguson. Allen & Unwin. Londres,1988.
-Mathematics: A Simple Tool for Geologists, D. Waltham. Blackwell Science. Oxford, 2000.

Software

Free programs such as Sage, Wolfram Alpha, Maxima, etc. are used. others for which the University has a licens