Universitat Autònoma de Barcelona

2021/2022

Mathematics for Geology

Code: 101045
ECTS Credits: 10

Degree	Type	Year	Semester
2500254 Geology	FB	1	A

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

Jaume Aguadé Bover
Joan Josep Carmona Domènech
Juan Francisco Piniella Febrer
Miquel Llabrés Florit
Ricard Riba Garcia
Isaac Corral Calleja

Prerequisites

Although there are no official prerequisites, it is advisable that you are reviewing

1) Powers and logarithms.

2) Plane trigonometry.

3) Combinations and Newton's binomial theorem.

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 and real numbers. Sistems of linear equations.Theorem of Rouché-Frobenius.
2. Matrices.
   Definitions. Elemental operations. Matricial calculus.
   Matrix inverse. Resolution of linear sistems.
3. The vectorial space R^n. Dependence and linear independence of vectors.
4. Eigen values and eigen vectors.
   Definictons. Diagonalitzation. Calculus of powers. Aplications
5. Plane Geometry. Distance between points and straight lines. Triangles.
6. Geometry in the sapce. Distancia. Estereographic projecction.

Calculus (3 ECTS)

1. Real functions of real variable.
Review of basic concepts. Definition of function. Domain and range. 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 limit concept. Calculation of limits of functions. Continuity of a function at a point and in an interval. Discontinuities of a function. Theorem of the intermediate value.
3. Derivatives and applications
The derivative of a function at a point. Derivation rules. The chain rule. Rolle's theorem. Increasement and decrecement of a function. Local extremities. Extremes and absolute values. Concavity and turning points. Applications: optimization problems.
4.Integral calculus

Primitives. Defined integral of a continuous function. The fundamental theorem of calculus. Barrow's rule. Integration techniques. Applications

Numerical and graphical calculation (2 ECTS)

1. Errors
Definitions. Operational errors. Law of error propagation. Applications
2. Scales.
Definitions. Construction of scales. Scales error. Applications
3. Representation of curves.
Empirical equations Rectification More common cases. Applications
4. Numerical resolution of equations.
The Bolzano method, bisection, secant and Newton Raphson. Reduction of the error. Applications
5. Interpolation extrapolation
The Lagrange method. Cubic "splines".
6. Numerical and graphic derivation.
Derivation formulas. Acceptance of the error.
7. Numerical and graphic integration.
The trapezoidal method. The formula of Simpson and rule 3/8. The weighing method.

Statistics (2 ECTS)

1. Probability.

1.1 Basic properties of probability. Conditional probability. Formula of Total Probabilities. Bayes Formula.

1.2 Discrete random variables: Bernoulli, Binomial, Hypergeometric.

1.3 The Normal distribution. Approach of the Binomial to the Normal.

2. Statistics.

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

2.2 Student's distribution. The case of unknown variance: the T-statistic. Interval of confidence for the average of the normal with unknown variance.

2.3 Introduction to hypothesis tests. Hhypothesis test for the average of the normal with known variance. Hypothesis test for the average of the normal with unknown variance.

Methodology

In the process of learning the subject it is fundamental the work of the student who at all times will have the help of the teacher.

Apart from the contact hours, the student must dedicate some time to self-employment. The contact hours are distributed in:

Theory: The teacher introduces the basic concepts corresponding to the subject matter showing examples of its application. The students must complement the teacher's explanations with the personal study.

Problems: The understanding of the concepts introduced in theory with the realization of problems and discussion of practical cases is worked. Students will work individually or in groups under the supervision of the teacher.

Practices: The students will learn to use packages of mathematical programs, symbolic, numerical and

statistical calculation (Maxima, Excel). The classes of practices will be carried out in the computer rooms. In these classes the application of mathematical tools will be worked on to problems that require the use of a computer application.

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

The course can be passed by midterm exams during the year. If the student does not pass these exams he or she can do a resit exam that will take place at the end of the course.

Partial exams: Each module will have a note N, computed from E = note of an exam of theory and / or problems of the whole mòdul, P = note of practices, C = note of midterm controls.

The note N is calculated as

N = 0.70 x E + 0.20 x P + 0.10 x C

The note by mid-term exams of the subject, F, will be obtained weighing the notes of each module by the number of credits, only in the case that the note of each module be greater or equal 3 out of 10, that is, the note by midterm exams will be

F = 0.3 x (N1 + N2) + 0.2 x (N3 + N4)

where N1, N2, N3 and N4 are the notes of the modules 1, 2, 3 and 4 respectively.

Second chance exam: The student who has not pass the subject by partial exams will be able to recover the moduls that he or she has not pass, or to improve his or her note, taking an examination that will take place at the end of the course. Of each module one could recover the note E but not P and C. In order to participate in the second chance exam the students must have been evaluated in a set of activities the weigh of which be equivalent, at least, to two thirds
of the total rating of the subject or module.

The note of each module, NR, for the final qualification will be obtained from ER = note of an examination of theory and problems of the whole module, P = note of practices, C = note of halfway controls. The note NR will be computed as

NR = 0.70 x max {E, ER} + 0.20 x P + 0.10 x C

The final note of the subject, NF, will be obtained weigting the notes of each module by the number of credits as long as the qualification of each module is equal or superior to 3 out of 10.If, after the recovery exam, the qualification of some modue is inferior to 3 , which implies that the student has not passed the subject, the qualification will be the minimum between NF and 4.

The student will have the qualification of Not Presented if he or she has take only one midterm exam. Thus the student who has presented to 2 or more midterm exams can not have as final qualification of Not Presented.

The date and time for the review of the several exams will be fixed.

The note of each module, NR, for the final qualification will be obtained from ER = note of an examination of theory and problems of the whole module, P = note of practices, C = note of halfway controls. The note NR will be computed as

NR = 0.70 x max {E, ER} + 0.20 x P + 0.10 x C

The final note of the subject, NF, will be obtained weigting the notes of each module by the number of credits as long as the qualification of each module is equal or superior to 3 out of 10. If, after the recovery exam, the qualification of some modue is inferior to 3 , which implies that the student has not passed the subject, the qualification will be the minimum between NF and 4.

The student will have the qualification of Not Presented if he or she has take only one midterm exam. Thus the student who has presented to 2 or more midterm exams can not have as final qualification of Not Presented.

The date and time for the review of the several exams will be fixed.

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

We shall use free software such as Sage, Wolfram Alpha, etc