Mathematics for Geology

Code: 101045
ECTS Credits: 10

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Degree	Type	Year
2500254 Geology	FB	1

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Teaching groups languages

You can view this information at the end of this document.

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, removing common factor, calculating with roots, solving an equation of the type x^2-3x^2 log x=0, they don't know what to do, 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) Combinatorics and powers of a binomial.

3) The direct calculation of derivatives of real functions.

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

Objectives and Contextualisation

This subject must be used to consolidate basic knowledge of mathematics that will be useful to understand concepts used in Geology, for example variation with respect to the depth of the temperature inside the Earth.

They will also be necessary to address, in higher courses, other more specialized subjects of the Geology Degree.

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

Àlgebra Lineal i geometria (3 ECTS)

1. Repàs de conceptes bàsics.
Nombres racionals i nombres reals. Operacions, arrels. Relació d'ordre. Equacions, inequacions.

2. Sistema d'equacions lineals. Matrius.
Definicions. Operacions elementals per files. Càlcul matricial.
Matriu inversa. Resolució de sistemes lineals. Determinants

3. Geometria plana.

Distància entre punt i recta. Triangles i funcions trigonomètriques. Resolucions de triangles. Equacions trigonomètriques

4. Geometria a l'espai.
Els espais vectorials R^2, R^3. Subespais i varietats. Vectors linealment independents i bases. Producte escalar i producte vectorial. Distàncies entre varietats.

Càlcul (3 ECTS)

1. Funcions reals de variable real.
Repàs de conceptes bàsics. Definició de funció. Domini i recorregut. Gràfiques. Operacions amb funcions. Funció inversa. Exemples de funcions importants (polinòmiques, exponencials, ...).

2. Límits i continuïtat.
Límit d'una funció en un punt. Generalitzacions del concepte de límit. Càlcul de límits de funcions. Continuïtat d'una funció en un punt i en un interval. Discontinuïtats d'una funció. Teorema de Bolzano.

3. Derivades i aplicacions
La derivada d'una funció en un punt. Regles de derivació. La regla de la cadena. Teorema del valor mig. Creixement i decreixement d'una funció. Extrems locals. Extrems i valors extrems absoluts. Concavitat i punts d'inflexió. Aplicacions: problemes d'optimització.

4. Càlcul integral.
Primitives. Integral definida d'una funció continua. Teorema fonamental del càlcul. Teorema de Barrow. Tècniques d'integració. Aplicacions del Càlcul Integral.

Càlcul numèric i gràfic (2 ECTS)

1. Errors.

Definicions. Errors operacionals. Llei de propagació d'errors. Aplicacions.

2.Escales.
Definicions. Construcció d'escales. Error de les escales. Aplicacions.

3 Ajust de dades empíriques.
Equacions empíriques. Rectificació. Casos més corrents. Aplicacions.

4. Resolució numèrica d'equacions.
El mètode de Bolzano, bisecció, secant i Newton. Acotació dels errors. Aplicacions.

5. Interpolació i extrapolació
El mètode de Lagrange. Els "splines" cúbics.

6. Derivació i integració numèriques i gràfiques.
Fórmules de derivació. Acotació de l'error. El mètode dels trapezis. La fórmula de Simpson i regla 3/8

Estadística (2 ECTS)

1.1 Propietats bàsiques de la probabilitat. Probabilitat condicionada. Fórmula de les Probabilitats Totals. Fórmula de Bayes.

1.2 Variables aleatòries.

Variables discretes: Bernoulli, Binomial, Hipergeomètrica.

1.3 La distribució Normal.

Aproximació de la Binomial per la Normal.

2.1 Introducció a l'Estadística.

Població i mostra, paràmetres i estimadors. Distribució de la mitjana mostral en el cas normal amb variància coneguda. El Z-estadístic. Interval de confiança per a la mitjana de la normal amb variància coneguda.

2.2 La distribució t de Student.

El cas de variància desconeguda: el T-estadístic. Interval de confiança per a la mitjana de la normal amb variància desconeguda.

2.3 Introducció als tests d'hipòtesis. Tests d'hipòtesis per a la mitjana de la normal amb variància coneguda. Tests d'hipòtesis per a la mitjana de la normal amb variància desconeguda.

Activities and Methodology

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

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 between them. 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 practicals 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.

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). Practice classes will be held in the computer classrooms. 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.

The use of the Virtual Campus will be of vital importance. This will be the most important channel of communication between students and teachers. Material for following the course will be uploaded there, for example problem lists. It will also be the means to publicize the qualifications. It will be important to consult the Virtual Campus frequently.

The teacher's tutoring schedule will be made public. It is highly recommended that students make use of these tutoring hours to resolve any doubts that arise throughout the course. In any case, help to resolve doubts will be guaranteed by telematic means.

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.

Assessment

Continous Assessment Activities

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

With the objective of avoiding possible translation errors of legal interpretation and also with the objective of facilitating the learning of the Catalan language for students who do not know it, it is advised that they look at the corresponding section of the guide in Catalan. If in doubt, ask your teachers, they will be happy to answer your questions.

Bibliography

Bibliografia bàsica

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

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

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

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

Bibliografia adicional

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

Software

The Maxima program will be used in the Algebra and Calculus practices. In Numerical Calculus the EXCEL spreadsheet will be used. The student will be able to use other free-to-use programs such as Sage or Wolfram Alpha, and others licensed by the University.

This type of knowledge in the use of programs will be absolutely essential in his future if he is to make use of mathematics.

Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	1	Catalan	annual	morning-mixed
(PLAB) Practical laboratories	1	Catalan	annual	morning-mixed
(PLAB) Practical laboratories	2	Catalan	annual	morning-mixed
(TE) Theory	1	Catalan	annual	morning-mixed