UAB
Universitat Autònoma de Barcelona

Mathematics for Geology

2026/2027

Code: 101045
Credits: 10

Degree programme	Type	Course
Geology	FB	1

Contact lecturer

Name : Wolfgang Pitsch

Email : wolfgang.pitsch@uab.cat

Teaching staff

Salim Boukfal Lazaar

Group languages

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

Prerequisites

The subject has no official prerequisites. Due to its content, it should be easy to assimilate for students who have a good high school education, have taken Mathematics subjects and passed the entrance exam to the University. But experience tells us the opposite. Geological students have many basic deficiencies in mathematics. Thus, without any criticism, they accept that sin(pi)=0.03 if the calculator tells them so. They also have many difficulties in simple algebraic calculations: simplifying, finding a common factor, calculating with roots, when faced with an equation of the type x^2-3x^2 log x=0, they do not know what to do, or they do not know how to solve a linear system of two equations with three unknowns, or derive the function f(x)= xe^x, etc. People who see that they have these deficiencies should try to overcome them. They should be aware that they will have to make much more effort than their classmates. They can also resort to reviewing concepts of the style in their high school books.

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

2) Combinatorics and power of a binomial.

3) Direct calculation of derivatives of real functions.

It is also very important that the Geological student appreciates that mathematics can be useful in their professional life and may be essential. Currently, many of them believes that they are not important or are inaccessible to them. The mentality of these students towards mathematics must change a lot.

Objectives

This subject should serve to consolidate basic knowledge of mathematics that will be useful for understanding concepts used in Geology, for example variation with respect to depth of temperature inside the Earth. They will also be necessary to address, in higher courses, other more specialized subjects of the Geology Degree.

Learning outcomes

- CM08 (Solve real quantitative problems in the field of geology.) Solve real quantitative problems in the field of geology.
- CM09 (Determine mathematical parameters and magnitudes associated with academic problems in the field of geology.) Determine mathematical parameters and magnitudes associated with academic problems in the field of geology.
- KM10 (Differentiate the most appropriate mathematical techniques for solving problems related to earth sciences.) Differentiate the most appropriate mathematical techniques for solving problems related to earth sciences.
- KM11 (Perform derivation and integration of simple functions, as well as basic differential and integral calculus problems.) Perform derivation and integration of simple functions, as well as basic differential and integral calculus problems.
- KM12 (Explain the basic tools and concepts of calculus, algebra, and mathematical analysis.) Explain the basic tools and concepts of calculus, algebra, and mathematical analysis.
- SM09 (Apply different mathematical approaches to basic problem-solving related to geology.) Apply different mathematical approaches to basic problem-solving related to geology.
- SM10 (Apply specific mathematical software in teamwork contexts related to geology.) Apply specific mathematical software in teamwork contexts related to geology.
- SM11 (Communicate to the general public the basic mathematical information associated with a geological problem.) Communicate to the general public the basic mathematical information associated with a geological problem.

Contents

Linear Algebra and Geometry (3 ECTS)

1. Review of basic concepts.

Rational numbers and real numbers.

Operations, roots. Order relation.

Equations, inequalities.

2. Systems of linear equations. Matrices.

Definitions. Elementary row operations. Matrix calculations.

Inverse matrix. Solving systems of linear equations. Determinants.

3. Plane Geometry.

Distance between a point and a line.

Triangles and trigonometric functions. Solving triangles.

Trigonometric equations.

4. Geometry in Space.

The vector spaces R^2, R^3.

Subspaces and affine varieties.

Linearly independent vectors and bases.

Dot product and cross product. Distances between affine varieties.

Calculus (3 ECTS)

1. Real-valued functions of a real variable.

Review of basic concepts.

Definition of a function.

Domain and range. Graphs.

Operations on 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 over an interval.

Discontinuities of a function. Bolzano's Theorem.

3. Derivatives and Applications.

The derivative of a function at a point. Differentiation rules.

The chain rule. Mean Value Theorem.

Increasing and decreasing functions. Local extrema.

Absolute extrema and extreme values. Concavity and inflection points. Applications: optimization problems.

4. Integral Calculus.

Antiderivatives.

Definite integral of a continuous function.

Fundamental Theorem of Calculus. Barrow's Theorem.

Integration techniques. Applications of Integral Calculus.

Numerical and Graphical Methods (2 ECTS)

1. Errors.

Definitions. Operational errors.

Error propagation law. Applications.

2. Scales.

Definitions.

Construction of scales.

Scale errors. Applications.

3. Fitting Empirical Data.

Empirical equations. Linearization.

Most common cases. Applications.

4. Numerical Solution of Equations.

Bolzano's method, bisection, secant, and Newton's methods.

Error bounds. Applications.

5. Interpolation and Extrapolation.

Lagrange interpolation method.

Cubic splines.

6. Numerical and Graphical Differentiation and Integration.

Differentiation formulas. Error bounds.

Trapezoidal rule. Simpson's rule and the 3/8 rule.

Statistics (2 ECTS)

1.1 Basic Properties of Probability.

Conditional probability.

Law of Total Probability. Bayes' Theorem.

1.2 Random Variables.

Discrete random variables: Bernoulli, Binomial, Hypergeometric.

1.3 The Normal Distribution.

Approximation of the Binomial distribution by the Normal distribution.

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 mean of a normal distribution with known variance.

2.2 Student's *t*-Distribution.

The case of unknown variance: the *t* statistic.

Confidence interval for the mean of a normal distribution with unknown variance.

2.3 Introduction to Hypothesis Testing.

Hypothesis tests for the mean of a normal distribution with known variance.

Hypothesis tests for the mean of a normal distribution with unknown variance.

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes
Personal and team work made by the students	153	6.12	CM08, CM09, KM10, KM11, KM12, SM09, SM10, SM11
Theory	40	1.6	CM08, CM09, KM10, KM11, KM12, SM09, SM10, SM11
Practices	19	0.76	CM08, CM09, KM10, KM11, KM12, SM09, SM10, SM11
Problems in the classroom	16	0.64	CM08, CM09, KM10, KM11, KM12, SM09, SM10, SM11

This annual subject has a complicated structure since it consists of four areas of mathematics that are related to each other, but at the same time somewhat independent of each other. They are the part of Algebra and Geometry (A), Calculus (C), Numerical Calculus (CN) and Statistics (E), which will be given the generic name of modules and will provide us with explanations in the guide. Each of them has theory, problems and

practices. Specifically, there are 30 hours of theory, 5 of problems and 6 of practices in (A) and (C), 10 hours of theory, 3 hours of problems and 4 hours of practices for (CN) and 10 hours of theory, 3 of problems and 3 of practices for (E).

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

The face-to-face hours are distributed as follows:

Theory: The teacher introduces the basic concepts corresponding to the subject matter, showing examples of their application, which 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 by completing problems and discussing practical cases. Students will previously have lists on the Virtual Campus that the student will have to work on their own. Given the few hours of problems available, only model problems can be done in the problem class.

Practical classroom. The student will learn to use symbolic, numerical and statistical mathematical calculation program packages (Maxima, Excel). The practical 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 objective of this learning will be for the student to be able to use the computer to address (and be able to solve) any mathematical question 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. Course material will be posted there, for example problem lists or theory summaries. It will also be the means to make the qualifications known. It will be important to consult the Virtual Campus frequently.

The tutoring schedule of the teachers 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 in resolving doubts by telematic means will be guaranteed.

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

Continuous assessment activities

Title	Weight	Hours	ECTS	Learning outcomes
Parcial exams	70%	12	0.48	CM08, CM09, KM10, KM11, KM12, SM09, SM10, SM11
Intermediate exam	10%	4	0.16	CM08, CM09, KM10, KM11, KM12, SM09, SM10, SM11
Practical exam	20%	6	0.24	CM08, CM09, KM10, KM11, KM12, SM09, SM10, SM11

a) Process and scheduled assessment activities

The assessment of each module is similar and will essentially consist of an assessment of the practices and the theory.

Each module will be graded based on E = grade of a theory exam and/or problems of the entire module, P = grade of practices, C = grade of a possible intermediate control.

The grade for each module, denoted by Q(module), will be calculated as

Q(A)= 0.7*E + 0.2*P + 0.1*C

Q(C)= 0.7*E + 0.2*P + 0.1*C

Q(CN)= 0.7*E + 0.3*P

Q(E)= 0.75*E + 0.25*P

The grade for partials will be

QP= 0.3*(Q(A)+ Q(C))+0.2*(Q(CN)+Q(E)).

If QP is greater than or equal to 5, the course is approved for partials.

b) Recovery process.

Students who have not passed partial exams will be able to retake the modules they have not passed, or improve their grade, by taking the retake exam that will take place at the end of the course. For each module, the grade E will be retaken, but not the P or C. There is no restriction on taking the retake exams. The grade obtained is denoted ER in each module that is taken.

The grade for each module will be calculated by replacing the value E with the maximum value {E, ER} in the previous formulas.

The final grade for the subject, which we will denote QF, will then be obtained with the same formula

QF= 0.3 * (QA+ QC) + 0.2 * (QCN+QE).

where QA,QC,QCN,QE are the grades of the corresponding modules after retake.

In the event that, after the recovery, the grade of any module is lower than 3, and QF is greater than or equal to 5. the teaching team must assess the situation.

The student will have a NO AVALUABLE if, at most, they have taken 4 evaluation tests of the entire subject (midterm exams, final exams, practical, etc.). Thus, the student who has taken 5 or more tests represents that they have been following the course and will be awarded the grade that results from the formulas.

c) Single Assessment

Given the nature of the course, there is no single comprehensive assessment consisting of one final examination covering the entire subject. However, students who wish to opt for the single assessment system must provide justification and submit their request during the period established by the Faculty.

If the request is approved, students must sit the resit examination for each of the four modules, which will also include a practical component (without the use of a computer). The final grade will be calculated using analogous formulas.

If a student obtains a grade between 3.5 and below 5.0, they will be eligible to take a resit examination.

The single assessment option is mutually exclusive with continuous assessment, while preserving the student's right to attend face-to-face classes.

Bibliography

Bibliografia bàsica

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- 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

In the Algebra and Calculus practical sessions, the Maxima software will be used. In Numerical Calculus, the Microsoft Excel spreadsheet application will be used. Students may also use other freely available software, such as Sage or Wolfram Alpha, as well as other software for which the University holds a license.

Proficiency in the use of these software tools is essential for students' future professional work whenever mathematics is applied.

Course groups and languages

The information provided is provisional until November 30. After this date, you will be able to consult the language of each group through this link. To access the information, you will need to enter the course CODE

Type of teaching	Group	Language	Semester	Shift
(TE) Theory	1	Spanish	annual	morning-mixed
(PAUL) Classroom practices	1	Unknown	annual	morning-mixed
(PLAB) Practical laboratories	1	Catalan/Spanish	annual	morning-mixed
(PLAB) Practical laboratories	2	Catalan/Spanish	annual	morning-mixed