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| **UAB Universitat Autònoma de Barcelona** | Mathematical Models<br>Code: 101032<br>Credits: 4 | 2026/2027 |

| Degree programme | Type | Course |
|---|---|---|
| Geology | OP | 3 |

## Contact lecturer

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## Teaching staff

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## Group languages

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

## Prerequisites

The pre-requisites of the course are (1) basic background in maths, physics and geology and (2) motivation in the quantification and modelling of the geological processes.

## Objectives

After acquiring a basic background in the different branches of Geology, together with fundamental knowledge of mathematics, physics, and chemistry, students are able to quantify a variety of geological processes through numerical modelling.

The aim of this course is to explore the potential of numerical modelling in Geology. To achieve this goal, the main learning objectives are:

- Understand the characteristics and significance of static and dynamic models applied to geological processes.
- Recognize different types of mathematical equations as representations of physical laws governing geological processes.
- Learn the fundamentals of numerical methods for solving ordinary and partial differential equations.
- Formulate and solve simple modelling problems in the geosciences.
- Develop scientific communication skills, both written and oral.

## Learning outcomes

- CM04 (Design the appropriate modelling to solve theoretical and practical problems related to geology.) Design the appropriate modelling to solve theoretical and practical problems related to geology.
- KM05 (Identify the main numerical modelling techniques applicable to earth sciences.) Identify the main numerical modelling techniques applicable to earth sciences.
- SM04 (Assess the economic viability of the industrial exploitation of a geological resource or service.) Assess the economic viability of the industrial exploitation of a geological resource or service.

## Contents

1. Introduction to mathematical models.
2. Example of mathematical equations applied to geological processes.
3. Numerical methods used to solve partial differential equations. Introduction to numerical computational environments (Matlab, Excel).
4. Example of numerical simulations applied to geology.

## Learning activities and methodology

| Title | Hours | ECTS | Learning outcomes |
|---|---|---|---|
| practical sesions (problems and computational classroom) | 18 | 0.72 | CM04, KM05 |
| Lectures | 16 | 0.64 | CM04, KM05 |
| Solving problems and exercises, reading of papers and define/solve geologic models | 50 | 2 | CM04, KM05, SM04 |

During the theoretical classes, an explanation to the principal techniques used in the numerical modelling of the geological processes will be done. In the practical classes, the students will learn how to solve problems using numerical modelling. For this purpose, an introduction to computational environments as "Matlab" and "Excel" will be done. The program "Matlab" is a high-level language and interactive environment for numerical computation, visualisation and programming. Using "Matlab", the students will be able to analyse data, develop algorithms and create models and applications. Practical classes are done using student's personal computers or/and computers in the faculty computational classroom. The student will develop a modelling project based on geological processes, and the project will be public presented and defenced.

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 |
|---|---|---|---|---|
| Report of the geological modelling project | 30 % | 8 | 0.32 | CM04, KM05 |
| Problem and exercise dossier | 40 % | 6 | 0.24 | CM04, KM05 |
| Presetation and oral defence of the geological modelling project | 30 % | 2 | 0.08 | CM04, KM05, SM04 |

The evaluation of the course is based on (1) the lab dossier of exercises and problems,and principally, (2) the

oral presentation and written report of a modelling project.
The weightings of these activities are (1) the lab dossier is 40% of the final grade and (2) the modelling project is 60% of the final grade, 30% for the oral presentation and defence, and 30% for the written report.
In the case that the modelling project is graded as "fail", the student will be allowed to a reassessment of the course by submitting a new written report and oral defence in the date indicated by the instructors.
To pass the course, the student must to obtain (1) a minimum score equal or higher than 3.5 in each part of the assessment activities and (2) an average score equal or higher than 5, attending the activity weightings. A student will be considered as "not assessable" only if the attendance to assessment activities is lower than 35% of the total weighting of the course.

This course does not include single assesment

• Plagiarism and Misconduct in assessment activities:
- Students who engage in misconduct (plagiarism, copying, personation, etc.) in an assessment activity will receive a grade of "0" for the activity in question.
- Total or partial plagiarism of any of the assessment activities will automatically be awarded a "fail" ("0") for the plagiarised item. Plagiarism is copying from unidentified sources and presenting this as original work (this includes copying phrases or fragments from the internet and adding them without modification to a text which is presented as original). Plagiarism is a serious academic offence. It is essential to respect the intellectual property of others, to identify any source uses, and to take responsibility for the originality and authenticity of all work produced.

## Bibliography

Fowler, A.C. Mathematical models in the applied sciences. New York: Cambridge University Press, 1997. ISBN 0521467039.

Frank R. Giordano, William Price Fox, Steven B. Horton, Maurice D. Weir. A First Course in Mathematical Modeling. 2008. Brooks/Cole, Cendage learning.

Xin-She Yany (2008). Mathematical modelling for Earth Sciences. Dunedin Academic Press ltd.

Taras Gerya, Swiss Federal Institute of Technology (ETH-Zurich). (2009). Introduction to Numerical Geodynamic Modelling. Cambridge University Press.

Slingerland, Rudy; Kump, Lee (2011). Mathematical Modeling of Earth's Dynamical Systems. Princeton University Press.

Simpson, G. (2017) Practical Finite Element Modeling in Earth Science Using Matlab. John Wiley & Sons Ltd. DOI:10.1002/9781119248644

## Software

Matlab and MS-Excel ( programms with campus license)

Other freeware programms: Phreeqc, Algodoo, etc

### 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 | Catalan/Spanish | first semester | morning-mixed |

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| (PLAB) Practical laboratories | 1 | Catalan/Spanish | first semester | morning-mixed |