Mathematical Models

Code: 101032
ECTS Credits: 4

2024/2025

Degree	Type	Year
2500254 Geology	OT	3
2500254 Geology	OT	4

Contact

Name: Albert Griera Artigas

Email: albert.griera@uab.cat

Teachers

Maria Merce Corbella Cordomi

Albert Griera Artigas

Teaching groups languages

You can view this information at the end of this 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 and Contextualisation

After acquisition of the basic background in the different branches of the geology, together with fundamentals on maths, physics and chemistry, the student is now able to quantify different geological processes by means of numerical modelling. The purpose of the course is to explore the possibilities of the numerical modelling in geology. For this reason, the main objectives are:

- Understand the characteristics and significance of static and dynamic modelling applied to geological processes.

- Recognise different types of mathematical equations to describe the geological processes using physical laws.

- Learn the basics of numerical methods to solve partial/ordinary differential equations.

- Define and solve simple examples applied to geosciences.

- Improve the working group and communication (verbal, written) skills.

Competences

Geology

- Contrast the solution obtained after solving a mathematical model, in terms of adjustment to the real phenomenon.
- Display understanding of the size of the space and time dimensions of Earth processes, on different scales.
- Identify and describe a problem mathematically, structure the available information on it and select a suitable model.
- Learn and apply the knowledge acquired, and use it to solve problems.
- Show an interest in quality and incorporate it into practice.
- Suitably transmit information, verbally, graphically and in writing, using modern information and communication technologies.
- Use concepts from physics when solving problems in geology.
- Use mathematical tools to solve geological problems.
- Work independently.

Learning Outcomes

1. Apply the necessary mathematical concepts for understanding and creating numerical models and simulations.
2. Contrast the solution obtained after solving a mathematical model, in terms of adjustment to the real phenomenon.
3. Identify and describe a problem mathematically, structure the available information on it and select a suitable model.
4. Learn and apply the knowledge acquired, and use it to solve problems.
5. Relate the simulations performed on different temporal and spatial scales to the geological processes being studied.
6. Show an interest in quality and incorporate it into practice.
7. Suitably transmit information, verbally, graphically and in writing, using modern information and communication technologies.
8. Use physical laws to simulate geological processes.
9. Work independently.

Content

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.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			

Lectures	16	0.64	1, 3, 4, 7, 8
practical sesions (problems and computational classroom)	18	0.72	1, 3, 5, 7
Type: Autonomous			
Solving problems and exercises, reading of papers and define/solve geologic models	50	2	1, 2, 3, 6, 7, 9

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

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Presetation and oral defence of the geological modelling project	30 %	2	0.08	1, 2, 3, 4, 6, 7, 8, 9
Problem and exercise dossier	40 %	6	0.24	1, 2, 5, 6, 8
Report of the geological modelling project	30 %	8	0.32	1, 2, 3, 4, 7, 8, 9

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.

Software

Matlab and MS-Excel (programms with campus license)

Other freeware programms: Phreeqc, Algodoo, etc

Language list

Name	Group	Language	Semester	Turn
(PLAB) Practical laboratories	1	Catalan	first semester	morning-mixed
(TE) Theory	1	Catalan	first semester	morning-mixed