

Degree programme	Type	Course
Environmental Sciences	OP	4

Contact lecturer

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Group languages

You can consult this information at the [end](#) of the document.

Prerequisites

The contents of the subject Basics of Mathematics.

Objectives

In this subject elements of modelling and simulation are introduced with the goal to analyse environmental problems and assess the impact (on sustainability, on the ecosystems, on the human health and/or on the economy) of the environmental policies that can cope with them.

The aim is for students to:

1. Recognize variables, hypotheses and important parameters in problems of the real world.
2. Formulate mathematical models for different problems related to environmental processes.
3. Obtain the solutions in an exact or approximate way using analytical or numerical tools.
4. Know how to interpret and visualize the obtained solutions.
5. Know how to contrast the mathematical results with the properties observed in the real problem.

Learning outcomes

- CM37 (Present proposals for the prevention and mitigation of the impact on the physical environment of natural or anthropogenic action, including that based on green chemistry.) Present proposals for the prevention and mitigation of the impact on the physical environment of natural or anthropogenic action, including that based on green chemistry.
- CM38 (Distinguish the most appropriate mathematical tools and models to describe the dynamics of specific environmental processes.) Distinguish the most appropriate mathematical tools and models to describe the dynamics of specific environmental processes.

- KM46 (Identify the most important chemical and geological processes in the different environmental compartments (hydrosphere, soil and atmosphere).) Identify the most important chemical and geological processes in the different environmental compartments (hydrosphere, soil and atmosphere).
- KM47 (Recognise the way in which human activity has an impact on the function of physical vectors (water, soil, oceans, atmosphere) in the natural environment.) Recognise the way in which human activity has an impact on the function of physical vectors (water, soil, oceans, atmosphere) in the natural environment.
- SM45 (Apply basic mathematical tools and models to describe the dynamics of environmental processes.) Apply basic mathematical tools and models to describe the dynamics of environmental processes.

Contents

1. Introduction to modelling

- Modelling strategies: verbal explanations, equations and algorithms.
- Types of models: deterministic vs estochastic, statitic vs dynamic, qualitative vs quantitative.
- Dimensional analysis.

2. Dynamical models with differential equations

- Flows and compartmental models. Aquifer contamination.
- Population models. Management of renewable resources.
- Heat theory. A greenhouse model and tipping points. The hysteresis effect.

3. Agent based models and introduction to computer programming

- Simulation of the radioactive activity of a material.
- Simulation of wildfires propagation.
- Simulation of diffusion of substance in the media.

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes
Solving problems and studying theoretical concepts	32	1.28	CM37, CM38, KM46, KM47, SM45
Problem session	9	0.36	CM38, KM47, SM45
Lectures	32	1.28	CM37, CM38, KM46, KM47, SM45
Practical session	9	0.36	CM38, SM45

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

The contact hours are distributed in:

- Lectures: The teacher introduces the corresponding basic concepts in the subject of the subject by showing several examples of its application. The student will have to supplement the teacher's explanations with the personal study.
- Problem session: The understanding and application of the concepts and tools introduced in the theory class, with the realization of exercises. The student will have lists of problems, a part of which will be solved in the problem classes. The rest will have to be solved by the student as part of his autonomous work.
- Practical session: The student will use packages of symbolic and numerical calculation programs. The practice classes will be held in the same classroom where the theory is done; students must bring their laptop to both problem classes and hands-on classes. In these classes the application of mathematical tools will be applied to models that require the use of computer software.

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
Final project	30%	24	0.96	CM38, SM45
Test	40%	12	0.48	CM37, CM38, KM46, KM47, SM45
Delivery of problems	30%	32	1.28	CM38, SM45

Continuous assessment

An exam will be held with a grade value of 40%. The qualification of the exam must be at least 3.5 for it to make average with the other assessment activities. Exercises will be carried out in the classroom that will count for 30% of the grade. A final project will be prepared that will count for the remaining 30% of the grade. The final project can be done in groups of a maximum of 3 people (it can be individual). The project will be defended in front of the teaching team of the subject and the rest of the classmates. The grade of the project will take into account both the participation in the classroom in the sessions dedicated to carrying out the project and the quality of the project presented and the defense.

Unique assessment

Students who have taken advantage of the single assessment modality must take a final test that will consist of a written exam that will consist of problem solving and some theoretical question. Before starting the exam, the student will submit a written report of the project they have carried out. The final grade is obtained as follows: the exam counts for 70% and the written project report counts for the remaining 30%. The qualification of the exam must be at least 3.5 for it to make average with the other assessment activities.

Recovery exam

It is possible to take an additional exam to recover the exam grade (corresponding to 40% of the grade in the continuous assessment and 70% of the grade in the single assessment). The grade of this exam replaces the grade obtained in the first exam.

Bibliography

Basic:

- John Harte. Consider a Spherical Cow - A course in Environmental Problem Solving. University Science Books, 1988.

- Regina Martínez i Barchino. *Models amb equacions diferencials*. Vol. 149. Univ. Autònoma de Barcelona, 2004.

Complementary:

- J.D. Murray, *Mathematical Biology*, Springer-Verlag, 1993.
- M. de Lara and L. Doyen. *Sustainable Management of Natural Resources, Mathematical Models and Methods*. Springer-Verlag.
- N. hritonenko and Y. Yatsenko. *Mathematical Modeling in Economics, Ecology and the Environment*. Springer.
- W. Gurney, and R.M. Nisbet. *Ecological dynamics*. Oxford University Press, 1998.
- R. Hilborn and M. Mangel. *The ecological detective: confronting models with data*. Princeton University Press, 1997.

Software

R and Netlogo.

In this subject, the use of Artificial Intelligence (AI) technologies is allowed as an integral part of the development of the work, provided that the final result reflects a significant contribution of the student in the analysis and personal reflection. The student must clearly identify which parts have been generated with this technology, specify the tools used and include a critical reflection on how these have influenced the process and the final result of the activity. The lack of transparency in the use of AI will be considered a lack of academic honesty and may lead to a penalty in the grade of the activity, or greater sanctions in serious cases.

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	second semester	morning-mixed
(PAUL) Classroom practices	1	Catalan	second semester	morning-mixed