Environmental Modelling

Code: 102809
ECTS Credits: 6

2024/2025

Degree	Type	Year
2501915 Environmental Sciences	OT	4

Contact

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Teaching groups languages

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

Prerequisites

The prerequisite is to have passed the subjects of Mathematics and Statistics of the degree.

Objectives and Contextualisation

In this subject the theory of dynamical systems is introduced with the goal to analyse enviromental problems and assess the impact (on sustainability, on the ecosystems, on the human health and/or on the economy) of the enviromental policies that can cope with them.

We intend that the student learn to:

- Recognize variables, hypotheses and important parameters in real mi problems.
- Formulate mathematical models for different problems related to environmental processes.
- Know how to identify different types of models.
- Obtain the solutions in an exact or approximate way using analytical or numerical tools.
- Know how to interpret and visualize the obtained solutions.
- Know how to contrast the mathematical results with the propertiesobserved in the real problem.

Competences

- Adequately convey information verbally, written and graphic, including the use of new communication and information technologies.
- Analyze and use information critically.
- Collect, analyze and represent data and observations, both qualitative and quantitative, using secure adequate classroom, field and laboratory techniques
- Demonstrate adequate knowledge and use the tools and concepts of mathematics, computer science and statistics to analyze and manage environmental issues.
- Demonstrate concern for quality and praxis.
- Demonstrate initiative and adapt to new situations and problems.
- Learn and apply in practice the knowledge acquired and to solve problems.
- Teaming developing personal values regarding social skills and teamwork.

- Work autonomously

Learning Outcomes

1. Adequately convey information verbally, written and graphic, including the use of new communication and information technologies.
2. Analyze and use information critically.
3. Apply mathematical models, both deterministic and random,
4. Demonstrate concern for quality and praxis.
5. Demonstrate initiative and adapt to new situations and problems.
6. Learn and apply in practice the knowledge acquired and to solve problems.
7. Observe, recognize, analyze, measure and adequately represent mathematical concepts applied to environmental sciences.
8. Teaming developing personal values regarding social skills and teamwork.
9. Use computer packages numerical and symbolic computation.
10. Using mathematical tools to describe and solve environmental sciences.
11. Work autonomously

Content

1. Discrete time models

- Phase space, states and trajectories.
- Linear models. General solution.
- Non linear models. Fixed points and stability. Periodic and chaotic orbits.
- Management of renewable resources.
- Analysis of mitigation policies for carbon dioxyde emissions.

2. Continuous time models: ordinary differential equations

- Relation between discrete time models and continuous time models.
- Phase portraits.
- Linear and non linear models. Linearization.
- Bifurcation diagrams.
- A greenhouse model. The histeresis effect.
- Aquifer contamination and bioremediation.

3. Introduction to partial differential equations

- Conservation equations. The advection-diffusion equation.
- Air pollution caused by an industrial plant.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lab session	9	0.36	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
Lectures	32	1.28	3, 7, 10
Problem session	9	0.36	1, 2, 3, 4, 5, 6, 7, 8, 10, 11

Type: Autonomous			
Solving problems and studying theoretical concepts	32	1.28	2, 3, 4, 5, 6, 7, 8, 9, 10, 11

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.

- Lab 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

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Class attendance	10%	0	0	6, 7, 10
Delivery of problems	30%	32	1.28	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
Final project	20%	24	0.96	1, 2, 3, 4, 5, 6, 7, 10, 11
Mid-term tests	40%	12	0.48	1, 2, 3, 4, 5, 6, 7, 8, 10, 11

Students will be asked for 3 problem submissions, one for each topic; 30% of the grade will be assessed and counted.

There will be two partial exams with a grade value of 20% each. An average of at least 4 of the two partials must be taken to be able to average with the other assessment activities.

A final project will be requested which will count for 20% of the grade.

10% of the grade will be for class attendance. Your participation in classes is considered very convenient.

Only exams can be retaken. And they can be recovered if the student has previously presented in 2/3 of the evaluable activities.

Unique assessment.

Students who have accepted the unique assessment modality will have to take a final test which will consist of a written exam that will consist of problem solving and some theoretical question. When finished, the student will hand in all the exercise assignments and the final project.

The final grade is obtained as follows: the exam counts 50%, the delivered problems 30% and the final project 20%.

To pass the course, the exam grade must be greater than 4 (on a scale of 10), and the final average (exams and other assessment tests) must be greater than 5

If the exam grade does not reach 4 or the final grade does not reach 5, there is another opportunity to pass the subject through the make-up exam. The recovery system is as follows: it will be possible to recover the part of the grade corresponding to the exam and the final project, which in this case must be done by the student individually (a total of 70%). The part of exercise deliveries is not recoverable.

Bibliography

Basic:

- M. de Lara, L. Doyen. Sustainable Management of Natural Resources, Mathematical Models and Methods. Springer-Verlag.
- N. hritonenko, Y. Yatsenko. Mathematical Modeling in Economics, Ecology and the Environment. Springer.
- R. Martínez i Barchino. *Models amb equacions diferencials*. Vol. 149. Univ. Autònoma de Barcelona, 2004.

Complementary:

- M. Braun, *Ecuaciones Diferenciales y sus aplicaciones.* Grupo Editorial Iberoamericano, México, 1990.
- J.D. Murray, *Mathematical Biology*, Springer-Verlag, 1993.
- S. H. Strogatz, *Non linear dynamics and chaos with applications to Physics, Biology, Chemistry and Engineering*, Westview Press, 2011
- F. R. Giordano, W.P. Fox, S.B. Horton, M.D. Weir, *A First Course in Mathematical Modeling*. Fourth Edition. Brooks/Cote, Cengage Learning, 2009.
- D. G. Zill, M. R. Cullen, *Ecuaciones diferenciales con problemas de valores en la frontera* (sexta edición). International Thompson editores, México 2006.

Software

Maxima: computational algebra system.

Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	1	Catalan	second semester	morning-mixed

(TE) Theory	1	Catalan	second semester	morning-mixed