Universitat Autònoma de Barcelona

2021/2022

Environmental Modelling

Code: 102809
ECTS Credits: 6

Degree	Type	Year	Semester
2501915 Environmental Sciences	OT	4	0

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Teachers

Clara Cufí Cabré

Prerequisites

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

Objectives and Contextualisation

The objective of the subject is to develop and study mathematical models of interest in environmental sciences. The mathematical techniques necessary to make predictions of the behavior of the solutions of these models will be introduced.

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 properties observed 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 in dimension 1.

The law of Malthus
Nonlinear models The discrete logistic model. Fixed points and stability. Graphic iteration.
Periodic behaviors and chaotic behaviors.

2. Linear models at discrete time in dimension greater than 1.

Systems of linear equations in differences. General solution
Populations with age structure. The Leslie model. Asymptotic behavior: the fundamental theorem of demography.
Markov chains.

3. Continuous time models in dimension 1: Differential equations.

Examples: Exponential growth. Migrations Radioactive decay Solutions
Differential equations of first order separable and linear.
The logistic differential equation. The Allee effect.
The hysteresis effect. A model of ecology. A model about the global energy balance.

4. Continuous time models in dimension greater than 1: Systems of differential equations.

Introduction: trajectories, equilibrium points, periodic orbits.
The linear systems. General solution Balances and stability: centers, spotlights, chairs and nodes.
The model of Lotka and Volterra.
Non-linear systems Linealització. Models of Ecology and kinetics chemistry.

Methodology

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 practical classes will be held in the computer rooms. 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.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lab session	9	0.36	2, 3, 6, 5, 4, 7, 1, 11, 8, 10, 9
Lectures	32	1.28	3, 7, 10
Problem session	9	0.36	2, 3, 6, 5, 4, 7, 1, 11, 8, 10
Type: Autonomous			
Solving problems and studying theoretical concepts	32	1.28	2, 3, 6, 5, 4, 7, 11, 8, 10, 9

Assessment

Students will be asked for 4 problem submissions, one for each topic; 40% 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, to be carried out in groups of two or three students, which will count for 20% of the grade.

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

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Delivery of problems	40%	32	1.28	2, 3, 6, 5, 4, 7, 1, 11, 8, 10, 9
Final project	20%	24	0.96	2, 3, 6, 5, 4, 7, 1, 11, 10

Mid-term tests	40%	12	0.48	2, 3, 6, 5, 4, 7, 1, 11, 8, 10

Bibliography

Basic:

- 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.

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

Software

Maxima: computational algebra system.