COURSE DATA

Data Subject	
Code	43275
Name	Modeling
Cycle	Master's degree
ECTS Credits	3.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
2148 - M.D. in Biodiversity: Conservation and Evolution	Faculty of Biological Sciences	1	First term

Subject-matter

Degree	Subject-matter	Character
2148 - M.D. in Biodiversity: Conservation and Evolution	12 - Techniques and tools for the study of ecosystems	Optional

Coordination

Name	Department
GUERRERO CORTINA, FRANCISCO	255 - Applied Mathematics

SUMMARY

This subject is included in the Master of Biodiversity within the set of subjects that provide the basic tools for the work of a biologist related to complex systems such as ecosystems. In this subject the student's mathematical knowledge is expanded in the aspects closest to real work, such as: statistical methods, numerical methods, General Systems Theory, construction of mathematical models and simulation, in order to achieve quasi-optimal-strategies of control over the evolution of ecosystems.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

It is recommended to have basic knowledge of Statistics and Probability and Calculus.

OUTCOMES

2148 - M.D. in Biodiversity: Conservation and Evolution

- To acquire basic skills to develop laboratory work in biomedical research.
- Be able to make quick and effective decisions in professional or research practice.
- Be able to access the information required (databases, scientific articles, etc.) and to interpret and use it sensibly.
- Be able to access to information tools in other areas of knowledge and use them properly.
- To be able to assess the need to complete the scientific, historical, language, informatics, literature, ethics, social and human background in general, attending conferences, courses or doing complementary activities, self-assessing the contribution of these activities towards a comprehensive development.
- Stimulate the capacity for critical reasoning and for argumentation based on rational criteria.
- Awaken interest in the social and economic application of science.
- Favour intellectual curiosity and encourage responsibility for one's own learning.
- Encourage ethical commitment and environmental awareness.
- Be able to communicate and disseminate scientific ideas.

LEARNING OUTCOMES

Given an imperfectly defined biological, ecological or environmental problem, the student should be able to:

- Identify the relevant elements related to the problem.
- Obtain from the previous elements a list of variables suitable to form part of a computerized model of the behavior and structure of the problem and, at the same time, to perfect the definition of the objectives and restrictions of the problem.
- Identify the influence relationships between previously identified variables and identify new variables and refine the definition of objectives and constraints of the problem.
- Express previously detected influence relationships as functional relationships.
- Consider as part of the model at least the following types of variables and functions: scalars, vectors, matrices, input variables of fixed or changing value with time, deterministic or random input variables, deterministic or random type functions, numerical variables and nominal variables.
- Transform a model represented by a list of variables and a list of equations into a computer simulator of the behavior and structure of the system.

- Design and carry out the necessary experiments with the simulator in order to be able to make adequate decisions for the optimal control of the system.

DESCRIPTION OF CONTENTS

1. Statistical methods

Presentation of data: tables and graphs.
Measures of central tendency and dispersion.
Probabilities: conditional probability, Bayes' theorem.
Discrete random variable: Binomial and Poisson distributions.
Continuous random variable: normal distribution, Chi-square, T-Student.
Confidence intervals.
Hypothesis testing.
Regression and correlation.

2. Numerical methods and programming

Polynomial interpolation.
Numerical integration of functions.
Numerical integration of differential equations.
Fundamentals of programming.

3. Modelling and simulation

Types of models. Analytical approach and systemic approach.
Introduction to system dynamics.
Basic mathematical notions for system dynamics I.
Behavioral archetypes of dynamic systems.
Creation of computer models.
Use of models in various fields.
Basic mathematical notions for system dynamics II.

4. Practical sessions

Practical session 1: Confidence intervals and contrasts.
Practical session 2: Linear regression model.
Practical session 3: Numerical integration of functions and ODEs.
Practical session 4: Predator-prey model.
Practical session 5: Model created by the student.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	20,00	100
Computer classroom practice	10,00	100
Development of individual work	14,00	0
Study and independent work	10,00	0
Readings supplementary material	1,00	0
Preparation of evaluation activities	10,00	0
Preparing lectures	4,00	0
Preparation of practical classes and problem	4,00	0
Resolution of case studies	2,00	0
TOTAL	75,00	

TEACHING METHODOLOGY

- **Theoretical module**. 20 hours in a conventional classroom (with blackboard and projection media). In these hours the essence of the programmed statistical, numerical and systemic methods will be explained, examples will be given and the students will solve equivalent problems. The interaction with the teacher will be constant. It is about replacing the master class with the presentation of a method with its theory and an example of its application by the teacher, and putting it into practice by the students immediately working in small groups, in order to explain details each other while the teacher visits the different groups during their work. Students are expected to make their own notes starting from the material provided by the teacher and expanding it with the bibliography.

- **Practical module**: 10 hours in a computer room where the practices related to theory will be carried out. Students must prepare a report for each practice, as well as a final presentation of a model chosen for this purpose and different for each student.

EVALUATION

In the first assessment period, the evaluation will be as follows:

1. Attendance to class with achievement and study. For this, the notes taken during the classes will be presented and expanded, if necessary, with the use of the bibliography. It is intended that they develop a summary manual that will be useful to them as a reference tool in the future. It will be scored with a score from 0 to 10. Grade A.
2. Reports of the practices carried out in the computer classroom in which everything worked during them is explained in detail, with special emphasis on the deduction of the conclusions. They are delivered individually. Grade B.

The final grade will be the result of the formula:

Final grade = 0.1*Grade A + 0.9*Grade B

In the second assessment period the evaluation will be slightly different:

1. Grades A and B remain from the first assessment period.
2. There will be an individual written test on the theoretical and practical contents of the course. Grade C.

The final grade will be:

Final grade = 0.1*Grade A + 0.4*Grade B + 0.5*Grade C.

REFERENCES

Basic

- Cuadras C M (1986) Problemas de Probabilidad y Estadística. Ed Anaya. Madrid.
- Aràndiga F, Mulet P (2008) Càlcul numèric. Publicacions Universitat de València PUV.
- Amat S, Aràndiga F, Arnau JV, Donat R, Mulet P, Peris R (2002) Aproximació numérica. Publicacions Universitat de València PUV.
- Aracil J. Introducción a la Dinámica de Sistemas. Alianza Editorial.
- López L, Martínez S (2000) Iniciación a la Simulación Dinámica. Ariel Economía. Barcelona.
- Ruiz_Maya Pérez L,Martín_Pliego López FJ (2005) Thomson Paraninfo. Madrid.

Additional

- Spiegel M R (1987) Teoría y Problemas de Probabilidades y Estadística. Mac Graw-Hill. México.
- Aubanell A, Benseny A, Delsbams A (1993) Útiles básicos de Cálculo Numérico. Ed. Labor.
- Hannon B, Ruth M (1997) Modeling Dynamic Biological Systems. Ed. Springer Verlag. New York.