COURSE GUIDE

Mathematics

Last updated date: 22/06/2021
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Grado (Bachelor's Degree)	Bachelor's Degree in Biology	Branch	Sciences
Module	Materias Básicas Instrumentales para la Biología	Subject	Matemáticas

Year of study	1º	Semester	1º	ECTS Credits	6	Course type	Core course

PREREQUISITES AND RECOMMENDATIONS

- It is recommended to have studied Mathematics in high school.

BRIEF DESCRIPTION OF COURSE CONTENT (According to the programme's verification report)

- Differential equations.
- Solutions of ordinary differential equations.
- Systems of differential equations: species interaction models.
- Parameter estimation.
- Discrete models in biology.
- Matrix population models in biology.
- Discrete differentation. Geometric interpretation. Biological interpretation.

SKILLS

GENERAL SKILLS

- CG01 - Capacidad de organización y planificación
- CG03 - Aplicar los conocimientos a la resolución de problemas
- CG04 - Capacidad de análisis y síntesis
- CG06 - Razonamiento critico
- CG16 - Creatividad
- CG17 - Capacidad de gestión de la información

SUBJECT-SPECIFIC SKILLS

- CE39 - Aplicar los procesos y modelos matemáticos necesarios para estudiar los principios organizativos, el modo de funcionamiento y las interacciones del sistema vivo
- CE76 - Saber matemáticas y estadística aplicadas a la Biología

LEARNING OUTCOMES

Formative

The main objective is for the student to understand mathematics as a useful tool in their training as a biologist. Emphasis will be placed on:

- obtaining information about a real biological situation from a mathematical model and
- criticism of the results obtained from the models and, where appropriate, criticism on the models themselves.

Skills

- Qualitative and quantitative knowledge of elementary functions.
- Handling of derivatives of functions.
- Interpretation of the ordinary differential equations and the systems that appear in some models of Biology.
- Identification of properties of the solutions of an ordinary differential equation and of the systems of ordinary differential equations from the equations.
- Recognition of the interaction between species from a mathematical model.
- Solving systems of linear algebraic equations.
- Interpretation of difference equations and systems of difference equations that appear in some models of Biology. Use of matrices in Gauss method and in discrete models.

PLANNED LEARNING ACTIVITIES

THEORY SYLLABUS

- Unit 0. Review of basic concepts. Equations and inequalities. Functions: derivation, handling of tables, sketch of graphs. Matrices and linear systems: reduced form of a matrix and system resolution.
- Unit 1. Continuous models of population growth. Differential equations. Qualitative study of the solutions. Malthus, Verhulst, Gompertz and von Bertalanffy models.
- Unit 2. Continuous models of interaction between species. Systems of differential equations. Equilibrium point and orbits. Phase portrait. Stability.
- Unit 3. Discrete models of population growth. Difference equations. Fixed points, cycles and stability. Malthus, logistic and Ricker models.
- Unit 4. Growth models structured by age. State models. Systems of equations in linear differences. Powers of a matrix. Positive matrices.
- Unit 5. Parameter estimation. Least squares method. Linear and nonlinear cases. Linearization.

PRACTICAL SYLLABUS

Computer practices with software to be determined by the teaching staff

Practice 1. Simulation of continuous models of population dynamics.
Practice 2. Simulation of interaction models between species.
Practice 3. Simulation of discrete models of population dynamics.
Practice 4. Simulation of matrix models of population dynamics.
Practice 5. Tools for parameter estimation in discrete and continuous models of biology.

RECOMMENDED READING

ESSENTIAL READING

- H. Anton. Introducción al álgebra lineal. Editorial Limusa, 1990.
- C. Rorres, H. Anton. Aplicaciones de álgebra lineal. Editorial Limusa, 1979.
- D.G. Zill. Ecuaciones diferenciales con aplicaciones. Editorial Iberoamérica, 1988.

COMPLEMENTARY READING

- F. Brauer, C. Castillo-Chávez, Mathematical Models in Population Biology and Epidemiology, Second Ed., Springer-Verlag, New York, 2012
- Caswell, H. (2001) Matrix Population Models: Construction, Analysis and Interpretation, 2nd edn. Sinauer Associates, Sunderland, Massachusetts, USA.
- L. Edelstein-Keshet. Mathematical Models in Biology. SIAM, Philadelphia, 2005.
- S.P. Ellner, J. Guckenheimer. Dynamic Models in Biology. Princeton University Press, 2006.
- M. Kot. Elements of Mathematical Ecology. Cambridge University Press, 2001.
- J.D. Murray. Mathematical Biology I: An Introduction (3rd Edition). Springer, 2002.
- J.D. Murray. Mathematical Biology II: Spatial Models and Biomedical Applications. (3rd Edition). Springer, 2003.
- J. Rodríguez. Ecología. Ediciones Pirámide, 2001.
- H.R. Thieme. Mathematics in Population Biology. Princeton University Press, 2003.

RECOMMENDED LEARNING RESOURCES/TOOLS

- Prado (https://prado.ugr.es/)

TEACHING METHODS

- MD01 Lección magistral/expositiva
- MD02 Sesiones de discusión y debate
- MD03 Resolución de problemas y estudio de casos prácticos
- MD06 Prácticas en sala de informática
- MD07 Seminarios
- MD08 Ejercicios de simulación
- MD10 Realización de trabajos en grupo
- MD11 Realización de trabajos individuales

ASSESSMENT METHODS (Instruments, criteria and percentages)

ORDINARY EXAMINATION DIET

In accordance with the Evaluation and Qualification Regulations for students at the University of Granada (can be consulted at https://www.ugr.es/sites/default/files/2017-09/examenes.pdf), for this subject it is proposed both a continuous evaluation and a single final one. By default, all students will follow the continuous assessment system, unless they indicate otherwise in a

timely manner to the Head of the Department by virtue of the previous regulations.

A) For the ordinary call, the continuous evaluation will have the following components:

- Evaluation of theoretical knowledge and problem solving, through two scheduled tests (N1, N2), each weighing 30% of the grade.
- Resolution of problems, questionnaires and / or any other activity that the teacher proposes, (N3), with a weight of 15% of the grade
- Evaluation of computer practices (N4) with a weight of 25% of the grade, distributed as follows: delivery of proposed exercises (10%) and a group work (15%).

In all the proposed evaluable activities, the evaluation may be complemented with interviews with the teaching staff. The explanations given in the interviews will be binding when grading the activities carried out by the student.

The rating will be the result of the sum N = 0.3 N1 + 0.3 N2 + 0.15 N3 + 0.25 N4. The course will be considered passed as long as the following two conditions are verified:

- The N sum is equal to or greater than 5 out of 10.
- The grades N1, N2, N3 and N4 are equal to or greater than 3 points out of 10 in each of them.

In this case, the grade for continuous evaluation will be N.

Those students who wish to do so may examine the contents corresponding to tests N1 and / or N2 on the date scheduled for the ordinary call by the Teaching Committee, in which case, the grade will replace the one previously obtained.

In the case of not passing the subject for:

- not comply i. then the final grade will be equal to the sum 0.3 N1 + 0.3 N2 + 0.15 N3 + 0.25 N4,
- not comply ii. although i. is verified, then the final grade will be 4.5.

It is also recalled that, according to the evaluation regulations of the UGR referred to above (chapter VI, Article 22, point 4):

"When the student has carried out activities and tests of the Continuous Assessment process contemplated in the Teaching Guide of the subject that constitute more than 50% of the total weighting of the final grade for the subject, they will appear in the minutes with the corresponding grade"

regardless of the performance of the ordinary call exam.

EXTRAORDINARY EXAMINATION DIET

For the extraordinary call, the qualification will be obtained through the following components

- Knowledge assessment by solving problems and theoretical-practical questions, through a written test with a weight of 75% of the grade.
- Evaluation of practices, by carrying out a practical test in a computer room, with a weight of 25% of the qualification. In case the student agrees, the N4 grade obtained by continuous evaluation will be considered.

The course will be considered passed if the sum of both parts reaches 50% of the total.

SINGLE FINAL ASSESSMENT (evaluación única final)

The student who takes advantage of the single final evaluation system will be evaluated on the date scheduled for the ordinary call by the Teaching Commission as follows:

- Knowledge assessment by solving problems and theoretical-practical questions, through a written test with a weight of 75% of the grade.
- Evaluation of practices, by carrying out a practical test in a computer room, with a weight of 25% of the qualification.

The course will be considered passed if the sum of both parts reaches 50% of the total.