COURSE GUIDE

Mathematics (2001114)

Approval date: 20/06/2024

Grado (Bachelor's Degree)	Grado en Biología	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)

- Continuous models in biology: differential equations
- Identification of the solutions of an ordinary differential equation.
- Models of relationships between species: systems of differential equations
- Parameter estimation.
- Discrete models in biology: difference equations.
- Discrete matrix models in biology.
- Derivation using tables. Geometric interpretation. Interpretation in Biology.

SKILLS

GENERAL SKILLS

- CG01 - Organisational and planning skills
- CG03 - Applying knowledge to problem solving
- CG04 - Capacity for analysis and synthesis
- CG06 - Critical reasoning
- CG16 - Creativity
- CG17 - Information management skills

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 - Knowing mathematics and statistics applied to Biology.

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 continuous biological models.
- Recognition of the interaction between species from a mathematical model.
- Solving systems of linear algebraic equations.
- Interpretation of equations and their solutions in some discrete models of Biology.
- Use of matrices 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, systems of linear equations and its resolution.
- Unit 1. Continuous growth models using differential equations. Qualitative study of the solutions. Malthus, Verhulst, Gompertz, and von Bertalanffy models.
- Unit 2. Continuous models of species interaction using systems of differential equations. Equilibrium points and orbits. Phase portrait. Stability.
- Unit 3. Discrete population growth models using difference equations. Fixed points, cycles, and stability. Malthus, logistic, and Ricker models.
- Unit 4. Age-structured growth models and state models using systems of linear difference equations.
- Unit 5. Parameter estimation using the least squares method. Linear and nonlinear cases. Linearization.

PRACTICAL SYLLABUS

Computer practices with software to be determined by the teaching staff

- Practice 0. Introduction.
- Practice 1. Simulation of continuous population models.
- Practice 2. Simulation of species interaction models.
- Practice 3. Simulation of discrete population models.
- Practice 4. Simulation of matrix population models.
- Practice 5. Tools for parameter estimation in continuous and discrete models in Biology.

RECOMMENDED READING

ESSENTIAL READING

- H. Anton, C. Rorres. Introducción al álgebra lineal (con aplicaciones en negocios, economía, ingeniería, física, ciencias de la computación, teoría de aproximación, ecología, sociología, demografía y genética), 5ª edición. Editorial Limusa Wiley, 2013.
- D.G. Zill. Ecuaciones diferenciales con aplicaciones de modelado (11ª edición). Cengage Learning Editores, 2019

COMPLEMENTARY READING

- Brauer, C. Castillo-Chávez. Mathematical Models in Population Biology and Epidemiology, Second Edition. Springer-Verlag, New York, 2012.
- H. Caswell. Matrix Population Models: Construction, Analysis and Interpretation (2nd edition). Sinauer Associates, Inc., 2006.
- 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, 4ª edición. Ediciones Pirámide, 2016.
- 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

According to the "Normativa de evaluación y de calificación de los estudiantes de la Universidad de Granada" (which can be consulted at https://www.ugr.es/sites/default/files/2017-09/examenes.pdf), for this subject both continuous assessment and a single final assessment are proposed. By default, all students will follow the

continuous assessment system, unless they request otherwise in due time and form to the Department Director in accordance with the previous regulations.
A) For the ordinary call, continuous assessment will have the following components:

- Evaluation of theoretical knowledge and problem-solving through:
  - A scheduled test N12 (from topics 1 and 2), with a weight of 32.5% of the grade.
  - A scheduled test N3 (from topic 3), with a weight of 16.25% of the grade.
  - A test N4 (from topic 4), on the date assigned to the ordinary call, with a weight of 16.25% of the grade.
- Problem solving, questionnaires, and/or any other activity proposed by the professor (N5), with a weight of 10% of the grade.
- Evaluation of computer practices (N6), with a weight of 25% of the grade and distributed as follows: submission of proposed exercises (10%) and completion of a group project (15%).

In all proposed activities, grading may be supplemented 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 grade will be obtained using the expression **N = (26*N12 + 13*N3 + 13*N4 + 8*N5 + 20*N6) / 80** (where the grades N12, N3, N4, N5, and N6 are scored out of 10). The subject will be considered passed provided that the following two conditions are met:
(i) The grade **N is equal to or greater than 5 points out of 10.**
(ii) The grades **N12, (N3+N4)/2, and N6 are equal to or greater than 3 points out of 10 each.**
In this case, the grade by continuous assessment will be **N**.
Those students who wish to do so may take exams on the contents corresponding to tests N12 and/or N3 on the date scheduled for the ordinary call by the Teaching Commission, in which case the grade obtained will replace the previously obtained one.
In the event of not passing the subject due to:

- Not meeting (i), then the final grade on the record will be **N**.
- Not meeting (ii) even if (i) is met, then the final grade on the record will be 4.5.

It is also reminded that, according to the evaluation regulations of the UGR referenced 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 weight of the final grade of the subject, it will appear on the record with the corresponding grade"
regardless of taking the ordinary call exam.

EXTRAORDINARY EXAMINATION DIET

For the extraordinary call, the grade will be obtained through the following components:

- Knowledge evaluation through problem-solving and theoretical-practical questions, via a written test with a weight of 75% of the grade. Alternatively, the grade (26N12 + 13N3 + 13N4 + 8N5) / 60 obtained in the continuous assessment will be considered.
- Practice evaluation, through the completion of a practical test in the computer lab, with a weight of 25% of the grade. Alternatively, the grade N6 obtained in the continuous assessment will be considered.

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

SINGLE FINAL ASSESSMENT (evaluación única final)

Students who opt for the single final evaluation system will be assessed on the date scheduled for the ordinary call by the Teaching Commission in the following manner:

- Knowledge evaluation: 75% of the grade. A written test will be conducted, covering the theory topics, including problem-solving and theoretical-practical questions.

- Computer practice evaluation: 25% of the grade. A test will be conducted, using a computer, covering the practice topics.

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

ADDITIONAL INFORMATION

Información de interés para estudiantado con discapacidad y/o Necesidades Específicas de Apoyo Educativo (NEAE): Gestión de servicios y apoyos (https://ve.ugr.es/servicios/atencion-social/estudiantes-con-discapacidad).

SOFTWARE LIBRE

Yes. LibreOffice and OpenOffice.