COURSE OUTLINE

1. GENERAL

SCHOOL	School of Agricultural Sciences		
ACADEMIC UNIT	Biosystems & Agricultural Engineering		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	BAE_400	**SEMESTER**	4th
COURSE TITLE	COMPUTATIONAL SIMULATIONS OF BIOSYSTEMS		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	3	
Laboratory	2	
TOTAL	**5**	**5**
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Special background(Simulation)
PREREQUISITE COURSES:	There are no prerequisite courses.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek, and in English for Erasmus students.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

This course serves as an introduction to modeling and simulation of biosystems, mainly through simple models of population dynamics. Fundamental ideas and methods in modeling, such as mass balance and the introduction of appropriate timescales for the study of processes, basic analytic tools, such as local stability theory of fixed points, and simulation of different sorts of models in Matlab are taught.

Upon successful completion, students will have the knowledge and skills to:

- To identify the attributes of a given model (whether it is deterministic or probabilistic, linear or not, continuous or discrete time, etc)
- To give the general solution of a model, where possible, and to simulate it in Matlab
- To calculate the fixed points of a model and analyze their stability properties
- To construct the phase diagram and the bifurcation diagram of a model
- To simulate Markov chains
- To numerically optimize model parameters

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology *Adapting to new situations* *Decision-making* *Working independently* *Team work* *Working in an international environment* *Working in an interdisciplinary environment* *Production of new research ideas*	*Project planning and management* *Respect for difference and multiculturalism* *Respect for the natural environment* *Showing social, professional and ethical responsibility and sensitivity to gender issues* *Criticism and self-criticism* *Production of free, creative and inductive thinking* *……* *Others…* *…….*

In general, upon completion of this course the student will have further developed the following general skills (from the list above):
Search, analysis and synthesis of data and information, using the necessary technologies
Decision making
Autonomous work
Team work

3. SYLLABUS

Lectures:
1) Simple models of population dynamics (birth-death processes) in discrete and continuous time. Review of linear homogeneous differential equations (DE) of 1st order with constant coefficients, and of linear homogeneous difference equations of 1st order with constant coefficients.
2) Simple compartmental models with in- and out-flows and their limiting behavior.
3) The logistic model of population dynamics, its analytical solution and the analysis of its solutions. Fixed points (FP) and their stability in single-state models.
4) Local stability of fixed points in single-state models. Analysis of various models.
5) Volterra - Lotka and Holling – Tanner prey-predator models. Phase diagrams, fixed points and periodic orbits in multi-state models.
6) Local stability of fixed points in multi-state models. Review of the concepts of eigenvector and eigenvalue from Linear Algebra.
7) The solution of linear homogeneous differential systems (DS) of 1st order with constant coefficients, and stability.
8) Local stability analysis of fixed points in various models of population dynamics.
9) Dependence of the number and type of fixed points on model parameters and bifurcation diagrams.
10) Linear homogeneous difference systems of 1st order with constant coefficients, their solution and stability. Applications to Leslie models.
11) Introduction to Markov chains.
12) Applications of Markov chains in biosystems.
13) Food-chain models in biosystems.

Labs:
1) Introduction to Matlab I (basic commands, graphs, M-files)
2) Introduction to Matlab II (flow control, functions)
3) Numerical solution of 1st order ordinary differential equations
4) Numerical solution of 1st order ordinary differential systems, phase diagrams I
5) Numerical solution of 1st order ordinary differential systems, phase diagrams II
6) Matrix algebra, linear algebraic systems, eigenvectors and eigenvalues
7) Linear homogeneous differential systems of 1st order with constant coefficients and their phase diagrams
8) Linear homogeneous difference systems of 1st order with constant coefficients
9) Markov chain simulation
10) Parameter optimization in biosystems

4. TEACHING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to face

<table>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>• Use of Google Jamboard and Matlab in Teaching
• Use of Matlab in Labs
• Learning process support through an e-class platform.</td></tr>
<tr><td>TEACHING METHODS
The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.
The student's study hours for each learning activity are given as well as the hours of non directed study according to the principles of the ECTS</td><td><table><tr><th>Activity</th><th>Semester workload</th></tr><tr><td>Lectures</td><td>39</td></tr><tr><td>Laboratory</td><td>26</td></tr><tr><td>Writing short reports on laboratory exercises</td><td>13</td></tr><tr><td>Studying and preparation for the final exam</td><td>47</td></tr><tr><td>Course total</td><td>125</td></tr></table></td></tr>
<tr><td>STUDENT PERFORMANCE EVALUATION
Description of the evaluation procedure
Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other
Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</td><td>1. The laboratories participate by 30% in the final grade. In order to be examined in theory, the student must have completed all the laboratories and have been successfully examined in them.
2. The main assessment criteria focus on understanding and correlating the knowledge that students gain from the course with other knowledge. Particular emphasis is placed on whether they have developed the ability to apply this knowledge to crop selection and to assess the impact of these changes on the environment. Emphasis is also placed on demonstrating critical ability and justifying the choices they make in each problem.
3. Evaluation is dynamic. It mainly involves problem solving. is done orally or in writing or with a combination of the two, with or without pre-examination on the basic principles of the course, with or without exculpatory advances and with other test or inventive methods, depending on the composition of the dynamics and the needs of the audience.
4. The above are done in the Greek language. For foreign language students (eg Erasmus students) conducted in English</td></tr>
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5. RECOMMENDED LITERATURE

- Βιβλίο [59395586]: Μαθηματικά μοντέλα στη Βιολογία 2η έκδοση, Σγαρδέλης Στέφανος Λεπτομέρειες
- Βιβλίο [50661221]: Περιβαλλοντικά Μοντέλα, 2η Έκδοση, Schnoor Jerald L. Λεπτομέρειες
- Βιβλίο [11441]: Οικολογία, Στάμου Γεώργιος Π. Λεπτομέρειες
- Βιβλίο [33156126]: ΤΑ ΜΑΘΗΜΑΤΙΚΑ ΤΗΣ ΖΩΗΣ, Ian Stewart Λεπτομέρειες

Additional reading:

- Βιβλίο [320336]: ΔΟΜΗ ΚΑΙ ΔΥΝΑΜΙΚΗ ΒΙΟΚΟΙΝΟΤΗΤΩΝ, ΓΕΩΡΓΙΟΣ ΣΤΑΜΟΥ Λεπτομέρειες
- Βιβλίο [59303654]: ΜΑΘΗΜΑΤΙΚΗ ΜΟΝΤΕΛΟΠΟΙΗΣΗ, ΣΤΑΥΡΟΣ ΚΟΜΗΝΕΑΣ Λεπτομέρειες
- Modeling Life [e-book], Alan Garfinkel, Jane Shevtsov, Yina Guo, HEAL-Link Springer ebooks, 2017.