COURSE OUTLINE

1. GENERAL

SCHOOL	School of Agricultural Sciences		
ACADEMIC UNIT	Agriculture		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	AGRI_ EE5	**SEMESTER**	8th
COURSE TITLE	Systems Simulation and Modeling of Agrobiosystems		

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	2	
Tutorial	0	
Laboratory	2	
TOTAL	**4**	**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*	General knowledge (Simulation and Modeling)
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*

Agrobiosystem is a human-induced ecosystem managed for the production of food, fuel and fiber. It covers 1/4th of the global land surface area. Problems such as greenhouse gas emissions, smog, erosion, salinization, water pollution, eutrophication, loss in biodiversity, and insect and pest prevalence are predominantly due to inaccurate agroecosystem management. The understanding of the mechanisms/processes responsible for the degradation of the agroecosystem could reverse these negative trends and can help to develop new strategies from gene to field scale. Models are a good tool to describe the response of agroecosystems under different sets of biotic and abiotic scenarios. This course serves as an introduction to modeling and simulation of agroecosystems, mainly through simple models of population dynamics. These models are helpful in ideotype designing, phenotyping, understanding of Genotype (G) x Environment (E) x Management (M) interactions, crop physiological mechanisms, water and nutrient management, conservation and precision agriculture, insect, pest, and disease forecasting, soil organic carbon dynamics, socioeconomic analysis, and climate impact assessments. However, to get reliable information from all these models, we need to have a goodquality data set.

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

- The Biosphere,
- Systems concepts

2. Systemic Properties of Agrobiosystems, Case studies

3. Systems Methodologies

- General systems methodology
- Life cycle assessment
- Biological modeling
- Data analysis
- Steps in agrobiosystems Modeling
- System Classification
- Input Functions of Time
- Output Functions of Time

4. 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.

5. Interacting population models: Growth and Feedback in Population Biology

- Exponential growth equation
- Logistic equation: 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.
- Lotka-Voterra's predator-prey equation
- Multispecies extension of Lotka-Volterra and Holling – Tanner prey-predator models.
- Phase diagrams, fixed points and periodic orbits in multi-state models.
- Local stability of fixed points in multi-state models. Review of the concepts of eigenvector and eigenvalue from Linear Algebra.

- The dynamics of infection
- Feedback analysis
- Steady state and isocline analysis

6. Conservation of Mass in Natural Resource Systems

- Simple compartmental models with in- and out-flows and their limiting behavior.
- One-compartment system
- Two-compartment system
- Three-compartment system
- Multiple-compartment system

7. Oscillations and Stability in Biological Systems

- Simple harmonic motion
- Damped motion
- Damped forced vibrations
- Forced free vibrations
- Stability test by the isocline and phase-plane methods

8. Linear homogeneous difference systems of 1st order with constant coefficients, their solution and stability. Applications to Leslie models.

9. Introduction to Markov chains.

10.Applications of Markov chains in agrobiosystems.

11.Food-chain models in agrobiosystems.

12. Parameter optimization in biosystems

13. Sustainability

- Sustainable harvesting
- Fisheries management
- Nutrient loading

Laboratory exercises

1. The steps to develop a simulation model. The agrobiosystem as a case study
2. Mechanistic modelling of plant growth. Input/Output functions of time
3. Simple models of population dynamics
4. Interacting population models (Exponential growth equation, Logistic equation, Lotka-Voterra's predator-prey equation)
5. Phase diagrams, fixed points and periodic orbits in multi-state models. Parameter optimization in the agrobiosystems
6. Conservation of mass in natural resource systems: Simple compartmental models with in- and out-flows and their limiting behavior.
7. Computer Simulation in Plant growth (DSSAT model, GreenLab model, CropSyst model)

4. TEACHING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to face lectures in the classroom, laboratory and field.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of Google Jamboard and Matlab in Teaching • Use of Matlab in Labs • Learning process support through an e-class platform.
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*	(see table below)

Activity	***Semester workload***
Lectures	26
Laboratory	26
Writing short reports on laboratory exercises	13
Final Exams	3
Studying and preparation for the final exam	57
Course total	**125**

learning activity are given as well as the hours of non directed study according to the principles of the ECTS	
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.*	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

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.
- Plant Growth Curves: The Functional Approach to Plant Growth Analysis, Roderick Hunt Publisher: Cambridge University Press; Revised ed. edition (9 Mar. 2010) ISBN-10 : 0521427746, ISBN-13 : 978-0521427746 https://www.amazon.de/-/en/Roderick-Hunt/dp/0521427746