CE81 - Mathematical Modelling

GENERAL

SCHOOL	EXACT SCIENCES		
DEPARTMENT	MATHEMATICS		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	CE81	**SEMESTER**	H
COURSE TITLE	MATHEMATICAL MODELLING		

INDEPENDENT TEACHING ACTIVITIES	**WEEKLY TEACHING HOURS**	**ECTS**
Lectures	4	6

COURSE TYPE	Scientific Field
PREREQUISITE COURSES	-
LANGUAGE OF TEACHING AND EXAMINATIONS	Greek/English
THE COURSE IS OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	http://eclass.uowm.gr/

LEARNING OUTCOMES

Learning Outcomes

Upon successful completion of the course, the students will be able to:

- know the basic stages for the construction of mathematical models,
- know the meaning and importance of fundamental laws, such as the principle of conservation of mass, energy, etc., as well as the variables that appear in them,
- use the fundamental laws for the production of simple mathematical models which will describe simple physical problems, e.g. one-dimensional flow in a cylindrical section, and other similar problems from chemistry, biology, etc.,
- know the concept of the functional, and the concept of the minimum for it, i.e.

introductory concepts of calculus of variations,

- define a functional and produce simple academic models such as Laplace equation,
- distinguish the various common academic problems that they encounter, e.g., P.O.E. first, second order, if they describe transport, diffusion, wave effects, etc.,
- know the basic steps for building mathematical models.

General Competencies

- Search, analysis and synthesis of data and information, using the necessary technologies.
- Indivisual work and also team work in an interdisciplinary environment
- Making decisions.
- Promotion of free, creative and inductive thinking.

CONTENT OF THE COURSE

Introductory concepts, what is the mathematical model.
Iterative concepts and theorems of Infinite Calculus, eg, parametrization of particle motion, divergence theorem, concept of tensor.
Description in Euler and Lagrange coordinates.
Conservation laws in one dimension.
Conservation of mass, energy momentum.
Derivation of a quantity in a passage that varies with time.
Conservation laws in many dimensions, and with discontinuities.
Use of laws and production of simple mathematical models, examples.
What is functional, its derivatives, finding minima in simple-special cases,
Examples of mathematical models with the process of finding minima for functors.

TEACHING AND LEARNING METHODS - EVALUATION

TEACHING METHOD	In the classroom.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY	Graphics and video software for representing natural phenomena. e-Lectues. Use of e-class. Communication through face-to-face discussions and e-mails.
TEACHING ORGANIZATION	

Activity	Semester Workload
Lectures	52 hours
Exercises, study and search for results in bibliography	35 hours

	Individual Study	63 hours
	Course Total (25 hours per ECTS)	150 hours
STUDENT EVALUATION	Projects, problem solving with a related search in the bibliography 30%. Written final examination 70%.	

RECOMMENDED BIBLIOGRAPHY

1. Mathematical Modelling-A Study in the Natural Sciences, Stavros Komineas, Evangelos Charmandaris, Publisher: Association of Greek Academic Libraries.
2. A Primer on Mathematical Modeling, Alfio Quarteroni, Paola Gervasio Springer, freeLink.
3. Applied Mathematical Modeling of Engineering Problems, Natali Hritonenko, Yuri Yatsenko.
4. Applied mathematics, Logan David, Translation: Dougalis V., Mitsoudis D., Stratis I., Univ. Publications of Crete. (Greek)
5. Applied Numerical Methods with MATLAB for Engineers and Scientists, S. Chapra, (Awaiting Translation by G. Sisias, publications Tziola AE.). (Greek)
6. A. B. Taylor, Mathematical Models in Applied Mechanics, Oxford University Press (1984).
7. G. K. Batchelor, An Introduction to Fluid Dynamics (Cambridge University Press, Cambridge, 2000).
8. N. D. Fowkes J. J. Mahoney, An Introduction to Mathematical Modelling, John Wiley (1990).
9. K. F. Riley, M. P. Hobson and S. J. Bence, Mathematical Methods for Physics and Engineering (3rd edition, Cambridge University Press, 2006).
10. Mathematical Modeling, Christof Eck, Harald Garcke, Peter Knabner, Springer, 2017.