INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Option IV - Modelling of Environmental Systems			Field of study	Environment and Geographic Information		
Master in	Renewable Energy and Energetic Efficiency			School	School of Technology and Management		
Academic Year	2023/2024	Year of study	2	Level	2-2	ECTS credits	6.0
Type	Semestral	Semester	1	Code	6793-475-2102-02-23		

Workload (hours)	162	Contact hours	T	TP	PL	TC	S	E	OT	O
			30	30	-	-	-	-	-	-

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s): Manuel Joaquim Sabença Feliciano

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Apply fundamental numerical methods to specific simulation problems
2. Analyse results from numerical simulations
3. Be aware of modelling methodologies for ecological and environmental problem solving
4. Develop and apply models using computational tools

Prerequisites

Before the course unit the learner is expected to be able to:
Basic knowledge in Mathematics and Statistics. Concepts of Ecology and System Dinamics.

Course contents

Introduction to modelling and simulation. Fundamentals of mathematical modelling: mathematical models and its classification; developing process of mathematical models. Mathematical methods and tools for modelling applications: static and dynamic formulations; analytical and numerical methods. Continuous simulation models: conceptual formulation; numerical specification; model evaluation and model use; Simulation problems applied to Ecology and Environment. Modeling of complex env. systems.

Course contents (extended version)

1. Basic concepts of systems analysis and simulation:
   - system, system analysis, model, and simulation
2. Theoretical phases of systems analysis:
   - conceptual-model formulation
   - quantitative-model specification
   - model evaluation
   - model use, and model validation
3. Conceptual-model formulation:
   - model objectives
   - bounding the system of interest
   - components of the system, state and driving variables, constants, auxiliary variables
   - material and information transfers, sources and sinks
   - relationships among components of interest, sub-models
   - representation of the conceptual model, description of expected patterns of model behaviour
4. Statistical modeling: regression as modeling tool
   - linear regression model, non-linear regression
   - growth and yield models, concepts on growth and yield
5. Quantitative-model specification:
   - quantitative structure of the model (difference equations and general compartment-model structure)
   - time units for the simulations
   - functional forms of the model, parameterization
   - baseline simulations
6. Model evaluation:
   - reasonableness of the model structure and interpretability of functional relationships
   - correspondence between model behaviour and the expected patterns of model behaviour
   - correspondence between model predictions and real data, sensitivity analysis
7. Model use: experimental design for the simulations, analysis and interpretation of the results

Recommended reading

1. Grant W. E. , Pedersen E. K. e Marín S. L. , 1997, Ecology and natural resource management. Systems analysis and simulation. John Wiley & Sons. USA.
2. Hannon B. e Ruth M. , 2014. Modeling dynamic biological systems. 2nd Ed. , Springer-Verlag Inc, New York.
3. Nirmalakhandan N. 2002. Modeling Tools for Environmental Engineers and Scientists. CRC Press. EUA.

Teaching and learning methods

Classes based upon the development of individual modeling projects relative to environmenal and ecological systems, lab exercices and presentation of scientific papers. Class project for most of the semester. Literature research, conventional and online resources. E-learning resources available to access presentations and other documentation.

Assessment methods

1. Regular students - (Regular, Student Worker) (Final, Supplementary, Special)
   - Projects - 60% (Project development, progress presentation/reporting, final presentation/report. Min. grade 7 marks)
   - Practical Work - 30% (Reports of lab exercises)
   - Presentations - 10% (Oral presentation of a scientific report)
2. Workers - (Student Worker) (Final, Supplementary, Special)
   - Projects - 50% (Modeling project.)
   - Final Written Exam - 50% (final exam Minimum grade: 7 marks)

Language of instruction

Portuguese, with additional English support for foreign students.

Electronic validation

Manuel Joaquim Sabença Feliciano	Luís Manuel Frolen Ribeiro	José Carlos Rufino Amaro
06-11-2023	06-11-2023	07-11-2023