Syllabus

Course Description

Course Title	Elements of modelling for Applied Physics and Engineering Systems
Course Code	46013
Course Title Additional	
Scientific-Disciplinary Sector	IIND-07/B
Language	English
Degree Course	PhD Programme in Sustainable Energy and Technologies
Other Degree Courses (Loaned)	
Lecturers	Prof. Andrea Gasparella, andrea.gasparella@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/30619
Teaching Assistant	
Semester	Second semester
Course Year/s	1
CP	3
Teaching Hours	20
Lab Hours	0
Individual Study Hours	75
Planned Office Hours	
Contents Summary	1. mastering the most important concepts about modelling physical systems 2. developing simulation models based on the mathematical description of physical systems 3. applying the concepts to case studies 4. understanding potential and limitations of simulation for applications

Course Topics	List of topics covered Modeling and simulating: Calculation vs. simulation. Model accuracy. Model validation. Model definition: Definition of model for physical systems. Analytical vs numerical solutions. Model refinement and extension. Finite difference approaches: Solution of partial derivatives differential equations with finite difference approaches. Consistency, stability and convergence. First order schemes (forward, backward). Second order schemes (central, Crank-Nicolson) Applications: Development of case studies. Examples from thermal and thermodynamic systems. Modelling of systems and solutions of control problems.
Keywords	
Recommended Prerequisites	
Propaedeutic Courses	
Teaching Format	Lectures (blackboard and/or slides) and spreadsheet implementation.
Mandatory Attendance	Not compulsory
Specific Educational Objectives and Learning Outcomes	(1) Knowledge and understanding: - Modelling and simulation vs calculations - Derivation of models for physical systems - Numerical solutions of differential equations (2) Applying Knowledge and understanding: - Defining models for case studies - Applying simulations to understand system behavior - Calculating multiple performance aspects (3) Making judgments: - Comparing different modelling approaches - Deciding the degree of accuracy required for the specific application - Optimizing the design or behavior of a system using modelling approaches

	(4) Communication skills: - Using the appropriate technical vocabulary related to the topic - Preparing a report representing and summarizing complex results and providing appropriate interpretation (5) Learning skills: - Decomposing a complex problem into sub-problems - Finding the analytical expression and the numerical solution - Comparing different methods and sources
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	
Evaluation Criteria	Marks are attributed according to the following assessment aspects: - Synthesis ability to explain the fundamental aspects of the problem (0=nothing, 1=insufficient; 2=sufficient; 3=full) - Analysis ability to describe details and specific formulas/models (0=nothing, 1=insufficient; 2=sufficient; 3=full) - Application ability to implement the principles and formulas and to solve practical cases (0=nothing, 1=insufficient; 2=sufficient; 3=full) - Reporting ability to represent and summarize the main results and to provide an appropriate interpretation
Required Readings	- Teaching material, handouts, booklets from the reserve collection
Supplementary Readings	- Carl-Eric Hagentoft, 2001, Introduction to Building Physics, Professional Pub Service
Further Information	
Sustainable Development Goals (SDGs)	Quality education, Climate action, Responsible consumption and production, Affordable and clean energy