Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Modelling Methods for Applied Physics
Course code	43013
Scientific sector	ING-IND/11 (09/C2)
Degree	PhD in Sustainable Energy and Technologies
Semester	2
Year	1
Academic year	2024/2025
Credits	3
Total lecturing hours	20
Specific educational objectives	**Learning objective of the course**: 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
Lecturer	Andrea Gasparella
Scientific sector of the lecturer	ING-IND/11 (09/C2)
Teaching language	English
Office hours	Monday 16-18
List of topics covered	**List of topics covered** Modeling and simulating: Calculation vs. simulation. Model accuracy. Model validation. Model definition: Definition of model for physica systems. Analytican 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.
Teaching format	Lectures (blackboard and/or slides) and spreadsheet implementation.
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

Evaluation criteria and criteria for awarding marks	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