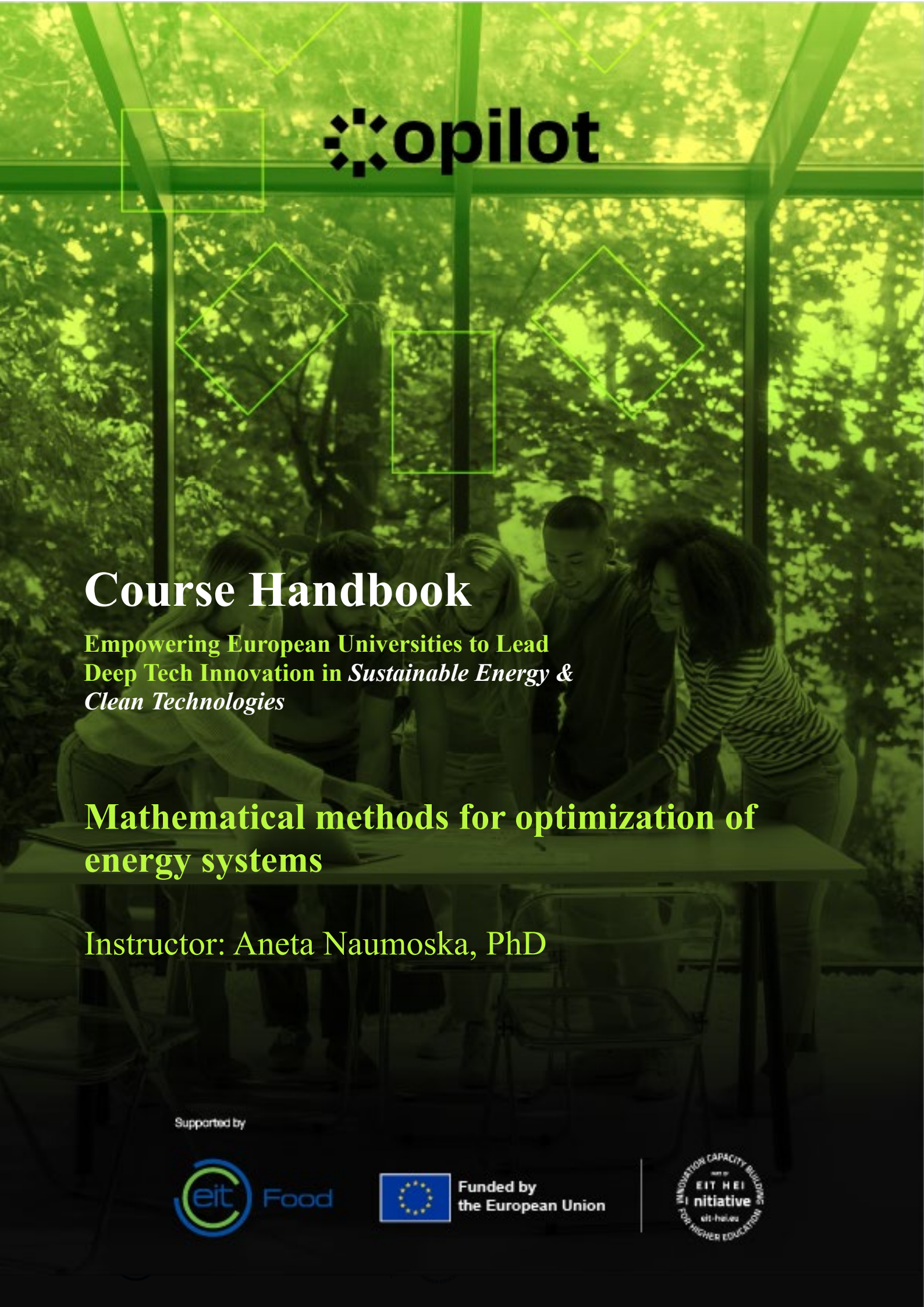


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Course Handbook

Empowering European Universities to Lead Deep Tech Innovation in *Sustainable Energy & Clean Technologies*

Mathematical methods for optimization of energy systems

Instructor: Aneta Naumoska, PhD

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Course Information

Title: ***MATHEMATICAL METHODS OF ENERGY SYSTEMS OPTIMIZATION***

Instructor: Aneta Naumoska, PhD

ECTS credits: 2

Course structure: *5 sessions, 2 lectures + 2 tutorials per session (intensive format)*

Mode of delivery: *online*

Course Summary

This course provides a practical and intuitive introduction to mathematical optimization for energy systems. It explores how optimization models are used to improve the performance, efficiency, and cost-effectiveness of energy technologies—from individual components to entire energy networks. Through lectures and problem-solving sessions, students learn how to formulate optimization problems, define objective functions, apply constraints, and use modern mathematical and computational methods to achieve optimal system designs.

Students will gain skills in:

- Formulating optimization models for energy systems using objective functions, variables, and constraints.
- Applying key mathematical methods such as linear, nonlinear, and multi-objective programming.
- Using calculus-based tools, Lagrange multipliers, and Kuhn–Tucker conditions to solve constrained problems.
- Exploring modern optimization techniques including genetic algorithms, simulated annealing, and AI-based methods.
- Analyzing and optimizing energy systems such as heat exchanger networks and thermoeconomic models.

By the end of the course, learners will be able to construct and solve mathematical optimization problems for real-world energy applications, enabling smarter system planning, improved efficiency, and more sustainable energy solutions.

Course Participants

This course is designed for a wide range of students, researchers, and professionals interested in the modeling, analysis, and optimization of energy systems. It is suitable for those in engineering, energy technology, environmental science, applied mathematics, and computer science who want to develop

practical and theoretical skills in energy system optimization. The course welcomes both academic and non-academic participants, encouraging interdisciplinary collaboration between universities, industry, and research organizations working toward more efficient, sustainable, and cost-effective energy solutions.

Learning Outcomes

Upon completion of the course, participants will be able to:

1. Formulate optimization problems for energy systems using objective functions, variables, and constraints.
2. Apply linear, nonlinear, and multi-objective optimization methods to real energy applications.
3. Use calculus-based techniques (Lagrange multipliers, Kuhn–Tucker conditions) to solve constrained problems.
4. Implement modern optimization algorithms, including genetic algorithms and simulated annealing.
5. Analyze and optimize components and system models.

Assessment

For each participant to complete successfully the course and be awarded the corresponding ECTS credits, they must pass the course assessment. The outcome of the assessment can be either Pass or Fail. For passing there the participant should achieve 51%. The following distribution maintains a balanced emphasis between conceptual understanding (quiz), practical modeling (assignment), and integrative project-based learning (capstone, report, presentation).

Assessment methods

- Short quiz – 10%
- Report of practical assignment – 20%
- Capstone project implementation – 30%
- Final project report – 25%
- Oral presentation – 15%

The link between learning objectives and assessment criteria can be seen below.

Learning outcomes	Assessment examples
• Foundational understanding of optimization principles, mathematical formulations, and core concepts needed to model energy systems.	Short quiz
• Ability to apply optimization methods and perform problem-solving using real or simulated energy system scenarios.	Practical assignment
• Constructing, solving, and optimizing a complete energy system model using the techniques learned in the course, fulfilling the outcomes related to applying	Capstone project implementation Project presentation

linear, nonlinear, and advanced optimization methods.	
• Ability to analyze results, justify modeling choices, and demonstrate a deep understanding of system-level optimization and thermoeconomic analysis	Final project report
• Ability to clearly explain the optimization model, methodology, and findings—showing mastery of both theoretical understanding and practical application of optimization techniques in energy systems.	oral presentation

Mentoring

In the context of this course, participants will receive personalized mentoring and guidance throughout the learning process. Mentoring will be provided through a combination of one-to-one consultations, small group sessions, and supervised project work.

Bibliography

1. *Wilde D. J. and Beightler C. S.* ***Foundations of Optimization.*** *Prentice-Hall, Inc., Englewood Cliffs, N.J (1967)*
1. *Luenberger D. G.* ***Introduction to Linear and Non-Linear Programming****. Addison-Wesley Publishing Co., Reading, Massachusetts (1973)*
2. *Christos A. Frangopoulos****. Methods of energy systems optimization.*** *(2003)*

Other Important Information

Course evaluation: Upon successful completion of the course, participants are required to fill in the course evaluation questionnaire.

Certificate: Upon successful completion of the course, participants will be issued a certificate of achievement provided by The University of Information Science and Technology "St. Paul the Apostle" Ohrid and EIT Climate KIC.

Plagiarism: UIST has explicit rules concerning academic dishonesty, including plagiarism. Course participants are reminded that all work submitted as part of the requirements for any examination (including coursework) of UIST must be expressed in their own words and incorporated in their own ideas and judgements.

Course Timetable

Session	Date and Time	Instructor	Venue
1st	03.04.2026 / 17:00	Aneta Naumoska, PhD	online
2nd	17.04.2026 / 17:00	Aneta Naumoska, PhD	online
3rd	24.04.2026 / 17:00	Aneta Naumoska, PhD	online
4th	01. 05.2026 / 17:00	Aneta Naumoska, PhD	online
5th	08.05.2026 / 17:00	Aneta Naumoska, PhD	online

Contact Details of Instructor(s)

Name	Email	Telephone number
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