



COURSE DESCRIPTION CARD - SYLLABUS

Course name

Applied mathematics [S2Bud1E>MS]

Course

Field of study

Civil Engineering

Year/Semester

1/1

Area of study (specialization)

Smart and resilient buildings

Profile of study

general academic

Level of study

second-cycle

Course offered in

English

Form of study

full-time

Requirements

compulsory

Number of hours

Lecture

15

Laboratory classes

0

Other

0

Tutorials

15

Projects/seminars

0

Number of credit points

2,00

Coordinators

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Lecturers

Prerequisites

Basic knowledge of the following subjects: mathematics, theoretical mechanics, strength of materials, structural mechanics, as covered in Civil Engineering or similar programs at the Bachelor of Science level.

Course objective

The application-oriented course introduces key mathematical tools used in modern civil engineering, with emphasis on sustainable design, modelling, and decision-making. It focuses on practical applications: structural behaviour, heat transfer, optimization, and lifecycle assessment. Mathematical techniques for solving related boundary value problems will be also covered.

Course-related learning outcomes

Knowledge:

Student:

- understands principles of mathematical modelling in engineering systems;
- knows basic concepts of ODE/PDE models in structural and thermal problems;
- knows principles of modelling issues of mechanics;
- understands optimization and sustainability trade-offs;

- is familiar with uncertainty and reliability concepts;

Skills:

Student is able to:

- formulate simple mathematical models of engineering problems;
- perform basic numerical simulations and estimations;
- apply optimization methods to engineering design problems;
- interpret results in the context of sustainability and engineering practice;

Social competences:

Student:

- is able to critically assess engineering solutions considering efficiency, safety, and environmental impact;
- understands the role of mathematics in decision-making and digital engineering tools;

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Continuous assessment (exercises) and a final written test.

Grading scale:

- 90 - 100% → A
- 80 - 89% → B
- 70 - 79% → C
- 60 - 69% → D
- 50 - 59% → E
- < 50% → F

Programme content

Lectures (15 h)

1. Introduction to mathematical modelling (model formulation, scaling, engineering interpretation)
2. Differential equations in engineering (ODEs - structural response, PDEs - heat transfer, diffusion)
3. Energy methods and variational approach (equilibrium, concept of weak formulation)
4. Numerical methods (discretization, FEM concept, error and stability)
5. Optimization in sustainable engineering (linear programming, constrained optimization)
6. Uncertainty and reliability (variability, safety margins, probabilistic thinking)

Exercises (15 h)

1. Modeling simple engineering systems (beam, heat conduction)
2. Solving ODE/PDE problems (analytical + simple numerical)
3. Numerical approximation (FEM concept, discretization exercises)
4. Optimization tasks (material minimization / CO₂ reduction)
5. Reliability and uncertainty (simple probabilistic analysis)
6. Final test

Course topics

Mathematical modelling, ODEs, PDEs, numerical methods, optimization, probability, risk and uncertainty, statistics, digital twins

Teaching methods

Traditional lecturing supported by computer-based calculations, presentations, and visualizations

Bibliography

Basic:

1. A. H-S. Ang, W. H. Tang, Probability concepts in engineering. Wiley 2007
2. E. Kreyszig, Advanced engineering mathematics. Wiley 2011

Additional:

1. Roger T. Fenner, J.N. Reddy, Mechanics of solids and structures. CRC Press/Taylor & Francis Group

2012
2. O. C. Zienkiewicz, R. L. Taylor, The finite element method for solid and structural mechanics. Elsevier
2005

Breakdown of average student's workload

	Hours	ECTS
Total workload	60	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00