POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name

Numerical methods in electrical power engineering [S2Elenerg1>MNwE]

Course

Field of study
Electrical Power Engineering

Year/Semester
1/2

Area of study (specialization)
Smart Grids

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

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Lecturers

Prerequisites

The student should have extended and deepened knowledge of mathematics (in the field of first-cycle engineering studies) and computer science (in the field of programming in a high-level language). The student should be aware of the need to expand their competences, know the limitations of their own knowledge and understand the need for further education.

Course objective

1. Familiarizing students with topics related to numerical methods, e.g. with the differences between real and computer arithmetic, numerical errors, discretization, and advanced numerical algorithms. 2. Application of learned algorithms to solve selected mathematical problems and engineering tasks in the field of electrical power engineering. 3. Supporting calculations with appropriate IT tools. 4. Impact of numerical errors. 5. Verification of the obtained solutions.

Course-related learning outcomes

Knowledge:
he has deep knowledge of numerical methods, mathematical modeling and software supporting calculations in the power engineering.

Skills:
has the ability to apply and modify mathematical models in the power engineering.

Social competences:
he understands the necessity to educate the society in the field of electricity and energy security. works creatively and enterprisingly.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Rules for passing the course:

LECTURE:

Knowledge acquired during the lecture is verified by a colloquium consisting of tasks with different scores. The issues on the basis of which the questions are developed will be given to students through e-courses at the end of December. The points are converted into a final grade. The pass threshold is 50% of the points. Students attending lectures have the opportunity to earn points for completing additional tasks.

LAB:

Skills acquired during laboratory classes are verified on the basis of:

* obtaining a certificate from Matlab (10 points = 10%),
* implementation (in groups) of tasks during lab classes (30 points = 30%),
* implementation and development (in groups) of one project (60 points = 60%).

Tasks must be posted through e-courses by the specified deadline.

NOTE: Completion of tasks and the project is possible only after obtaining a Matlab certificate.

A total of 100 points can be obtained. The points are converted into a final grade. The pass mark is 50% of points.

The above score also applies to the student's preparation for laboratory classes and teamwork skills.

Programme content

1. Floating point arithmetic, round-off errors.
2. Numerically stable and unstable algorithms, 'well-conditioned' and 'ill-conditioned' problems.
3. Numerical differentiation.
4. Discretization of areas. Characteristics of mesh methods.
5. Initial value problems for ordinary differential equations and system of differential equations
6. Boundary- and initial-boundary value problems for partial differential equations. Finite difference method.

Course topics

The lecture program covers the following topics:
1. Floating-point arithmetic.
Real number – various forms of notation.
Factoring numbers.
Converting numbers between decimal and binary systems and related problems.
Rounding and error measures.
Floating-point representations of real numbers.
Real numbers and machine numbers.
Machine accuracy.
Arithmetic operations with floating-point numbers.
Characteristics of floating-point arithmetic on a selected example.
Numerical errors.

Stable and unstable algorithms.
Task conditioning.

2. Area discretization. Characteristics of mesh methods.

3. Numerical differentiation of functions of one and two variables: Taylor's formula.
Order of convergence of O(*) methods.
Estimating errors.

4. Numerical methods for solving initial value problems for ordinary differential equations and systems of differential equations. Selected one-step Runge-Kutta methods.
Graphical interpretation.
Local and global error. Total solution error.
Order of convergence of O(*) methods.
Estimating errors.

5. Boundary and initial-boundary value problems for partial differential equations.
Rectangular grids.
Finite difference method.

The laboratory program covers the following topics:
1. Introduction to Matlab.

2. Floating-point arithmetic.
Rounding error representations of activities.
Machine accuracy.
Investigating the properties of floating-point arithmetic.
Floating point overflow and underflow.
Single and double precision real types.
Examples of unstable algorithms and ill-conditioned tasks.

3. Numerical differentiation: Taylor's formula.
Correlation between step, order of convergence of the method and accuracy of the solution. Influence of numerical errors on the quality of the solution.

4. Numerical methods for solving initial value problems for ordinary differential equations and systems of differential equations. Selected one-step Runge-Kutta methods.
Investigation of the relationship between the integration step and the convergence of the solution and the method error. Stability and instability of solutions. The influence of the order of convergence of methods on the quality of the solution.

5. Boundary problems for partial differential equations.
Finite difference method. Convergence of solutions on the example of Laplace's equation.

Teaching methods

Lectures:
1.Lecture with multimedia presentation supplemented by examples given
on the blackboard.
2.Lecture conducted in an interactive way of formulating questions to students.
3.Student activity is taken into account during the course of the assessment.
4.Theory presented in connection with practice.
5.Theory presented in connection with the current knowledge of students,
6.Taking into consideration various aspects of the presented issues,
7. introducing a new topic, preceded by a reminder of related content, known to students from other subjects.

Laboratories:
1. computational experiments,

2. reviewing reports by the laboratory"s leader,
3. work in teams,

Bibliography

Basic
1. Fortuna, Macukow, Wąsowski, Metody numeryczne, WNT: PWN, 2017
2. Kincaid, Cheney, Analiza numeryczna, WNT 2006,

Additional
1. R.L. Burden, J.D. Faires, Numerical analysis, PWS-Kent Publishing Company, 2015.
2. D.Spałek, Metody numeryczne w elektrotechnice, Wyd.Politechniki Śląskiej2020.
3. E. Kącki, A. Małolepszy, A. Romanowicz, Metody numeryczne dla inżynierów, Wyd. Politechniki Łódzkiej 2000

Breakdown of average student's workload

	Hours	ECTS
Total workload	55	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)	25	1,00