COURSE DESCRIPTION CARD - SYLLABUS

Course name
Numerical methods in engineering [S2Eltech1E>MNwT]

Course

Field of study
Electrical Engineering

Year/Semester
1/2

Area of study (specialization)
Electrical Systems in Industry and Vehicles

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
15

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

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Lecturers

Prerequisites

The student starting this subject should have knowledge and skills of a numerical methods course from first-cycle studies. 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

Presentation of advanced numerical methods useful in solving complex engineering problems, including in the field of electrical engineering. Support of engineering calculations with appropriate IT tools.

Course-related learning outcomes

Knowledge:
1. Has an expanded and in-depth knowledge of some mathematics fields, including elements of discrete and applied mathematics, necessary for modeling and analyzing the operation of advanced electrical devices and systems as well as describing and analyzing the operation and synthesis of complex electrical systems. [K2_W01]

2. Has an expanded knowledge of advanced numerical methods used to solve complex technical tasks in electrical engineering. Knows and understands English terminology related to the field of studies. [K2_W02]
3. Has extended knowledge of computer-aided design. Knows and understands ergonomic rules, health and safety at work [K2_W18]

Skills:
1. Can obtain information from literature, database and from other sources as well as interpret, evaluate and critically analyze and formulate them with adding justified opinions [K2_U01]
2. Can work individually and as a part of a team, can drive the team in order to achieve deadlines; can determine directions of his and others further learning [K2_U02]
3. In formulating and solving engineering tasks, he can integrate knowledge from many sources and related disciplines. Can use analytical, simulation and experimental methods [K2_U16]

Social competences:
1. Recognizes the importance of knowledge in solving cognitive and practical problems and understands that in technology knowledge and skills quickly become obsolete and therefore require constant replenishment [K2_K01]
2. Is aware of the importance to develop professional achievements and comply with the rules of work ethics. [K2_K02]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Written assessment of the lecture part. Passing threshold: 50% of points.

Skills acquired as part of the laboratory are verified on the basis of developed projects / final test. Passing threshold: 50% of points.

Programme content

Discretization of areas. Characteristics of mesh methods. Numerical differentiation. Initial / boundary / initial-boundary value problems for differential equations and systems of equations (ordinary and partial). Finite difference method.

Course topics

The lecture program covers the following topics:
1. Reminder of information from the first level regarding the following topics:
Floating-point arithmetic.
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 problems for ordinary differential equations / systems of differential equations / higher order 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. Matlab.

2. Numerical differentiation: Taylor's formula.
The impact of method error and rounding of activities on the quality of the solution.

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

4. Systems of differential equations and higher order 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.

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

Teaching methods

1) lectures:
- lecture with presentation supplemented with examples given on the board,
- a lecture conducted in an interactive manner with formulating questions to students,
- during the lecture initiating the discussion,
- theory presented in close connection with practice,
- theory presented in connection with the current knowledge of students,
- presenting a new topic preceded by a reminder of related content known to students in other subjects.
2) laboratory:
- detailed reviewing of reports by the laboratory chair and discussions on comments,
- using tools that enable students to perform tasks at home,
- demonstrations,
- work in teams,
- computational experiments,
- students' activity during classes is taken into account when issuing the final mark.

Bibliography

Basic:
1. Kincaid D., Cheney W., Analiza numeryczna [Numerical Analysis: Mathematics of Scientific Computing (The Sally Series; Pure and Applied Undergraduate Texts, Vol. 2)], WNT, Warszawa 2006.
2. Spałek, Metody Numeryczne W Elektrotechnice, Oficyna Wydawnicza Politechniki Warszawskiej

Additional:
1. Burden, Faires, Numerical analysis, Prindle, Weber&Schmidt, Boston,
2. Markiewicz T., Szmurło R., Wincenciak S., Metody numeryczne. Wykłady na Wydziale Elektrycznym Politechniki Warszawskiej, OWPW, Warszawa, 2015.

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