



COURSE DESCRIPTION CARD - SYLLABUS

Course name

Numerical methods in engineering [S2Eltech2>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

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

dr inż. Barbara Szyszka

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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

1. Presentation of advanced numerical methods useful in solving complex engineering problems, including in the area of electrical engineering. 2. Supporting calculations with appropriate IT tools. 3. Influence of numerical errors. 4. Verification of obtained solutions.

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:

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. The points are converted into a final grade. The pass threshold is 50% of the points. For those present at the lectures, there is a possibility of gaining points for completing additional tasks.

LAB:

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

- * obtaining a Matlab certificate (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 should be posted through e-courses by the specified deadline.

NOTE: Creating and posting the project and tasks completed during lab classes is only possible after obtaining a MATLAB certificate.

There are 100 points to be earned in total. The points are converted into a final grade. The pass mark is 50% of the points. The above scoring also applies to the student's preparation for laboratory classes and the ability to work in a team.

Programme content

1. Discretization of areas. Characteristics of mesh methods.

2. Numerical differentiation.

3. Initial value problems for ordinary differential equations and system of differential equations

4. Boundary- and initial-boundary value problems for partial differential equations. 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 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. Matlab.

2. 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.

3. Numerical methods for solving initial value 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. 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. Spalek, 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.
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	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