COURSE DESCRIPTION CARD - SYLLABUS

Course name
Numerical methods in techniques [S2MwT1>MNwT]

Course

Field of study
Mathematics in Technology

Year/Semester
1/1

Area of study (specialization)
–

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
30

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

dr inż. Barbara Szyszka
barbara.szyszka@put.poznan.pl

Lecturers

Prerequisites

The student has an extended and in-depth knowledge of: * mathematics (in terms of material studies grade 1: especially in: linear algebra, differential calculus and the initial-boundary value problems for ordinary and partial differential equations) * numerical methods (for studies of the first-cycle studies) * computer science (programming in high level language). The student is able to solve math problems analytically within the range specified above. The student is able to use at least one software to solve tasks using basic numerical methods. The student is aware of the level of his knowledge. The student is aware of deepening and expanding knowledge.

Course objective

Understanding the advanced numerical methods. Applying them to solve complex mathematical and engineering problems. Supporting mathematical and engineering calculations with appropriate IT tools. Verification of obtained solutions.

Course-related learning outcomes

Knowledge:
The student has advanced general knowledge about terminology in numerical methods, also in a foreign

language.
The student has deepened and theoretically founded knowledge of numerical methods; knows at least one software package or a programming language in detail.
The student has advanced knowledge of computer-aided design.
The student has advanced knowledge of the principles of health and safety at work.

Skills:
The student can use knowledge of higher mathematics.
The student is able to construct and analyse complex mathematical models.
The student can use mathematical techniques, tools and methods, including numerical methods to solve advanced engineering tasks or simple research problems.
The student can construct an algorithm for solving a complex engineering task or a simple research problem and implement and test it in a selected programming environment.
The student can formulate and test hypotheses related to engineering tasks or simple research problems, integrate knowledge in the field of exact and natural sciences and engineering and technical sciences, carry out detailed research using analytical and simulation methods, interpret the results obtained and draw conclusions.
The student is able to select the appropriate sources of knowledge and obtain the necessary information from them.
The student can make a critical analysis of the measurement results obtained.
The student is able to use hardware, in accordance with general requirements and technical documentation; knows how to apply the principles of health and safety at work.

Social competences:
The student is aware of the role and importance of knowledge in solving practical problems; is aware of the need to deepen and expand knowledge;
The student is ready to think and act in a creative way, taking into account safety work; is aware of the responsibility for the work of the team and its individual participants.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Lectures:
* assessment of knowledge and skills demonstrated on the written test.
* control of perception during lectures.
Laboratory exercises:
* assessment of skills related to the implementation of project tasks
* assessment of student preparation for laboratory classes and assessment of skills related to the implementation of laboratory exercises
* assessment of teamwork skills

Programme content

Update: 31.01.2020.
Initial-value problems for ordinary differential equations (higher-order systems of differential equations).
Boundary value problems for ordinary differential equations.
Numerical differentiation of functions of several variables.
Initial-boundary value problems for partial differential equations - finite difference methods.

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

2. 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.

3. 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.

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

Teaching methods

lectures:
lecture with multimedia presentation supplemented with examples given on the blackboard,
lecture conducted in an interactive manner with formulating questions for students,
taking into account the students" activity,
during the lecture initiating the discussion,
theory presented in connection with practice,
theory presented in connection with the current knowledge of students,
taking into account different aspects of the issues presented,
presentation of a new topic preceded by a reminder of related content known to students in other subjects;
laboratories:
laboratories supplemented with multimedia presentations,
reviewing reports by the laboratory"s leader,
work in teams,
computational experiments;

Bibliography

Basic
1. Kincaid, Cheney, Analiza numeryczna, WNT 2006,
2. Burden, Faires, Numerical analysis, Prindle, Weber&Schmidt, Boston,

3. Kącki, Równania różniczkowe cząstkowe w zagadnieniach fizyki i techniki, WNT, Warszawa
Additional
1. Zarowski, An introduction to numerical analysis for electrical and computer engineers, Wiley
2. Rosłoniec, Wybrane metody numeryczne z przykładami zastosowań w zadaniach inżynierskich, Oficyna Wydawnicza Politechniki Warszawskiej,
3. B. Szyszka, An Interval Version of Cauchy’s Problem for the Wave Equation, AIP Conference Proceedings 1648, s. 800006-1 − 800006-4, 2015 AIP Publishing LLC.

Breakdown of average student's workload

	Hours	ECTS
Total workload	80	3,00
Classes requiring direct contact with the teacher	49	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	31	1,00