COURSE DESCRIPTION CARD - SYLLABUS

Course name
Numerical Methods in Physic and Technology [S2FT2>MNwFiT]

Course

Field of study
Technical Physics

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
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

Knowledge of physics, mathematics and computer science at the level after the first degree of education in the field of technical physics. Skill in analyzing simple physical systems from the point of view of the laws of physics governing their evolution. Understanding the role of physics in the process of creating new technologies. Skill in acquiring information from listed sources.

Course objective

1. Acquaintance of the students with the basic algorithms of numerical analysis. 2. Development of practical skills in independently developing programs that implement the known algorithms in the selected programming environment. 3. Team work ability development.

Course-related learning outcomes

Knowledge:
1. student, who has completed the course, is able to select and describe mathematical models for the description and analysis of physical processes and systems using vectors, matrices, systems of differential equations, non-linear equations.
2. student, who has completed the course, is able to explaine the basic methods and principles of

operation of numerical algorithms for solving systems of linear equations, numerical interpolation and approximation of experimental results and integration of differential equations, in particular equations of motion.

Skills:
1. student, who has completed the course, is able to use mathematical knowledge to describe and create computer models of processes as well as physical and technical systems.
2. student, who has completed the course, is able to formulate a complex physical / technical problem in the form of a mathematical model, propose a computer algorithm and a strategy for its solution.

Social competences:
1. student, who has completed the course, is able to to work responsibly on a designated multi-threaded task, independently and in a team.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

In terms of the methods used to verify the achieved learning outcomes, the following grading thresholds are applied:
<0–50)% unsatisfactory
<50–60)% - satisfactory;
<60–70)% - satisfactory plus;
<70–80)% - good;
<80–90)% - good plus;
<90–100> - very good.
The grade is based on an individual written assignment and/or the assessment of an oral response.

Programme content

Participants will learn algorithms for : solving a set of linear equations, interpolation, approximation, numerical integration, solving an ordinary differential equations, solving a nonlinear equation, Fast Fourier Transforms

Course topics

Lecture:
1. Numerical solving a set of linear equations: Gaussian Elimination algorithm, Gauss-Jordan algorithm.
2. Polynomial interpolation: direct method in Stevin monomial base, Lagrangian method and Aitken iterative method, Newton’s divided difference method.
3. Spline interpolation method.
4.Polynomial approximation: linear and nonlinear approximation with higher order polynomials.
5. Numerical integration algorithms: rectangles rule, trapezoidal rule, Simpson’s 1/3 Rule and Simpson’s 3/8 Rule. Simple and complex Newton-Cotes quadratures. Romberg method. Richardson extrapolation. Gaussian Quadrature.
6. Numerical solving an ordinary differential equations: Euler"s method, Runge-Kutta 2nd Order Methods (MidPoint and Heun"s method), Runge-Kutta 4th order method, RKN algorithms and velocity Verlet algorithm.
7. Numerical solving a nonlinear equations : Bisection Method, False-Position Method, Secant Root Finding Method, Newton's Method.
8.Fourier series, Fourier Transforms (FT, DFT), Fast Fourier Transform (FFT)
Laboratory classes:
1. Acquaintance of the students with the IDE that enables the creation of numerical programs that solve problems appearing in physics and technology.
2. Polynomial interpolation - Lagrangian method.
3. Spline interpolation.
4. Approximation.
5. Fourier Transform.
6. Numerical solving a nonlinear equations.
7. Numerical integration.
8. Numerical solving an ordinary differential equations.

Teaching methods

1. Lectures: multimedia presentation illustrated with examples given on the blackboard.
2. Laboratory classes: practical exercises, conducting numerical experiments, discussion, teamwork.

Bibliography

Basic:
1. Z. Fortuna, B. Macukow, J. Wąsowski. “Metody numeryczne”, WNT, Warszawa.
2. J. i M. Jankowscy. ”Przegląd metod i algorytmów numerycznych”, WNT, Warszawa.

Additional:
J. Stoer. “Wstęp do metod numerycznych” PWN, Warszawa, tom 1,2

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00