COURSE DESCRIPTION CARD - SYLLABUS

Course name
Analytical and symbolic methods [S1FT1>MAiS]

Course

Field of study
Technical Physics

Year/Semester
2/3

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
30

Other (e.g. online)
0

Tutorials
15

Projects/seminars
0

Number of credit points

7,00

Coordinators

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Lecturers

Prerequisites

Understanding the necessity of personal competence development, readiness to cooperation in a team.

Course objective

1. Acquaintance of the students with mathematical methods used in various problems in physics and technology. 2. Demonstrating the usefulness of symbolic and numerical computing packages as a tool supporting the mathematical analysis of the behavior of simple physical systems. 3. Development of practical skills in solving problem in physics and mathematics with the use of known mathematical methods 4. Development of practical skills in using a package of symbolic and numerical calculations for the analysis of processes running in simple physical systems. 5. Team work ability development

Course-related learning outcomes

Knowledge:
1. student, who has completed the course, is able to explain mathematical methods useful for formulating and solving simple problems associated with technical physics [k1_w01].
2. student, who has completed the course, is able to describe selected computer programs supporting engineering calculations [k1_w05].

3. student, who has completed the course, is able to describe the state of knowledge in the field of computer simulation of physical processes [k1_w13].

Skills:
1. student, who has completed the course, is able to use the acquired mathematical knowledge to describe the processes running in a simple physical system and create models, and know how to use analytical methods to solve tasks in the field of technical physics [k1_u01]
2. student, who has completed the course, is able to independently develop a model and mathematical equations describing a process running in a simple physical system on the basis of literature and other sources [k1_u02,k1_u03].
3. student, who has completed the course, is able to correctly use a computer calculation package for an analytical or numerical solution of a given physical or technical problem, presenting the results of calculations or simulations using properly formatted graphs and animations, and then make a critical analysis of the obtained results [k1_u09,k1_u19]
4. student, who has completed the course, is able to independently find additional information about the instructions contained in the calculation package on the basis of available documentation in english [k1_u11]

Social competences:
1. student, who has completed the course, is able to work in a team, to carry out tasks arising from division of work in a team, to take responsibility for team work results. [k1_k01]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
W01, W05, W13, U01 : Assessment of knowledge demonstrated in written work during the last lecture in semester on the grounds of scored points:
50.1%-70.0% (3)
70.1%-90.0% (4)
90.1%-100.0%(5)
U02, U09, U011, U019 : Assessment of activity during Tutorials and Laboratory classes. Assessment of knowledge demonstrated in written work during the last Tutorial in semester on the grounds of scored points. Assessment of programming skills demonstrated in practice.
50.1%-70.0% (3)
70.1%-90.0% (4)
90.1%-100.0%(5)
K01 Assessment of an individual oral presentation with the use of a computer program.

Programme content

1. Locally Cartesian curvilinear systems, basic differential operators in curvilinear systems. A detailed description of the movement in the central fields as an example of the use of a flat polar system. Binet"s theorem.
2.Calculus of variations - the extreme of a functional with fixed and movable ends; dependent on one or more functions and their derivatives, the Euler-Lagrange equation.
3. Lagrange equations and Hamilton"s equations in mechanical systems. Rules of behavior.
4. Analytical functions: Cauchy-Riemann conditions, Cauchy theorem, Cauchy integral formula, derivatives and integrals of analytical functions, Hilbert transforms, main integral value, Laurent series
5. Special functions and orthogonal polynomials.
Laboratory classes
1. Introduction to programming using the symbolic and numerical calculations package instructions:
a) analytical and numerical methods - solving equations and systems of equations, calculating derivatives and integrals, finding extremes, solving differential equations and systems of differential equations;
b) graphics - creating 2- and 3-dimensional charts, contour charts and animations, saving to files
c) basics of programming - loops, functions.
2. Analysis of the properties of simple systems using the learned instructions of the symbolic calculation package:
a) range determination and analysis of the missile trajectory taking into account the resistance forces of

the medium,
b) the resonance curves of the forced harmonic oscillator with a changing damping coefficient, analysis of the critical damping,
c) vibrations of the chain of n atoms connected by harmonic forces, determination of natural frequencies and normal modes, animation of system vibrations, periodic and non-periodic boundary conditions
d) small vibrations of an undamped pendulum mounted on a rotating base as an example of a system in which the stable equilibrium point bifurcates - analysis of the dependence of the frequency of vibrations on the rotational speed of the table,
e) interference image behind a diaphragm with any number of slits - analysis of the image dependence on the wavelength and explanation of the operation of the diffraction grating
f) diffraction image behind the diaphragm of variable width - analysis of the resolution of the lens with a given diameter

Teaching methods

1. Lectures: multimedia presentation, solving example tasks on the blackboard,
2. Tutorials: solving problems, discussion
3. Laboratory classes: practical exercises, carrying out numerical experiments, discussion, team work.

Bibliography

Basic
1. F.W. Byron, R.W. Fuller, Matematyka w fizyce klasycznej i kwantowej t. 1-2, PWN W-wa 1973
2. I.M. Gelfand, S.W. Fomin, Rachunek wariacyjny, PWN 1979;
3. Fizyka matematyczna, J. Stefaniak, H. Kamiński, G. Kamińska, WPP 2008;
4. W. Żakowski, W. Leksiński, Matematyka t. 4, WNT W-wa 1995
5. Pang Tao, Metody obliczeniowe w fizyce, PWN 2001
Additional
1. Wybrane rozdziały Matematycznych Metod Fizyki, Andrzej Lenda, Wydawnictwo AGH, 2004
2. A. Zagórski, Metody matematyczne fizyki, OW PW, 2007
3. Dieter W. Hermann, Podstawy symulacji komputerowych w fizyce, WNT 1997
4. R. Grzymkowski, J. Pochciał, Elementy rachunku wariacyjnego, Wykłady z modelowania matematycznego 7, Gliwice 2009
5. A. Hennel, Zadania i problemy z Fizyki, t. 1-3, PWN

Breakdown of average student's workload

	Hours	ECTS
Total workload	162	7,00
Classes requiring direct contact with the teacher	77	3,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	100	4,00