COURSE DESCRIPTION CARD - SYLLABUS

Course name
Elements of mathematical physics

Course

Field of study
Mathematics in technology

Area of study (specialization)

Level of study
Second-cycle studies

Form of study
full-time

Year/Semester
2/3

Profile of study
general academic

Course offered in
Polish

Requirements
compulsory

Number of hours

Lecture
30

Tutorials
15

Laboratory classes

Projects/seminars

Other (e.g. online)

Number of credit points

3

Lecturers

Responsible for the course/lecturer:
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Responsible for the course/lecturer:

Prerequisites

knows the basic concepts of physics in the field of high school; knows the basic issues of ordinary and partial differential equations and calculus of variation; freely uses the tools of mathematical analysis, in particular, differential and integral calculus and vector analysis; freely uses the Green, Gauss and Stokes integral theorems; knows the limitations of his knowledge and understands the need for further education

Course objective

To acquaint students with the applications of mathematics in physics

Course-related learning outcomes

Knowledge

1. the student will know the classification of selected partial differential equations

2. know the relationship between the problems of the theory of partial differential equations and other branches of science

3. be familiar with the methods of solving classical partial differential equations, can use them in typical practical problems

Skills

1. is able to use partial differential equations in typical practical problems

2. is able to formulate selected physical problems in terms of partial differential equations

Social competences

1. knows the limitations of his knowledge and understands the need for further learning

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Written tests, oral answers, active participation in classes

Written exam

Programme content

1. Reference system, relativity of motion, transformations of selected quantities when changing the reference system.

2. The principle of inertia, the class of inertial systems. Galilean transformations.

3. Principles of Newton's dynamics. Principles of conservation of classical mechanics and the first integrals of Newton's system of equations.

4. Lagrange's approach to classical mechanics. Configuration space, the concept and classification of constraints. Lagrange's equations and Hamilton's principle of minimum operation. Noether theorems, system symmetries and conservation laws.

5. Hamiltonian mechanics. Hamilton's canonical equations. Canonical transformations. Hamilton-Jacobi equation.

6. Elements of the special theory of relativity. Space-time interval. Minkowski pseudo-metric, Lorentz transformations. Four vectors, tensors, counter- and covariant components. A quadrovector of momentum, force and energy-momentum tensor.

7. Elements of classical field theory. Classical electrodynamics, field strengths and potentials, Maxwell's equations. Gauge transformation. Electrodynamics as a theory with the Abelian gauge group U (1).

8. Elements of quantum mechanics. Classical quantization, observables and operators. Schroedinger equation. Dirac equation, the concept of spin.

9. Classical field theory with non-Abelian gauge group, Yang-Mills field.

10. Higgs mechanism, spontaneous symmetry breaking.

11. Galois symmetry in discrete quantum mechanics, arithmetic Hamiltonians.

Teaching methods

1) Lectures:

- an interactive lecture with the formulation of questions to a group of students or to identified specific students,

- theory presented in relation to the current knowledge of students,

- presenting a new topic preceded by a reminder of related content, known to students from other subjects,

- taking into account various aspects of the presented issues,

- student activity during classes is taken into account when assigning the final grade.

2) Exercises:

- solving example tasks on the blackboard,

- initiating discussions on solutions,

- home task sets.

Bibliography

Basic

1. L. D. Landau, J. M. Lifszyc, Mechanika, Wydawnictwo Naukowe PWN 2007.

2. W. I. Arnold, Matematyczne Podstawy Mechaniki Klasycznej , PWN 1981.

3. W. Rubinowicz, W. Królikowski, Mechanika Teoretyczna, Wydawnictwo Naukowe PWN 2017.

4. R. S. Ingarden, A. Jamiołkowski, Mechanika Klasyczna, , PWN 1980.

5. R.F. Gantmacher, Wykłady z Mechaniki Analitycznej, PWN 1972.

6. L. D. Landau, J. M. Lifszyc, Teoria Pola, Wydawnictwo Naukowe PWN 2010.

7. R. S. Ingarden, A. Jamiołkowski, Elektrodynamika Klasyczna, PWN 1981.

8. A. Bechler, Kwantowa Teoria Oddziaływań Elektromagnetycznych, , Wydawnictwo Naukowe PWN 1991.

9. E. Leader, E. Predazzi, Wstęp do teorii oddziaływań kwarków i leptonów, PWN 1990.

Additional

1. K. Huang, Fundamental Forces of Nature, The Story of Gauge Fields, World Scientific 2007.

2. R. P. Feynman, A.R. Hibbs, D. F. Styler, Quantum Mechanics anfd Path Integrals, Mc Graw-Hill 2005.

3. J. Milewski, G. Banaszak, T. Lulek, M. Labuz, R. Stagraczyński, Galois actions on the eigenproblem of the Heisenberg heptagon, Open Systems & Information Dynamics, 19, No. 2, 1250012, (2012).

Breakdown of average student's workload

	Hours	ECTS
Total workload	90	3,0
Classes requiring direct contact with the teacher	45	1,5
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	45	1,5

[1] delete or add other activities as appropriate