Syllabus
Course Program

Theoretical foundations for modeling physical processes. 2

Specialty
113 – Applied mathematics

Institute
Institute of Computer Modeling, Applied Physics and Mathematics

Educational program
Computer and mathematical modeling

Department
Mathematical modeling and intelligent computing in engineering (161)

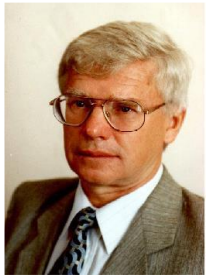
Level of education
Bachelor's level

Course type
Special (professional), Mandatory

Semester
6

Language of instruction
English

Lecturers and course developers



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More about the lecturer on the department's website

General information

Summary

“Theoretical Foundations of Modeling Physical Processes.(Part 1,2)” is one of the fundamental disciplines in the preparation of a bachelor's degree in applied mathematics. Part one includes the theory of elasticity, and part two is devoted to the theory of plates and shells. The applied significance of these subjects is due to the fact that most disasters that occur are associated with insufficient strength of structures, when their individual elements cease to perform their functions under the influence of load and lose their strength. The knowledge of such phenomena and the ability to resist them is mandatory for specialists conducting applied research in various fields of mechanics of solid deformable bodies.

Course objectives and goals

The goals of the program are to equip students with the ability to solve complex specialized problems and practical problems of applied mathematics in professional activities or in the process of study, which involves the application of mathematical theories, methods, algorithms, information technologies and specialized software.

Format of classes

The training includes lectures, practical classes, mandatory homework and a course project. The final control is an exam.

Competencies

- Ability to use and adapt mathematical theories, methods and techniques to prove mathematical statements and theorems.
- Ability to perform tasks formulated in mathematical form.
- Ability to choose and apply mathematical methods for solving applied problems, modeling, analysis, design, management, forecasting, decision-making.
- Ability to conduct mathematical and computer modeling, analysis and data processing, computational experiment, solving formalized problems using specialized software.
- Ability to formulate a mathematical statement of a problem, based on the statement in the language of the subject area, and choose a method of solving it that ensures the required accuracy and reliability of the result.
- Ability to create mathematical models of real objects and processes, develop methods for solving problems and evaluate the adequacy of results

Learning outcomes

- Demonstrate knowledge and understanding of the basic concepts, principles, theories of applied mathematics and use them in practice.
- Formalize problems formulated in the language of a particular subject area; formulate their mathematical formulation and choose a rational method of solution; solve the obtained problems by analytical and numerical methods, evaluate the accuracy and reliability of the results.
- To master the basic methods of developing discrete and continuous mathematical models of objects and processes, analytical study of these models for the existence and uniqueness of their solution.
- Be able to conduct practical research and find solutions to incorrect problems.
- Use specialized software products and software systems of computer mathematics in practical work.
-. To be able to create mathematical models of real objects and processes, develop methods for solving problems and evaluate the adequacy of results

Student workload

The total volume of the discipline is 120 hours (4 ECTS credits): lectures - 32 hours, practical classes - 32 hours, independent work - 56 hours..

Course prerequisites

Mathematical analysis, Linear algebra, Differential equations (basic concepts), Programming, Theoretical mechanics. Theoretical foundations for modeling physical processes (Part 1).

Features of the course, teaching and learning methods, and technologies

The educational process includes: lectures with the use of computer information tools; practical classes, independent work. The lecture course is taught using problem-based learning methods through the application of such forms of learning as thematic and problem-based lectures. The purpose of such lectures is to develop students' logical and independent understanding of the material.

Independent work of students includes: preparation for practical classes, study of recommended scientific literature, writing reports on mandatory work.

Program of the course

Topics of the lectures

Introduction

The subject of the theory of plates and shells. Basic definitions and limitations. Kirchhoff hypotheses in the theory of plate bending.

Topic 1: Basic equations of the theory

1.1. Displacements and deformations in plates
1.2. Physical relations of plate theory. Forces and moments
1.3. Static equations. Derivation of the Sophie-Germain equations.
1.4. Boundary conditions in the theory of plate bending

Topic 2. Application of trigonometric series.
2.1. Solving problems of bending of rectangular plates by the Navier method
2.2. Levy's method.

Topic 3. Polar coordinates
3.1. Differential equations of bending of circular plates in polar coordinates and their solutions.
3.2. Solving problems of the axis of symmetric bending of circular and annular plates.

Topic 4. Variational formulations and methods for solving problems of plate bending.

Topic 5. The theory of shells
5.1.Fundamentals of differential geometry of surfaces.
5.2. Curvilinear coordinates. Local basis.
5.2. First and second quadratic forms of surfaces.

Topic 6. The complete system of equations of the theory of shells
6.1. Geometric relations of the theory of shells
6.2. Forces and moments in shells.
6.3. Differential equations of the theory of shells.
6.4. Boundary conditions.

Topic 7. Theory of cylindrical shells. Axisymmetric problems.

Topic 8. Momentless theory of shells.

Topics of the workshops

Topic 1: Problems of cylindrical bending of plates

Topic 2. Problems of cylindrical bending of compound plates

Topic 3. Intermediate test on the topic of cylindrical bending

Topic 4. Solving problems of the axis of symmetrical bending of circular and annular plates.

Topic 5. Application of the Ritz method for problems of plate bending

Topic 6. Solving problems of symmetric bending axis of cylindrical shells

Topic 7. Problem formulation for compound thin-walled structural elements

Topics of the laboratory classes

Self-study

Completion of independent works, current control and module works. Implementation of mandatory work

Course materials and recommended reading

1. E. Ventsel,T. Krauthammer. Thin Plates and Shells.Theory, Analysis, and Applications. The Pennsylvania State University. Marcel Dekker, Inc. New York • Basel. 2001. ISBN: 0-8247-0575-0

2. Brush, D.O. and Almroth, B.O., Buckling of Bars, Plates, and Shells, McGraw-Hill, New York, 1975.

3. Timoshenko, S. and Woinowsky-Krieger, S., Theory of Plates and Shells, McGraw-Hill, New York, 1959.

4. Flugge, W., Stresses in Shells, 2nd edn, Springer-Verlag, Berlin, 1962.

5. Gol'denveizer, A.L., Theory of Thin Shells, Pergamon Press, New York, 1961

6. Kraus, H., Thin Elastic Shells, John Wiley and Sons, New York, 1967.

Assessment and grading

Criteria for assessment of student performance, and the final score structure

To assess a student's performance, a point accumulation system is used. Maximum number of points for:
- independent work 5 points,
- control work 10 points,
- modular test 15 points.
- mandatory homework 20 points.

As an alternative to the cumulative point system, it is possible to take a written exam

Grading scale

Total points	National	ECTS
90–100	Excellent	A
82–89	Good	B
75–81	Good	C
64–74	Satisfactory	D
60–63	Satisfactory	E
35–59	Unsatisfactory (requires additional learning)	FX
1–34	Unsatisfactory (requires repetition of the course)	F

Norms of academic integrity and course policy

The student must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": to demonstrate discipline, good manners, kindness, honesty, and responsibility. Conflict situations should be openly discussed in academic groups with a lecturer, and if it is impossible to resolve the conflict, they should be brought to the attention of the Institute's management.
Regulatory and legal documents related to the implementation of the principles of academic integrity at NTU "KhPI" are available on the website: http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Approval

Approved by

Head of the department
Oleksiy Vodka

Guarantor of the educational program
Gennadiy Lvov