Syllabus
Course Program

Modeling and design of processes, products, equipment

Specialty
131 – Applied mechanics

Institute
Educational-scientific Institute of Mechanical Engineering and Transport

Educational program
Applied mechanics

Department
Hydraulic Machines (150)

Level of education
Master's level

Course type
Optional

Semester
2

Language of instruction
English

Lecturers and course developers

Olga Panamariova

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Candidate of Technical Sciences, associate professor of the department "Hydraulic machines named after G.F. Proskura" NTU "KhPI"
Has more than 40 scientific works. Conducts lectures, laboratory and practical classes on the courses: "Design of technical objects and equipment", "Modeling and design of processes, products, equipment"

Yevhenii Krupa

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Candidate of Technical Sciences, Associate Professor of the Department of Hydraulic Machines named after G.F. Proscura of NTU "KhPI"

The author of more than 50 scientific and educational works (articles, manuals, monographs, patents on a useful model). Courses: "Fundamentals of bladed hydraulic machines theory", "Hydraulic turbines and reversible hydraulic machines", "Fundamentals of CAD for bladed hydraulic machines", "Design of bladed hydraulic machines"

General information

Summary

The discipline is aimed at students mastering the basics of mathematical modeling, modern methods of projecting and designing hydro pneumatic systems.

Course objectives and goals

The purpose of this course is to provide students with basic knowledge of modeling, engineering and technical design methods in industry, to inculcate the skills of engineering creativity and technical aesthetics, and to consolidate practical skills in the development of technical design of elements of hydro pneumatic drives and equipment that meet modern indicators and product quality requirements.

Format of classes

Lectures, practical work, independent work, modular tests, consultations, distance learning. Execution of individual calculation and graphic tasks. The final control is an exam. Educational materials are available to students through Microsoft Teams and Microsoft Office 365.

Competencies

ZK1 Ability to identify, pose and solve problems.
ZK3 Skills in using information and communication technologies.
ZK4 Ability to generate new ideas (creativity).
FC1 Specialized conceptual knowledge of the latest methods and techniques of designing and researching structures, machines and/or processes in the field of mechanical engineering.
FC6 Ability to apply appropriate mathematical, scientific and technical methods, information technologies and applied computer software to solve engineering and scientific problems in applied mechanics.

Learning outcomes

PRN1 Demonstrate the ability to perform modeling, static and dynamic analyzes of structures, mechanisms, materials and processes at the design stage using modern computer systems.
PRN3 Demonstrate knowledge of the organization, functioning, technical and software support of information and measurement computerized systems in scientific research of mechanical systems and processes

Student workload

The total volume of the discipline is 120 hours. (4 ECTS credits): lectures – 32 hours, practical work – 16 hours, independent work – 72 hours.

Course prerequisites

To successfully complete the course, the student must receive practical training in the use of CAD in the design of elements of hydraulic and pneumatic means of automation and the development of design and technological documentation in the format of a modern machine-building enterprise. These questions are considered in the disciplines "CAD hydro pneumatic drives", "Modern technologies in applied mechanics".

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

Lectures provide an interactive form of conducting with the use of multimedia technologies, video materials. Practical work is carried out in a combined format of individual and team project work. Independent work involves the study of topics from the curriculum of the discipline in the process of working with information sources. Consolidation of knowledge, acquisition of competencies and program learning results occurs during the performance of practical and computational tasks. Control of educational work is carried out during the defense of practical works, writing modular control works, answers in classes and exams.

Program of the course

Topics of the lectures

Topic 1. Introduction. Purpose and objectives of the course.
Basic concepts of modeling and design.
Topic 2. Basic types of modeling.
Introduction to modeling theory. Types of models, their classification. The main types of modeling.
Topic 3. The principle of model construction.
Definition, properties of products. Sequence of creation of products. Types and decomposition of hydropneumatic equipment into main components.
Topic 4. General technical requirements for hydraulic and pneumatic drives
The concept of the quality of elements of hydropneumatic automation. Quality indicators.
Topic 5. Basics of CALS technologies. Product design life cycle and stages
The concept of the product life cycle and its main stages. Basics of CALS technologies.
Topic 6. Basic concepts and principles of mathematical modeling.
History of mathematical modeling. Basic definitions. Types and types of mathematical models. Principles of creating mathematical models.
Topic 7. Methods of mathematical modeling of working processes of elements of hydraulic drives.
Classification of mathematical methods. Mathematical models of working processes of hydropneum equipment.
Topic 8 Modeling of hydropneumatic automation elements using CAD
Modern CAD for designing hydropneumatic elements. Three-dimensional modeling of hydropneumatic automation elements in CAD systems.
Topic 9 Synthesis of hydropneumatic actuator schemes using Festo FluidSim.
Features of FluidSim. Basic elements and principles of FluidSim operation. Sequence, methods of creating hydropneumatic circuits and modeling their operation
Topic 10 Basics of modeling elements of hydropneumatic drives in Matlab Simulink
Modeling of the main hydraulic elements in Matlab Simulink. The main elements of the environment. The general structure of the environment. System of models, methods, library. The structure of hydraulic apparatus models.

Topics of the workshops

Topic 1. Method of iterations for solving algebraic and transcendental equations.
Topic 2 Newton's method for solving algebraic and transcendental equations.
Topic 3 Dichotomy method for solving algebraic and transcendental equations.
Topic 4 Automated modeling of a hydraulic drive in the MathCad environment
Topic 5 Development of a drawing, three-dimensional model and design of a part in the CAD system
Topic 6 Modeling the operation of hydropneumatic systems using Festo Fluidsim
Topic 7 Introduction to Matlab-Simulink
Topic 8 Development of a block diagram of a solution in Matlab-Simulink of a system of differential equations of a nonlinear mathematical model.

Topics of the laboratory classes

Laboratory work is not included in the course.

Self-study

Elaboration of lecture material, independent study of topics and issues that are not taught in lectures, preparation for practical classes, performance of computational and graphic tasks, preparation for the exam.

Course materials and recommended reading

List of sources of information. Basic literature:

1. Basics of design and modeling: Educational - methodical manual / comp. L. M. Khomenko. – Uman: FOP Zhovtyy O.O., 2016. – 125 p.
2. Mathematical modeling of systems and processes: study guide/ R.M. Pavlenko, S.F. Filonenko, O.M. Cherednikov, V.V. Tretyak. - K.: NAU, 2017. - 392 p.
3. Mathematical modeling of work processes in the control equipment of the hydraulic impulse drive / Ya. V. Ivanchuk, R. D. Iskovich-Lototskyi, I. V. Sevostyanov, N. R. Veselovska, K. O. Koval, R. S. Belzetskyi, K. V. Dobrovolska, Y. Yu. Kusha, B. P. Volovik // Mechanics and Advanced Technologies. – 2021. – No. 2. – P. 193-202.
4. V. B. Strutynskyi, Modeling technology of dynamic processes and systems: monograph / V. B. Strutynskyi, N. R. Veselovska. – Vinnytsia: O. Vlasyuk, 2007. – 466 c.
5. Simulation modeling in the problems of machine-building production: training. manual / H. V. Bilovol [etc.] ; ed. O. M. Shelkovy; NTU "KhPI". — Kharkiv: NTU "KhPI", 2019. — 500 c.
6. Akimov T.E. Implementation and use of CALS technologies in mechanical engineering / T.E. Akimov, A.M. Vasin // Ninth International Scientific and Practical Internet Conference "Modernity, Science, Time". [Electronic access]:http://www.intkonf.org.
Additional literature:
7. Andrenko P.M. Hydraulic devices of mechatronic systems: training. manual / P.M. Andrenko. – Kh.: Publishing center of NTU "KhPI", 2013. – 188 p.
8. Pashkov E.V., Osynskyi Yu.O. Industrial mechatronic systems based on a pneumatic drive. Sevastopol: SevNTU, 2007. – 394 c. 9.
9. Veselovska G.V. Computer graphics / Veselovska G.V., Khodakov V.E., Veselovskyi V.M. - Kherson.: OLDI - plus, 2008. – 584 p.

Information resources on the Internet:
http://www.kpi.kharkiv.edu/gdm/
http://library.kpi.kharkov.ua
http://library.nung.edu.ua/

Assessment and grading

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

100% of the final grade consists of the results of the assessment in the form of an exam (40%) and the current assessment (60%). Exam: written assignment (2 theory questions + problem solving) and oral presentation. Current evaluation: modular control works (20%), performance and defense of practical works (20%), calculation task (20% each).

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	Date of approval, signature	Head of the department Andrii ROGOVYI
	Date of approval, signature	Guarantor of the educational program Volodymyr RUBASHKA