Syllabus
Course Program

Modern technologies in the development and design of hydraulic equipment

Specialty
133 – Industrial machinery engineering

Institute
Educational-scientific Institute of Mechanical Engineering and Transport

Educational program
Industrial machinery engineering

Department
Hydraulic Machines (150)

Level of education
Bachelor's level

Course type
Optional (profile)

Semester
6

Language of instruction
English, Ukrainian

Lecturers and course developers

Oleksandr Ivanovych Hasyuk

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

Work experience - 18 years.
The author of more than 50 scientific and educational and methodical works, including 5 textbooks and teaching aids with the seal of the Ministry of Education and Culture, 25 patents for useful models.
Leading lecturer in the disciplines: "Dynamics of hydropneumatic systems", "Technology of manufacturing hydropneumatic drives", "Operation and diagnostics of hydropneumatic systems"

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 course offers students an in-depth study of advanced engineering methods, software and tools that are used in modern solutions to complex engineering problems. This course combines a theoretical approach with practical skills, enabling students to understand and apply modern technologies in their future professional activities.

Course objectives and goals

The purpose of this course is to acquaint students with modern technologies and innovations used in the field of applied mechanics. The course is aimed at expanding students' knowledge of advanced methods of research, modeling and solving complex engineering problems using modern tools and software. As a result of the course, students will be able to apply this knowledge to solve real problems in the field of applied mechanics and contribute to the development of engineering technologies.

Format of classes

Lectures, laboratory classes, consultations, self-study, course work. Final control is in the form of an exam.

Competencies

ZK-3. Ability to apply professional knowledge and skills in practice.
ZK-4. The ability to flexibly adapt to real professional situations, to show a creative approach, initiative.
ZK-5. The ability to critically evaluate and rethink accumulated experience (own and others), to analyze one's professional and social activities.
ZK-6. Ability to solve problems in professional activities based on analysis and synthesis.
SK-1. The ability to apply analytical methods and computer software tools to solve engineering tasks in industrial mechanical engineering.
SK-3. The ability to apply appropriate quantitative mathematical, scientific and technical methods, as well as computer software tools to solve engineering problems in industrial engineering.
SK-5. Ability to implement advanced engineering developments to obtain practical results.
SK-6. The ability to understand and solve the tasks of modern production aimed at meeting the needs of consumers.
SK-8. Ability to demonstrate creative and innovative potential in project development.
SK-13. Ability to determine areas of use of engineering knowledge.
SK-14. Ability to apply a systematic approach to solving engineering problems.
SK-15. Ability to use knowledge to select construction materials, equipment, processes.
SK-16. Ability to demonstrate understanding of engineering requirements to ensure rapid and sustainable development.

Learning outcomes

RN-1. The ability to demonstrate knowledge and understanding of the fundamentals of fundamental and engineering sciences that underlie industrial mechanical engineering.
PH-2. The ability to demonstrate knowledge of mechanics and mechanical engineering and outline the prospects for their development.
PH-4. The ability to set and solve engineering tasks of industrial mechanical engineering using appropriate calculation and experimental methods
PH-5. The ability to use the acquired knowledge in the analysis of engineering objects, processes and methods.
RN-7. Ability to experiment and analyze data.
RN-9. Ability to choose and apply the necessary equipment, tools and methods.
PH-10. The ability to combine theory and practice to solve an engineering task.
RN-11. Ability to demonstrate professional skills and abilities.
RN-19. The ability to solve complex specialized tasks and practical problems in a certain field of professional activity or in the learning process, which involves the application of certain theories and methods of the relevant science and is characterized by the complexity and uncertainty of conditions.

RNB.03-5. Be able to design machines and equipment related to drilling, production and transportation of oil and gas.

Student workload

The total volume of the course is 180 hours (6 ECTS credits): lectures - 64 hours, laboratory works - 32, self-study - 84 hours.

Course prerequisites

The following disciplines are required for successful completion of the course: Resistance of Materials, Machine Parts, Applied Materials Science, Interchangeability, Standardization and Technical Measurement.

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

Lectures are conducted using multimedia tools on the Microsoft Teams platform in the form of presentations, demonstration of visual aids, as well as reference lecture notes and a textbook. The study of real cases of diagnosis and repair of hydraulic systems to analyze problems and develop solution strategies. Working with specialized equipment and tools for studying the characteristics and diagnostics of hydraulic systems. Developing team skills through collaborative work on hydraulic system diagnostics and repair projects. Studying the use of modern technologies such as sensors, pressure sensors and software to monitor and analyze the condition of hydraulic systems. Evaluation of the assimilation of theoretical knowledge and practical skills through test papers and assessment.
The material is hosted on the Microsoft 365 resource and on the Moodle platform.

Program of the course

Topics of the lectures

Topic 1. Introduction. Basic concepts and definitions. Machine-building products as an object of exploitation.
Service purpose of the product. The product is a set of functional modules. Product quality. Geometric accuracy of the part and the product
Topic 2. Spatial and temporal connections.
Basics of basing. Dimensional chains. Methods of achieving the accuracy of the closing link. Calculation of flat dimensional chains Spatial dimensional chains. Temporary chains.
Topic 3. Machine-building product as a technological object of production.
Modulus of surfaces (MP) of the part. Detail drawing in modular view. Module connection (MS) of parts. Distribution of MP and MS in products. The method of product description as an object of production. Description of the three-cornered drilling bit in a modular design. Product technology. Technical and economic indicators of production.
Topic 4. Basic provisions and regularities of technological processes
Elementary base of technological processes. Types of technological processes. The phenomenon of dispersion of the initial indicators of the technological process. Technological dimensional holidays. Temporary chains of technological processes.
Topic 5. Patterns of product quality deviations in the manufacturing process.
General provisions of the mechanism of formation of geometric errors of products. The effect of elastic and thermal movements on the accuracy of part manufacturing. The effect of wear and tear of elements of the technological system on the accuracy of part manufacturing. The influence of residual stresses on the accuracy of part manufacturing. Evaluation of quality deviations of the surface layer of the part. Evaluation of the surface roughness of the part. Evaluation of product quality deviations during the technological process. The education of measuring frequencies
Topic 6. Integrated generative technologies and their place in modern production.
Integrated technologies of modern production and their components. Integrated generative technologies and their levels. Physical basics of layer-by-layer growing of products. Processes of layer-by-layer materialization of the 3D electronic image of the product. Product generation from liquid, solid, gas phase and plasma. Other methods of generation. Elements that form layers during product generation.
Topic 7. The place of integrated macro-level generative technologies in the creation of products.

The structure of macro-level generative technologies. 3D CAD modeling and creation of a layer-by-layer electronic image (model). 3D CAD modeling systems in generative technologies. Machine building SL11R. Power Solution system (Delcam). Unigraphics System (Unigraphics Solution). CATIA system (Dassault Systemes). System Pro / Engineer (Parametric Technology Corporation). Mid-level CAD systems. Description of 3D images of products with STL files. General features of generative methods of materialization

Topic 8. The essence of the main generative methods of materialization.

3D CAD models of products: SLA (Stereo Lithographies Apparatus) - stereolithography. SLS (Selective Laser Sintering) - selective laser sintering. 3DW (Three-Dimensional Welding) - three-dimensional surfacing. BRM (Ballistic Particle Manufacturing) - manufacturing using particle ballistics. DMD (Direct Metal Deposition) - direct application of metal. FDM (Fused Deposition Modeling) - GPD (Gas Phase Deposition) modeling.

Topic 9. Classification of macro-level generative technologies.

Principles of systematics. Macro-level classification of integrated generative technologies. A complex of energy signs. A complex of material science features. Complex of technological and instrumental features of GT. A complex of signs of IGT formation. Examples of application of classification principles to generative macro-level technologies. Information system for supporting decision-making on the use of integrated macro-level generative technologies.

Topic 10. Integrated generative technologies of the transitional cm-mm level.

Basic concepts. Classification of surfacing methods. Electric arc surfacing. Types of arc surfacing. Electroslag welding (ESH). Plasma surfacing. Induction surfacing. Immersion of a heated part in a mold-crucible with molten metal. Centrifugal surfacing of cylindrical parts. Gas surfacing. Electrocontact surfacing (plating). Plating by explosion welding. Computer systems for designing surfacing technologies

Topic 11. Integrated generative technologies of the transitional mm-μm level.

Classification of methods of layer-by-layer gas-thermal growing of coatings. Technologies of layer-by-layer gas thermal build-up of coatings. Gas-flame build-up. Detonation coating. Electric arc metallization. The method of growing plasma coatings. High-frequency flame build-up. Induction method of increasing coatings.

Topic 12. Integrated generative macro-level technologies.

Basic concepts. Mechanisms of formation of coatings by evaporation or spraying and condensation in a vacuum. Vacuum methods of growing coatings. Ion (cathode) sputtering. Ion-thermal growing. Growing coatings from electric arc discharge plasma with a hot cathode. Growing coatings from electric arc discharge plasma with a cold cathode. Method of activated reaction evaporation Electron-beam flame growth of coatings. Synthesis of multilayer ion-plasma coatings in a single-vacuum intelligent cycle. Method of ion deposition.

Topics of the workshops

There are no practical classes.

Topics of the laboratory classes

1. Acquaintance with samples of typical parts of machines, which are manufactured at enterprises with different series of production. Temporary chains.
2. Familiarization with the machine tool equipment of the workshop laboratory of the department of hydraulic machines (lathes, drilling machines, planning machine, mechanical saw, sharpening machine, hydraulic press and stamping devices).
3. Construction of dimensional chains of various types. Assessment of measurement accuracy. Evaluation of quality deviations of the surface layer of the part. Evaluation of the surface roughness of the part. Evaluation of product quality deviations during the technological process.
4. Integrated technologies of modern production and their components. Integrated generative technologies and their levels.
5. 3D CAD modeling and creation of a layer-by-layer electronic image (model).

Self-study

The individual task is presented in the form of a calculation work on the topic "Writing the technological process of the part specified by the teacher" according to the options

Course materials and recommended reading

1. I. Yu. Markina, O. V. Nesterenko, V. M. Radchenko, and others. Modern technologies of applied mechanics and mathematics: a collection of scientific works / Kyiv: KPI named after Igor Sikorskyi, 2018. 252 p.
2. S. I. Nosenko Computer modeling in fracture mechanics. Kharkiv: KhPI Publishing House of NTU, 2016. 296 p.
3. I. Yu. Markina, O. V. Nesterenko, V. M. Radchenko, and others. Modern technologies of applied mechanics and mathematics: a collection of scientific works / Kyiv: KPI named after Igor Sikorskyi, 2018. 252 p.
4. G. I. Safonova, O. O. Khokhlova. Plasticity and strength of materials: modern research methods and engineering applications. Kharkiv: KhPI Publishing House of NTU, 2017. 404 p.
5. O. O. Khokhlov, V. G. Yasynskyi. Modern technologies of mathematical modeling in solid mechanics: monograph / Kyiv: NTUU "KPI", 2016. 312 p.
6. O. Chernysh. Applied mechanics. Part I. Study guide. Kyiv: NTU "KPI", 2022. 292 p.

Assessment and grading

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

The overall grade for the course consists of the following components:
calculation work - 40 points,
exam (in the form of a test task) - 60 points

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	30.06.2023	Head of the department Andrii ROGOVYI
	30.06.2023	Guarantor of the educational program Iryna TYNIANOVA