



Syllabus Course Program

Design and Calculation of Volumetric Hydraulic Machines and Hydropneumatic Systems

Specialty

131 – Applied Mechanics

Educational program

Applied Mechanics

Level of education

Master's level

Semester

2

Institute

Institute of Education and Science in Mechanical Engineering and Transport

Department

Hydraulic machines named after G. F. Proskura (150)

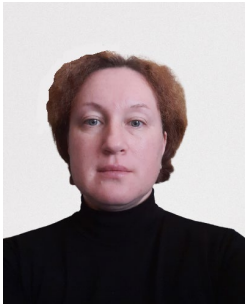
Course type

Professional, Selective

Language of instruction

English, Ukrainian

Lecturers and course developers



Nadiia Fatieieva

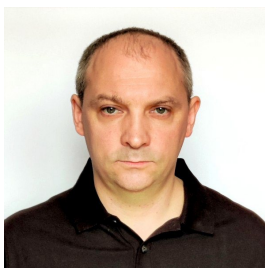
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Candidate of Technical Sciences, Assistant Professor, Assistant Professor of the Department of Hydraulic machines named after G. F. Proskura

Author and co-author of more than 30 scientific and methodological publications.

Courses: "Fundamentals of Hydraulic Drive Theory", "Design of Volumetric Hydraulic Machines and Hydraulic Drives for the Oil and Gas Industries", "Reliability, Operation and Maintenance of Hydraulic Machines", "Machines and Equipment for Oil and Gas Drilling", "Calculation and Construction of Volumetric Hydropneumatic Machines and Hydropneumatic Drives", "Modern Scientific Schools of the Department".

[More about the lecturer on the department's website](#)



Oleksandr Fatyeyev

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Candidate of Technical Sciences, Assistant Professor of the Department of Hydraulic machines named after G. F. Proskura

Author and co-author of more than 30 scientific and methodological publications.

Courses: "Proportional Hydraulics", "Modern Technologies in Applied Mechanics", "Workflows of modern industries", "Certification and Metrological Quality Assurance", "Theory of Automatic Control".

[More about the lecturer on the department's website](#)

General information

Summary

The course "Design and Calculation of Volumetric Hydraulic Machines and Hydropneumatic Systems" develops the knowledge and skills necessary for the effective design and calculation of volumetric hydraulic machines and hydropneumatic systems. During their studies, students will learn how to apply advanced engineering methods for calculating the main parameters of volumetric hydraulic machines and hydropneumatic systems; effectively develop machines and equipment for industrial engineering based on computer-aided design systems.

Course objectives and goals

To form and develop students' scientific and practical outlook, modern forms of theoretical thinking, and to provide students with knowledge in the field of design and calculation of volumetric hydraulic machines and hydropneumatic systems, necessary for further mastering special disciplines and practical activities in the speciality.

Format of classes

Lectures, practical classes, consultations, self-study. Individual assignment – coursework. Final control in the form of an exam.

Competencies

GC1. Ability to identify, formulate and solve problems.

GC2. Ability to make informed decisions.

GC3. Skills in the use of information and communication technologies.

GC8. Ability to learn and acquire modern knowledge.

PC1. Specialised conceptual knowledge of the latest methods and techniques for designing and researching structures, machines and/or processes in the field of mechanical engineering.

PC2. Ability to critically analyse and predict the performance parameters of new and existing mechanical structures, machines, materials and production processes in mechanical engineering based on knowledge and use of modern analytical and/or computerised methods and techniques.

PC6. Ability to apply appropriate mathematical, scientific and technical methods, information technology and applied computer software to solve engineering and scientific problems in applied mechanics.

Learning outcomes

PLO2. To demonstrate knowledge of the principles of construction and operation of systems for automation of technological research, design and development work, technological training and engineering analysis in mechanical engineering.

PLO3. Demonstrate the ability to perform modelling, static and dynamic analyses of structures, mechanisms, materials and processes at the design stage using modern computer systems.

PLO5. Demonstrate the ability to independently solve problems of an innovative nature (qualification work, course design), the ability to argue and defend the results obtained and decisions made, including publicly.

Student workload

The total volume of the course is 150 hours (5 ECTS credits): lectures – 48 hours, practical classes – 16 hours, self-study – 86 hours.

Course prerequisites

Bachelor's degree is required. To successfully complete the course, you must have knowledge and practical skills in the following disciplines: "Hydraulics, hydraulic and pneumatic drives", "Fundamentals of hydraulic drive theory", "Information technology and programming".

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

Lectures are delivered using multimedia technologies. Practical classes use a project-based approach to learning, game methods, and focus on the use of information technology in the design of volumetric hydraulic machines and hydropneumatic systems.

Educational materials are available to students through OneDrive, Whiteboards, on the educational platform of NTU "KhPI" <https://dlc.kpi.kharkov.ua/course/view.php?id=1853>

Program of the course

Topics of the lectures

Topic 1. Introduction to the course.

General information about volumetric hydraulic machines. Purpose and application of volumetric hydraulic machines. Principle of operation of volumetric hydraulic machines.

Topic 2. Gear hydraulic machines.

Schemes of gear hydraulic machines, their features and weaknesses. Static calculation of gear hydraulic machines. Determination of flow characteristics of a gear pump.

Topic 3. Radial piston pumps and hydraulic motors.

Classification of rotary machines and their schemes of operation. Determination of the main parameters that characterise the working process of radial piston hydraulic machines.

Topic 4. Vane pumps and hydraulic motors.

Single chamber and double chamber hydraulic vane machines. Constructions of vane hydraulic machines.

Topic 5. Axial piston pumps and hydraulic motors.

Scheme of mechanisms of axial piston pump in bent axis design and axial piston pump in swashplate design. End face distribution of liquid. Spool distribution of liquid.

Topic 6. Hydraulic cylinders. Rotary Actuators.

Basic schemes of hydraulic cylinders. Static calculations of hydraulic cylinders. Telescopic cylinders. Rotary Actuators.

Topic 7. Regulation of volumetric hydraulic machines.

Volumetric and throttle control of the hydraulic drive.

Topic 8. Hydraulic valves.

Purpose and operation of hydraulic valves. Designs and types of hydraulic valves depending on their purpose.

Topic 9. Throttle valves, flow control valves and filters.

Designs and types of throttle valves. Designs and types of flow control valves. Designs and types of filters.

Topic 10. Directional valves.

Purpose and operation of hydraulic directional valves. Directional spool valves, rotary directional spool valves, directional poppet valves – their design, features and weaknesses.

Topic 11. Auxiliary devices for hydraulic systems.

Control and measuring equipment. Hydraulic lines. Types of hydraulic lines, their calculation. Connection of hydraulic lines.

Topic 12. Design principles for hydraulic drives.

Topic 13. Features of the pneumatic system application.

Structure of a pneumatic drive. Element base of pneumatic drives.

Topics of the workshops

Topic 1. Design and analysis of structural, principal, functional hydraulic schemes.

Topic 2. Selection of hydraulic fluid. Main properties of hydraulic fluids.

Topic 3. Determination of parameters of gear, vane, radial piston hydraulic machines.

Topic 4. Study of the design and principles of operation of hydraulic cylinders. Familiarisation with methods of calculating the main parameters of hydraulic cylinders.

Topic 5. Calculation of a volumetric rotary actuator.

Topic 6. Purpose of regulating equipment of the hydraulic drive, determination of the main parameters.

Topic 7. Purpose of guiding equipment of hydraulic drive, determination of basic parameters.

Topic 8. Determining the parameters of a hydraulic lift.

Topics of the laboratory classes

The curriculum doesn't include laboratory classes.

Self-study

The course involves completing a coursework on the design and calculation of volumetric hydraulic machines. The results of the design and calculations are presented in a written report.

Students are also recommended additional materials (videos, literature, articles) for self-study and analysis.

Course materials and recommended reading

Compulsory materials

1 Дранковський В. Е., Миронов К. А., Фатєєва Н. М., Резва К. С., Крупа Є. С. Технічна термодинаміка, гідравліка і гідромашини: навч. посібник у 2 ч. Ч. 2: Гідродинаміка та гідравлічні машини. Харків: НТУ "ХПІ", 2020. 223 с. http://repository.kpi.kharkov.ua/bitstream/KhPI-Press/44360/5/Book_2020_Drankovskiy_Tekhnichna_termodynamika_Ch_2.pdf

2 Зайченко Є. Т. Гідравліка та гідроприводи. Харків: НТУ "ХПІ", 2007. 130 с. <http://library.kpi.kharkov.ua>

3 Буренніков Ю. А., Немировський І. А., Козлов Л. Г. Гідравліка, гідро- та пневмоприводи. Вінниця: ВНТУ, 2013. 273 с. <http://library.kpi.kharkov.ua>

4 Яхно О. М., Чебан В. Г., Фінкельштейн З. Л., Лур'є З. Я., Чекмасова І. А. Розрахунок, проектування та експлуатація об'ємного гідроприводу. Київ: НТТУ «КПІ», 2006. 216 с. <http://library.kpi.kharkov.ua>

5 Погорілець О. М., Волянський М. С., Войтюк В. Д., Пастушенко С. І. Гідропривод сільськогосподарської техніки. Київ: Вища освіта, 2004. 368 с.

6 Сидоренко В. П., Яхно О. М. Гідравліка і гідроприводи. Київ: Університет "Україна", 2008. 163 с.

Additional materials

1 Гевко Б. М., Білик С. Г., Ліник А. Ю., Фльонц О. В. Гідропривод і гідроавтоматика сільськогосподарської техніки. Тернопіль: ТНТУ ім. Івана Пулюя, 2015. 384 с.

2 Жук А. Я., Желябіна Н. К. Теорія и практика приводов. В 3 кн. Кн. 2: Гидро- и пневмопривод. Запорозьке: ЗГИА, 2001. 232 с. <http://library.kpi.kharkov.ua>

3 Бочков В. М., Сілін Р. І. Розрахунок та конструювання металорізальних верстатів. Львів: Бескид Біт, 2008. 448 с. <http://library.kpi.kharkov.ua>

Assessment and grading

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

100% of the final grade consists of assessment results in the form of an exam (40%) and current assessment (60%).

Exam: written assignment (2 theory questions + problem solving) and oral presentation.

Current assessment: performing practical works (25%) and defence of the course work (35%).

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

Guarantor of the educational
program
Volodymyr RUBASHKA