Syllabus of the educational component
Programme of the discipline

Fluid Power Systems for Turbine Blade Pitch Control

Code and name of the speciality
G4 Energy production (by specialization)

Specialization
Renewable energy sources and hydropower

Educational programme
G4 Energy production (by specialization)

Level of education
Second (Master's)

Semester
2

Institute
Educational and Research Institute of Mechanical Engineering and Transport (MIT)

Department
Department of Energy Machinery Engineering named after G.F. Proskura (150)

Type of discipline
Selective

Form of study
Full-time

Language of instruction
English

Teachers, developers

Mariana Stryzhak
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D. in Engineering, Associate Professor, Associate Professor of the Department of Energy Machinery Engineering named after G.F. Proskura of NTU "KhPI"

Author of more than 60 scientific and educational publications. Leading lecturer in the courses: "Theory of Automatic Control and Dynamics of Mechatronic Systems", "Modern Element Base of Mechatronic Systems", "Volumetric Hydraulic Machines", "Fundamentals of Calculation and Design of Electro-Hydraulic and Electro-Pneumatic Transducers", "Fundamentals of Scientific Research".

More about the lecturer on the department's website

General information

Abstract

The discipline is devoted to the study of the principles of operation, control and monitoring of hydraulic and pneumatic drive with proportional control in operational and production facilities in various industries, design of systems and devices and modernisation of hydraulic and pneumatic drive with proportional control of automated mechatronic facilities.

Purpose and objectives of the discipline

Developing students' abilities:

- to solve complex practical problems of automation of technical objects by creating hydraulic and pneumatic drive systems in combination with hydraulic automation and robotics for technical objects for various purposes;

- design structures, calculate and adjust the operating parameters of hydraulic and pneumatic devices with proportional control and hydraulic and pneumatic drives based on them.

Class format

Lectures, laboratory classes, essay, consultations. Final control – test.

Competences

GC5. Ability to use information, communication and digital technologies.

GC7. Ability to apply knowledge in practical situations.

GC8. Knowledge and understanding of the subject area and understanding of professional activities.

SC3. Ability to make an optimal choice of technological equipment, tools, technical complexes, have a basic understanding of the rules of their operation.

SC4. Ability to use computer-aided design systems (CAD, CAM, CAE) and specialised application software to solve technological problems in applied mechanics.

SC6. Ability to describe and classify technical objects and processes based on knowledge and understanding of basic mechanical theories and practices, as well as basic knowledge of related sciences.

SC7. Ability to apply appropriate quantitative mathematical, technical methods and computer software to solve typical professional problems of applied mechanics.

Learning outcomes

ELO2. Use knowledge of the theoretical foundations of electrical engineering, electronics and related sciences to solve professional problems.

PO4. Use application software to perform technological calculations, process information and research results.

PO5. To know the design, methods of selection and calculation, basics of maintenance and operation of drives of machine tools and robotic equipment.

PO6. Understand the principle of operation of automated control systems for technological equipment, in particular microprocessor-based, be able to select and use the best means of automation, automation of production processes.

Scope of the discipline

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

Prerequisites for studying the discipline (prerequisites)

To successfully complete the course, you must have knowledge and practical skills in the following disciplines: "Fundamentals of Informatics", "Calculations and Modelling of Hydropneumatic Systems", "Hydraulics", "Fundamentals of Hydraulic Drive Theory", "Modern Element Base of Mechatronic Systems".

Features of the discipline, teaching methods and technologies

Lectures are conducted interactively with the use of multimedia technologies, and laboratory classes are held in the laboratory of the Department of Machine Parts and Hydropneumatic Systems. Teaching materials are available to students via Microsoft Teams.

Programme of the discipline

Study sessions

Lectures

Topics of lecture classes	Hours
Introduction to fluid power: history of development; fluid power versus fluid transport systems; advantages, disadvantages and fields of application.	2
Physical and chemical properties of hydraulic fluids: viscosity, viscosity index, corrosion resistance, flammability; criteria for fluid selection.	2
Fundamentals of hydraulics: laminar and turbulent flow; major and minor energy losses in pipelines and fittings.	2
Classification and principle of operation of hydraulic pumps: gear, vane and piston pumps; pump selection criteria.	2
Hydraulic actuators: classification and design of hydraulic cylinders (single-acting, double-acting, telescoping) and hydraulic motors.	2
Directional control valves and check valves in hydraulic systems, including pilot-operated and shuttle valves.	2
Pressure control valves (relief, reducing, sequence valves) and flow control valves.	2
Hydraulic accumulators: types and applications; intensifier circuits and cylinder synchronizing circuits.	2
Properties of air and perfect gas laws; principle of operation and classification of compressors.	2
Pneumatic control valves: directional, quick-exhaust and shuttle valves; pneumatic actuators.	2
Design considerations for pneumatic circuits; discrete control logic; basic pneumatic circuits.	2
Logic elements and Boolean control functions in pneumatic and electropneumatic automation.	2
Ladder logic programs and basics of PLC programming; sequence control circuits.	2
Speed control and synchronizing circuits; sequencing circuits with sequence and counterbalance valves.	2
Locking circuits with pilot check valves, fail-safe circuits, and open- and closed-circuit hydrostatic transmissions.	2
Control of proportional hydraulic and pneumatic valves; examples of industrial applications of mechatronic drives.	2

Total lecture hours: 32

Practical classes

Practical classes are not provided within this discipline.

Laboratory classes

Topics	Hours	Weight coefficient a
Implementation of elementary functions using standard pneumatic equipment: creating and modelling manually and electrically controlled pneumatic circuits in FluidSim.	3	0.2

Topics	Hours	Weight coefficient a
Pneumatic schemes for reverse control of air motors using three-line and four/five-line distributors.	3	0.2
Pneumatic schemes of pneumatic motor speed control by throttle and flow-control methods.	3	0.2
Control schemes for pneumatic motors with cycle control by end position, pressure and time.	3	0.2
Use of pulse control of pneumatic distributors with memory in automation of technological processes.	4	0.2
Total hours	**16**	**1.0**

Independent work

Independent work includes self-study of theoretical material and preparation for laboratory classes, as well as preparation of an individual task.

Self-study of theoretical material

Topics for self-study	Hours
Fluid power fundamentals for self-study: hydraulic fluid standards, fluid conditioning and filtration, and fire-resistant fluids.	14
In-depth study of hydraulic pump and motor characteristics: efficiency curves, cavitation, and noise control.	14
Design and sizing of pneumatic and hydraulic circuit components for typical industrial applications.	16
Electro-hydraulic and electro-pneumatic proportional and servo control: amplifier cards, feedback types, and dynamic response.	16
Maintenance, diagnostics and troubleshooting of hydraulic and pneumatic drive systems; filtration requirements.	12

Total hours: 72

Topics of individual assignments

The course involves preparing an individual task on a topic within hydraulic and pneumatic drive systems with proportional control, agreed with the lecturer. The result is presented in the form of a PowerPoint presentation.

Informal education

The course involves completing a calculation and design assignment that entails developing a hydraulic or pneumatic drive system, calculating its components, selecting an optimization method, and using software tools to verify the functionality of the resulting circuit. The outcome is documented in a written report.

Students are also provided with additional materials for independent study and analysis.

Recommended courses, trainings, internships

Fundamentals of Fluid Power – University of Minnesota (Coursera)

Oil Hydraulics and Pneumatics – IIT Madras / NPTEL

Hydraulic and Pneumatic Actuators – Alison

Literature, training materials and information resources

Main literature

1. Scholz D. Proportional hydraulics. Basic course: Textbook.- SE "FESTO".- Kyiv.- 2002.- 123p.

2. Functional modules of mechatronics systems with pneumatic, electromechanical and hydraulic actuators [Electronic resource]: textbook / O.P. Hubarev, O.S. Hanpantsurova, K.O. Belikov, A.M. Murashchenko; Igor Sikorsky Kyiv Polytechnic Institute.

3. Yakhno O.M. et al. Applied hydroaeromechanics and mechatronics / Edited by Yakhno O.M. - Vinnytsia: VNTU, 2019.- 711 p.

4. Proportional Hydraulics. Workbook Basic Level/ D. Scholz, A. Zimmermann, Festo Didactic GmbH&Co, OCKER Ingenieurbüro, Denkendorf 1998, 352 S.

5. Hydraulic means of automation: Basic course/Translation into Russian, ed: "Festo Didactic KG, D-7300, Esslingen, 1988, 410 pp.

6. Ebel F., von Terzi M. Festo Didactic. Mechatronics: Festo Didactic GmbH&Co., D73770 Denkendorf, 2000.- 108 S.

7. Elektrohydraulik: elektrische Steuerungen fur Hydraulik.- Ruksaldruk, Berlin: Beuth.-1990.-90 S.

8. Mechatronika/ pod kier. Dietmara Schmida.- Polish edition REA, Warshawa.- 2002.- 384p.

9. Mobilhydraulik und Elektronik. Mannesmann Rexroth.- Bonitas-Bauer.- Wurzburg.-1992.-416 S.

10. Proportional Hydraulics. Workbook Basic Level/ D. Scholz, A. Zimmermann, Festo Didactic GmbH&Co, OCKER Ingenieurbüro, Denkendorf 1998, 352 S.

11. Proportional- und Servoventil-Technik Der Hydraulik Trainer Band 2/ R. Ewald, J. Hutter, D. Kretz, A. Schmitt, Mannesmann Rexroth GmbH, Lohr am Main, Würzburg 1998, 304 S.

Grading system

The final grade for the educational component is determined by the responsible lecturer, based on the topics and types of classes in accordance with the syllabus, and is an integral assessment of the results of all types of educational activity of the student. The final grade must reflect all grades for the components of the educational process, taking into account their weight coefficients k:

Current control (practical works), k_1	Control works, k_2	Laboratory works, k_3	Final control, k_4
0.0	0.0	0.6	0.4

The sum of the coefficients must equal one: $k_1 + k_2 + k_3 + k_4 = 1$. The weight coefficients of the final grade are selected by the course developer.

The final grade is calculated using the formula:

$$O = L \cdot k_3 + E \cdot k_4,$$

where: L – weighted average grade for laboratory works;
E – grade for the final control (exam).

Current grades for each component are given on a 100-point scale in accordance with the NTU “KhPI” regulation “On the criteria and system for assessing knowledge and skills and on the rating of higher education students”. The final grade is assigned according to the calculated O, rounded to the nearest whole number upward.

Grading scale

Total points	National assessment	ECTS
90-100	Excellent	A
82-89	Good	B
75-81	Good	C
64-74	Satisfactory	D

Total points	National assessment	ECTS
60-63	Satisfactory	E
35-59	Unsatisfactory (further study required)	FX
1-34	Unsatisfactory (re-study required)	F

Standards of academic ethics and course policy

The student must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": show discipline, good manners, goodwill, honesty, responsibility. Conflict situations should be openly discussed in study groups with the teacher, and if it is impossible to resolve the conflict, they should be brought to the attention of the staff of the Institute's directorate.

Regulatory and legal support for the implementation of the principles of academic integrity of NTU “KhPI” is available on the website: http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Approval

Silabus has been approved — 29.08.2026, protocol № 1 — Head of the Department Andrii Rogovyi

29.08.2026 — Guarantor of the OP Andrii Rogovyi