Syllabus educational component of the Ministry of Education (elective discipline)

Hydropneumatic automation

Subjects:	Hydropneumatic automation
Level of higher education:	first (undergraduate)
Course page in Moodle:	https://dl.khadi.kharkov.ua/course/view.php?id=733
The scope of the educational	4 credits (120 hours)
component	
Final control form	Test
Consultations:	on schedule
Name of the department:	department of construction and road machines
Teaching language:	English
Course leader:	Avrunin Hryhoriy Avramovich, Ph.D., associate
	professor
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Brief content of the educational component:

the purpose is the formation of knowledge and skills to independently solve production functions and typical tasks of activities in the field of hydraulic drive and hydropneumatic automation for lifting and transport, construction, road and reclamation machines and equipment and technological processes in production, in particular, solving tasks of automating the operation of equipment.

Subject: a pedagogically adapted system of concepts about the principles of operation of hydropneumoautomatics for use in modern lifting and transport, construction, road and reclamation machines to increase the level of automation and technical level.

The main tasks of studying an academic discipline are:

- to know the principle of operation of elements of hydropneumatic automation and electrohydropneumatic automation;
- basics of calculating elements of hydropneumatic automation, their technical characteristics and product nomenclature;
- to be able to perform justifications and calculations of the main parameters of hydropneumatic automation elements;
- draw up and analyze hydraulic schematics of machines;
- to have an idea of the modern nomenclature of hydraulic drive elements and electro-hydropneumatic automation.

Prerequisites for studying the educational component:

Sketch geometry, engineering and computer graphics; Higher mathematics; Theoretical mechanics; Construction materials technology and materials science; Strength of Materials; Theory of mechanisms and machines.

Competencies acquired by the acquirer:

General competences:

Ability to apply knowledge in practical situations.

Ability to communicate in the national language both orally and in writing. Ability to communicate in a foreign language.

Special (professional) competences:

The ability to perform the analysis of automation objects based on knowledge of the processes taking place in them and to apply the methods of the theory of automatic control for research, analysis and synthesis of automatic control systems.

The ability to design automation systems taking into account the requirements of relevant regulatory documents and international standards.

The ability to use knowledge about the types, structure, power drives and peculiarities of work processes of construction, road machines and equipment for their automation based on computer-integrated technologies.

Learning outcomes:

To understand the essence of the processes that take place in automation objects in the fields of instrument construction and automation of construction, road machinery and equipment, and to be able to analyze automation objects and justify the choice of their structure, algorithms and control schemes based on the results of the study of their properties

To be able to apply methods of automatic control theory for research, analysis and synthesis of automatic control systems.

Know the principles of operation of automation technical means and be able to justify their choice based on the analysis of their properties, purpose and technical characteristics, taking into account the requirements for the automation system and operating conditions; have skills in setting up technical means of automation and control systems.

Thematic plan

Tania	Name of topics (LK, LR, PR, SZ, SR)		Number of	
No			extram	
1	LC1. Introduction (historical process of development of		urai	
	automation). Types of working fluid energy (PP). Structural diagram and principle of operation of an automatic gearbox with a complex torque converter	2	2	
	LR1. Acquaintance with the laboratory base of hydropneumatic automation. Safety measures when performing laboratory work	2	2	
	SR1. Introduction (historical process of hydropneumatic drive development).	4 Wed	4 Wed	
2	LC2. Pascal's law and the continuity equation. Calculation of flow, pressure losses and leaks in turbulent and laminar flow regimes in elements of hydropneumatic automation. Schematic diagrams of a hydropneumatic drive using devices of hydropneumatic automation and electrohydropneumatic automation. Working fluids and their conditioners. Units of pressure and flow RR.	2	2	
	LR2. Graphic designation of hydropneumatic devices. Rules for the execution of schematic diagrams.	2	2	
	ЛРЗ Calculation and analysis of pressure losses and PP flow in the turbulent flow regime	2	2 Wed	

	SR2.Working fluids and their conditioners (filters and coolers)	16 Wed	16 Wed
3	LC3. Methodology for calculating the volume hydraulic drive (OHP) of the lift.Analysis of the basic equation of hydrostatics. Basic structural schemes and calculation of hydraulic cylinders.	2	2
	LR4. Calculation and analysis of force from pressure in the volume hydraulic drive of the lift	2	2 Wed
4	LC4. Classification of hydraulic machines. The principle of operation of pumps, hydraulic motors and hydraulic cylinders, in particular a pump with a crank-connecting mechanism, axial-and radial-piston, gear and plate types.	2	2
	SR3. The principle of operation of pumps and hydraulic motors of axial and radial piston, gear and plate types.	24 Wed	24 Wed
	LC5. Hydraulic distributors. Multifunctional spool pressure valve for automating the operation of the OGP. Throttle hydraulic distributors. The principle of action. Power amplifier of the "nozzle-valve" type. Power and output characteristics of the interthrottle chamber. Double throttle of the "nozzle-valve" type.	2	2
5	LR5. Calculation of the parameters of the reduction valve with a proportional electromagnet.	2	2 Wed
	LR6. Calculation and analysis of changes in flow and pressure in the interthrottle chamber of the "nozzle-valve" throttle.	2	2 Wed
	LR7. Calculation of the speed of movement of the spool of a hydraulic amplifier with a double throttle "nozzle-damper"	2	2 Wed
	LK6. Hydraulic equipment based on electromagnets with proportional electric control. Principle of operation and characteristics of a proportional electromagnet (PE). The use of PE in hydraulic distributors, safety and reducing hydraulic valves, calculation of initial characteristics. Examples of application effectiveness	2	8 Wed
	LR8. Analysis of changes in rotation frequency and power of a hydraulic motor with a trailing-type regulator on the pump.	2	2 Wed
6	LR9. Analysis of changes in torque and rotation frequency of a hydraulic motor with a regulator on a "constant power" pump.	2	2 Wed
	LR10. Analysis of the deviation of the pressure drop on the three-wire flow regulator PP.	2	2 Wed
	LR11. Analysis of the efficiency of energy saving systems.	2	2 Wed
	CP4. The use of PE in hydraulic distributors, safety and reducing hydraulic valves, calculation of initial characteristics. Examples of application effectiveness	24 Wed	16 Wed
7	LC7. Volumetric hydraulic drives with throttle and machine control. Calculation of the speed of the hydraulic cylinder and hydraulic motor.	2	2 Wed
	LR12. Study of the construction of hydraulic distributors for HTZ tractors. Calculation of forces acting on the spool and hydraulic losses.	2	2 Wed
	LR13. Analysis of the operation of regulators of the working volume of pumps and hydraulic motors on the example of a loader	2	2 Wed

	LR14. Analysis of the change in the speed of the hydraulic motor due to the external load during throttle control of the fuel consumption	2	2 Wed
	LC8. Hydraulic devices for the safety of OGP operation. Use of hydraulic locks and brake hydraulic valves. Energy saving in hydraulic drives. Filtration and heat exchange of RR in volumetric hydraulic drives.	2	4 Wed
8	LR15. Analysis of the operation of automation systems of a hydraulic drive with a closed circuit of the flow of RR.	2	2 Wed
	LR16.Modern measuring equipment for testing hydraulic drives. Metrological processing of measurement results.	2	2 Wed
	SR5. Metrological processing of measurement results.	4 Wed	4 Wed
Toget her	LK	16	10
	LR	32	4
	SR	72	106

Individual educational and research task (if available): does not have.

Teaching methods:

- TM1-verbal method (lecture);
- TM2 practical method (laboratory classes);
- TM4 work with educational and methodical literature;
- TM8 project method.

Assessment forms and methods

- FMO2 final control (semester assessment)
- FMO3 oral control (conversation)
- FMO5 test control
- FMO7 practical test (protection of laboratory work)

Evaluation system and requirements:

Current performance

1 The current success of applicants for the performance of educational types of work in training sessions and for the performance of independent work tasks is evaluated using a four-point rating scale with subsequent transfer to a 100-point scale. During the evaluation of the current performance in are counted all types of work provided by the curriculum program

1.1 Lecture classes are evaluated by determining the quality of performance of specified tasks.

1.2 Practical classes are evaluated by the quality of performance of a control or individual task, performance and design of practical work.

2 Evaluation of the current success rate of higher education applicants is carried out at each practical session (laboratory or seminary) on a four-point scale ("5", "4", "Z", "2") and are entered in accounting journal academic success

- "excellent": the winner mastered the theoretical material flawlessly, demonstrates deep knowledge of the relevant topic or academic discipline, the main provisions;

- "good": the applicant has mastered the theoretical material well, has the main aspects from primary sources and recommended literature, presents it in a reasoned manner; has practical skills, expresses his thoughts on certain problems, but certain inaccuracies and errors are assumed in the logic of the presentation of theoretical content or in the analysis of practical ones;

- "satisfactory": the applicant has basically mastered the theoretical knowledge of the educational topic or discipline, orients himself in primary sources and recommended literature, but answers unconvincingly, confuses concepts, answers additional questions uncertainly, does not have stable knowledge; when answering questions of a practical nature, reveals inaccuracy in knowledge, does not know how to evaluate facts and phenomena, connect them with the future profession;

- "unsatisfactory": the applicant has not mastered the educational material of the topic (discipline), does not know scientific facts, definitions, hardly orients himself in primary sources and recommended literature, lacks scientific thinking, practical skills are not formed. **3**Final score by current activity is recognized as an arithmetic average sum points for each lesson, for individual work, current control works according to the formula:

$$K^{current} = \frac{K1 + K2 + \dots + Kn}{n}$$

Where $K^{current}$ – final assessment of success based on the results of current control;

*K*1,*K*2,...,*Kn*- evaluation of success *n* -th measure of current control;

n - the number of measures of current control.

Grades are converted in points according to the calculation scale (table 1).

Та	able 1 – Recalculation of the average grade for the current activity int	o a multi-
point so	cale	

4-point scale	100 points scale	4-ball scale	100 points scale	4-ball scale	100 points scale	4-ball scale	100 points scale
5	100	4.45	89	3.90	78	3.35	67
4.95	99	4.4	88	3.85	77	3.3	66
4.9	98	4.35	87	3.80	76	3.25	65
4.85	97	4.3	86	3.75	75	3.2	64
4.8	96	4.25	85	3.7	74	3.15	63
4.75	95	4.20	84	3.65	73	3.1	62
4.7	94	4.15	83	3.60	72	3.05	61
4.65	93	4.10	82	3.55	71	3	60
4.6	92	4.05	81	3.5	70	from 1.78 to 2.99	from 35 to 59
						reassen	nbly
4.55	91	4.00	80	3.45	69	from 0 to 1.77	from 0 to 34
4.5	90	3.95	79	3,4	68	repeated	study

Final assessment:

1 A student of higher education receives a credit in the last lesson in the discipline based on the results of the current assessment. The average score for the current activity is converted into points on a 100-point scale, according to the conversion table (table 1).

Graduates of higher education, who have an average current grade in the discipline lower than "3" (60 points), in the last session can increase their current grade by taking tests in the discipline.

Assessment of the knowledge of applicants through testing is carried out according to the following scale:

- "Excellent": at least 90% of correct answers;

- "Very good": 82% to 89% correct answers;
- "Good": from 74% to 81% of correct answers;
- "Satisfactory": from 67% to 73% of correct answers;
- "Fair enough": 60% to 66% correct answers;
- -"Unsatisfactory": less than 60% of correct answers.

2 The condition for obtaining credit is:

-making up for all missed classes;

-the average current grade in the discipline is not lower than "3" (60 points).

3 For performing individual independent work and participating in scientific events, winners are awarded additional points.

3.1 Additional points are added to the sum of points scored by the student of higher education for the current educational activity (for disciplines, for which the final form of control is a test), or to the final grade in the discipline, for which the final form of control is an exam.

3.2 The number of additional points awarded for different types of individual tasks depends on their volume and importance:

-prizes in the discipline at the international / all-Ukrainian competition of scientific student works - 20 points;

-prize places in the discipline at the All-Ukrainian Olympiads - 20 points;

-participation in the international / all-Ukrainian competition of scientific student works - 15 points

-participation in international / all-Ukrainian scientific conferences of students and young scientists - 12 points;

-participation in all-Ukrainian Olympiads in the discipline - 10 points

-participation in olympiads and scientific conferences of the Khnadu in the discipline - 5 points;

-performance of individual scientific and research (educational and research) tasks of increased complexity - 5 points.

3.3The number of additional points cannot exceed 20 points.

4The result of the study is evaluated (select is required):

-on a two-point scale (passed/failed) according to table 2;

-on a 100-point scale (for differentiated assessment) according to table 3.

The final grade together with additional points cannot exceed 100 points.

Table 2 -The scale for transferring points to the national evaluation system

On a 100-point scale	On a national scale
from 60 points to 100 points	counted
less than 60 points	not counted

 Table 3–The scale for evaluating the knowledge of students based on the results of the final control of the academic discipline

Score	Evaluation on a		Evaluation according to the ECTS scale		
in	national scale				
points	exam	test	Rating	Criteria	
90-100	Perfectly	Enrolled	A	The theoretical content of the course has been mastered in its entirety, without gaps, the necessary practical skills for working with the mastered material have been formed, all educational tasks provided for in the training program have been completed, the quality of their performance has been assessed with a number of points close to the maximum	
80–89	υ		В	The theoretical content of the course has been mastered in its entirety, without gaps, the necessary practical skills for working with the mastered material have mainly been formed, all educational tasks provided for by the training program have been completed, the quality of most of them has been assessed with a number of points close to the maximum	
75-79	Fine	inrolled	C	The theoretical content of the course has been mastered in its entirety, without gaps, some practical skills of working with the mastered material have not been formed enough, all educational tasks provided for by the training program have been completed, the quality of none of them has been assessed with a minimum number of points, some types of tasks have been completed with errors	
67-74	Batisfactorily F		D	The theoretical content of the course is partially mastered, but the gaps are not of a significant nature, the necessary practical skills for working with the mastered material are basically formed, most of the educational tasks provided by the training program have been completed, some of the completed tasks may contain errors	
00-00				partially mastered, some practical work skills have not been formed, many educational tasks provided by the training program have not been completed, or the quality of some of them has been assessed with a number of points close to the minimum.	

Score	Evaluati	on on a		Evaluation according to the ECTS scale		
in	nationa	national scale		Critoria		
points	exam	test	Rating	Citteria		
35–59	Unsatisfactorily	t counted	FX	The theoretical content of the course has been partially mastered, the necessary practical work skills have not been formed, most of the prescribed training programs of educational tasks have not been completed, or the quality of their implementation has been assessed with a number of points close to the minimum; with additional independent work on the course material, it is possible to improve the quality of the performance of educational tasks (with the possibility of retaking)		
0–34	Unacceptable	No	F	The theoretical content of the course has not been mastered, the necessary practical work skills have not been formed, all completed educational tasks contain gross errors, additional independent work on the course material will not lead to any significant improvement in the quality of the performance of educational tasks (with a mandatory repeat course)		

Course policy:

- the course involves working in a team, the environment in the classroom is friendly, creative, open to constructive criticism;

- mastering the discipline involves mandatory attendance of lectures and practical classes, as well as independent work;

- independent work involves the study of individual topics of the academic discipline, which are presented in accordance with the program for independent study, or were considered briefly;

- all tasks provided by the program must be completed within the set time;

- if the student of higher education is absent from classes for a good reason, he presents the completed tasks during independent preparation and consultation of the teacher;

- the coursework must be protected no later than a week before the beginning of the examination session (indicated if available);

- while studying the course, students of higher education must adhere to the rules of academic integrity set forth in the following documents: "Rules of academic integrity of participants in the educational process of the Khnadu" (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_dobroch_1.p_df), "Academic integrity. Checking the text of academic, scientific and qualification papers plagiarism"

(https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_85_1_01.pdf),

"Moral and ethical code of participants in the educational process of the National Academy of Sciences

(https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_MEK_1.pdf).

- in case of detection of plagiarism, the applicant receives 0 points for the task and must repeat the tasks provided for in the syllabus;

- writing off during tests and exams is prohibited (including using mobile devices). Mobile devices are allowed to be used only during online testing.

Recommended Books:

1.1.Avrunin G.A. Fundamentals of volumetric hydraulic drive and hydropneumatic automation: a study guide / G. A. Avrunin, I. I. Kyrychenko, I. I. Moroz; under the editorship G. A. Avrunin. – Kharkiv: Khnadu,2009. – 424 p.

1.2. Avrunin G.A. Hydraulic equipment of construction and road machines: textbook / (G. A. Avrunin, I. G. Kyrychenko, V. B. Samorodov); under the editorship G. A. Avrunin. - Kharkiv: Khnadu, 2016. - 438 p.

1.3. Avrunyn G.A. Operation of hydraulic equipment of construction and road machines: (tutorial) / G. A. Avrunin, I. G. Kyrychenko, V. B. Samorodov; under the editorship G. A. Avrunina. – Kh.: Khnadu, 2013. – 438 p.

1.4. Methodical guidelines for the study of the discipline "Hydropneumoautomatics" (laboratory classes) / Avrunin G.A., Kholodov A.P. // I'M LOOKING FOR IT. - 2020. - 116 p.

Additional sources:

2.1. DSTU 3455.1-96 (2-96; 3-96; 4-96). Volumetric hydraulic drives and pneumatic drives. Terms and definitions. State Standard of Ukraine. - Kyiv: 1997. - 196 p.

2.2. DSTU ISO 4413:2002. Volumetric hydraulic drives. General rules for application (ISO 4413:1998, IDT. - Derzhpozhivstandard of Ukraine. - Kyiv: 2005. - 31 p.

2.3. Volumetric hydraulic drive and hydropneumatic automation: textbook / (G. A.

Avrunyn, I. V. Hrytsai, I. G. Kyrychenko and others). - Kharkiv: Khnadu, 2008. - 412 p. 2.4. Hydropneumatic automation. – Distance course / Avrunin G.A. https://dl.khadi.kharkov.ua/course/view.php?id=733

2.5. Hydraulic machines and hydraulic units (<u>http://www.kpi.kharkiv.edu/gdm</u>).

2.6. Industrial hydraulics and pneumatics (<u>http://www.jornal-pgp.ua</u>).

2.7. Hydraulic drive. Main components. Training course on hydraulics (www.BoschRexroth.com).

2.8. Industrial and mobile hydraulics (www.parker.com).

2.9. Sauer Danfoss. Technical Information (www.sauer-danfoss.com).

Developer(s)

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