

Ministry of Education and Science of Ukraine
Dnipro university of technology

Department of Electric Drive



«APPROVED»
Head of Department
Khudolii S.S. _____
«30» August 2022

WORK PROGRAM OF THE ACADEMIC DISCIPLINE
«Fundamentals of Electric Drives»

Field of study	14 Electrical engineering
Specialty	141 Electrical energetics, electrical engineering and electromechanics
Academic level	first (bachelor)
Academic program	«Electrical energetics, electrical engineering and electromechanics»
Specialization	-
Status	normative
Total workload	5 credits ECTS (150 hours)
Type of summative assessment	exam
Period of study	4 semester (7, 8 terms)
Language of study	English

Lecturer: Prof. Beshta O.S., Prof. Sadovoi O.V.

Prolonged: on: 20__/20__ a.y. _____ (_____) «__» 20__y.
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on 20__/20__ a.y. _____ (_____) «__» 20__y.
(sign, name, data)

Dnipro
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2022

Work program of the academic discipline «Fundamentals of electric drives» for bachelors of the educational and professional program «Electrical energetics, electrical engineering and electromechanics» of the specialty 141 Electrical energetics, electrical engineering and electromechanics / Dnipro University of Technology, Department of Electric Drive. – D.: DNIPROTECH, 2022 – 14 p.

Authors:

– Beshta Oleksandr Stepanovych – Corresponding member of the National Academy of Sciences of Ukraine, Professor, Doctor of Technical Sciences, Professor of the Department of Electric Drive;

– Sadovoi Oleksandr Valentynovych – Professor, Doctor of Technical Sciences, Professor of the Department of Electric Drive.

The work program regulates:

- the aim of the discipline;
- the disciplinary learning outcomes generated through the transformation of the intended learning outcomes of the degree program;
- basic disciplines;
- volume and distribution by forms of organization of the educational process and types of classes;
- discipline program (thematic plan by type of training);
- algorithm for assessing the level of achievement of disciplinary learning outcomes (scales, tools, procedures and assessment criteria);
- tools, equipment and software;
- recommended sources of information.

The work program is designed to implement a competency approach in planning an education process, delivery of the academic discipline, preparing students for control activities, controlling the implementation of educational activities, internal and external quality assurance in higher education, accreditation of degree programs within the specialty.

Approved by the decision of the Scientific and Methodological Commission of the specialty 141 Electrical energetics, electrical engineering and electromechanics (protocol №21/22-07 of 14.07.2022).

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1 AIM OF THE DISCIPLINE

In the educational and professional program «Electrical energetics, electrical engineering and electromechanics» of the specialty 141 Electrical energetics, electrical engineering and electromechanics the distribution of program learning outcomes (PLO) for the organizational forms of the educational process is done. In particular, the following learning outcomes are attributed to the discipline Ф4 «Fundamentals of Electric Drives»:

ПП03	To know the principles of operation of electric machines, devices and automated electric drives and be able to use them to solve practical problems in professional activities
ПП07	To carry out the analysis of processes in the electric power, electrotechnical and electromechanical equipment, the corresponding complexes and systems
ПП08	To select and apply suitable methods for analysis and synthesis of electromechanical and electric power systems with specified parameters

The aim of the discipline is to form competencies in the construction, principle of action and analysis of processes in automated electric drives.

The implementation of the aim requires transforming program learning outcomes into the disciplinary ones as well as an adequate selection of the contents of the discipline according to this criterion.

2 INTENDED DISCIPLINARY LEARNING OUTCOMES

Code PLO	Disciplinary learning outcomes (DLO)	
	Code DLO	Content
ПП03	ПП03.1-Ф4	To determine the principles of construction and functioning of elements of control systems of electromechanical complexes.
ПП07	ПП07.1-Ф4	Evaluate the parameters of electromechanical equipment and corresponding complexes and systems and develop measures to increase their energy efficiency and reliability.
ПП08	ПП08.1-Ф4	Demonstrate skills in working with modern equipment, as well as performing calculations of modes of operation of electromechanical equipment, corresponding complexes and systems.
	ПП08.2-Ф4	Invent new ways to solve the problem of economic transformation and use of electricity

3 BASIC DISCIPLINES

Subjects	Achieved learning outcomes
Б5 «Theoretical foundations of electrical engineering»	ПП05 To know the basics of the theory of the electromagnetic field, methods of calculating electric circuits and be able to use them to solve practical problems in professional activities.
Ф1 «Electric Machines»	ПП03.1-Ф1 To determine principle of construction and functioning of electric machines units as part of electric power, electrical, and electromechanical complexes, and systems. ПП03.2-Ф1 To assess working parameters of electric machines as part of electrical, electric power, and electromechanical equipment and relevant complexes and

Subjects	Achieved learning outcomes
	systems, and to develop measures of their energy efficiency and reliability improvement.
Φ6 «Technical Mechanics»	<p>ΠΠ07.1-Φ6 Compose and resolve equilibrium equations for systems of forces, determine force factors and build their diagrams.</p> <p>ΠΠ07.2-Φ6 Compose and solve the equation of motion of material bodies.</p> <p>ΠΠ07.3-Φ6 Find the kinematic characteristics of the motion of solids.</p> <p>ΠΠ07.4-Φ6 Use general theorems and principles of dynamics for analysis, mechanical processes in machines and devices of electromechanical equipment.</p>

4 WORKLOAD DISTRIBUTION BY THE FORM OF EDUCATIONAL PROCESS ORGANIZATION AND TYPES OF CLASSES

Type of classes	Workload hours	Distribution by forms of education, hours					
		Full-time		Full-time		Extramural	
		Lecture classes	individual work	Lecture classes	individual work	Lecture classes	individual work
lectures	78	34	44	-	-	8	70
practical	23	8	15	-	-	-	23
laboratory	49	17	32	-	-	6	43
seminars	-	-	-	-	-	-	-
TOTAL	150	59	91	-	-	14	136

5 DISCIPLINE PROGRAM BY TYPES OF CLASSES

Code DLO	Types and topics of training sessions	Volume of components, hours
	LECTURES	78
ΠΠ03.1-Φ4	<p>1 Basics of electric drive mechanics</p> <p>The main trends and features of the development of the theory and practice of modern electric drive. The purpose and commitment of the discipline, its content and connection with related disciplines.</p> <p>Kinematical calculated schemes of the mechanical part of the electric drive.</p> <p>Equation of movement with unchanged and variable moments of inertia.</p>	9
ΠΠ07.1-Φ4	<p>2 Electromechanical and mechanical characteristics of engines</p> <p>Electromechanical properties, characteristics, and modes of operation of DC motors</p> <p>DC motors characteristics in brake modes</p> <p>The characteristics and brake modes of the sequential excitation engine</p> <p>Electromechanical properties and characteristics of asynchronous motors</p> <p>The characteristics of an asynchronous motor in brake modes</p> <p>Characteristics and modes of operation of synchronous engines</p>	18

ІІР07.1-Ф4	3 Dynamics of electromechanical systems Transitional processes of electric drive with a linear mechanical characteristic (start, reverse, braking). Formation of transitional processes in controlled systems - engine.	10
ІІР07.1-Ф4	4 Electric drive coordinates Rheostatal control of DC and AC motors Parametric means of adjusting the speed of asynchronous engines. Typical electric drive structures when managing coordinates Features of current and speed adjustment in the system VSC-DCV converter Features of current and speed adjustment in the GD system Features of current and speed adjustment in the system frequency converter-asynchronous motor Features of current adjustment and speed of synchronous motors	20
ІІР08.2-Ф4 ІІР07.1-Ф4	5 Energetics of Electric drive Electric drive energy. Energy loss in established and transitional modes. Energy efficiency and adjustable electric drive indicators Energy characteristics of managed rectifiers Impact of managed rectifiers on a nutrient network and a means of reducing it	11
ІІР08.1-Ф4	6 Principles of Calculation of Electrical Power Classification of modes of operation of electric motors Construction of a load diagram Methods for selecting and checking the engine by heating	10
	LABORATORY WORKS	49
ІІР07.1-Ф4	Experimental determination of the moment of inertia	6
ІІР07.1-Ф4	Investigation of mechanical characteristics of the DC motor of independent excitation	8
ІІР07.1-Ф4	Investigation of mechanical characteristics of the DC motor of successive excitation	8
ІІР07.1-Ф4	Investigation of the mechanical characteristics of the asynchronous engine	9
ІІР07.1-Ф4	Investigation of the characteristics of the GM system	9
ІІР07.1-Ф4	Investigation of the characteristics of the TC-M system	9
	PRACTICAL WORKS	23
ІІР08.1-Ф4	Renovation of resistance moments, moments of inertia and masses to engine speed	6
ІІР08.1-Ф4	Reducing the moments of resistance and inertia to the moving mass	6
ІІР08.1-Ф4	Construction of mechanical characteristics of the DC motor in engine mode and brake mode	3
ІІР08.1-Ф4	Construction of mechanical characteristics of an asynchronous engine in engine mode and brake mode	3
ІІР08.1-Ф4	Calculation of engine power by loading chart	5
	TOTAL:	150

For the implementation of the hybrid form of teaching students, the electronic resource of the e-learning in the discipline is used at the following address:
<https://do.nmu.org.ua/course/view.php?id=3174>

6 KNOWLEDGE PROGRESS TESTING

Certification of student achievement is accomplished through transparent procedures based on objective criteria in accordance with the University Regulations “On Evaluation of Higher Education Applicants' Learning Outcomes”.

The level of competencies achieved in relation to the expectations, identified during the control activities, reflects the real result of the student's study of the discipline.

6.1 Grading scales

Assessment of academic achievement of students of the Dnipro University of Technology is carried out based on a rating (100-point) and institutional grading scales. The latter is necessary (in the official absence of a national scale) to convert (transfer) grades for mobile students.

The scales of assessment of learning outcomes of the DNIPROTECH students

Rating	Institutional
90 ... 100	відмінно / Excellent
74 ... 89	добре / Good
60 ... 73	задовільно / Satisfactory
0 ... 59	незадовільно / Fail

Discipline credits are scored if the student has a final grade of at least 60 points. A lower grade is considered to be an academic debt that is subject to liquidation in accordance with the Regulations on the Organization of the Educational Process of DNIPROTECH.

6.2 Tools and procedures

The content of diagnostic tools is aimed at controlling the level of knowledge, proficiency/skills, communication, autonomy, and responsibility of the student according to the requirements of the National Qualifications Framework (NQF) up to the 6th qualification level during the demonstration of the learning outcomes regulated by the work program.

During the control activities, the student should perform tasks focused solely on the demonstration of disciplinary learning outcomes (Section 2).

Diagnostic tools provided to students at the control activities in the form of tasks for the formative and summative knowledge progress testing are formed by specifying the initial data and a way of demonstrating disciplinary learning outcomes.

Diagnostic tools (control tasks) for the formative and summative knowledge progress testing are approved by the department.

Types of diagnostic tools and procedures for evaluating the formative and summative knowledge progress testing are given below.

Diagnostic and assessment procedures

FORMATIVE ASSESSMENT			SUMMATIVE ASSESSMENT	
training sessions	diagnostic tools	procedures	diagnostic tools	procedures
lectures	control tasks for each topic	performing the task during lectures	complex control work (CCW)	determination of the weighted average result of formative assessments;
practical	control tasks for each topic	performing tasks during practical classes		performing CCW during the exam at the request of the student
	individual task	performing tasks during independent work		
laboratory	control tasks for each laboratory work	performing tasks during laboratory works and their defense		

During the formative assessment, lecture classes are evaluated by determining the quality of performance of specific control tasks. Practical classes are assessed by the quality of the control and individual tasks. Laboratory work is assessed by the quality of its performance and defense.

If the content of a certain type of classes is subordinated to several components of the description of the qualification level according to the NQF, the integral value of the grade can be determined taking into account the weighting coefficients set by the lecturer.

Provided that the level of results of the formative assessments of all types of training at least 60 points, the summative assessment can be carried out without the student's immediate participation by determining the weighted average value of the obtained grades.

Regardless of the results of the formative assessments, every student during the summative knowledge progress testing has the right to perform the CCW, which contains tasks covering key disciplinary learning outcomes.

The number of specific tasks of the CCW should be consistent with the allotted time for completion. The number of CCW options should ensure that the task is individualized.

The value of the mark for the implementation of the CCW is determined by the average evaluation of the components (specific tasks) and is final.

The integral value of the assessment of the implementation of the CCW can be determined taking into account the weighting coefficients established by the department for each component of the description of the qualification level of the NQF.

6.3 Criteria

Actual student learning outcomes are identified and measured relative to what is expected during the control activities using criteria that describe the student's actions to demonstrate the achievement of learning outcomes.

To assess the performance of control tasks during the formative assessment on lectures, laboratory and practical classes the coefficient of mastery is used as a criterion, which automatically adapts the assessment indicator to the rating scale:

$$O_i = 100 a/m,$$

where a is a number of correct answers or significant operations performed in accordance with the solution standard; m is the total number of questions or significant operations of the standard.

Individual tasks and complex control works are assessed expertly using criteria that characterize the ratio of requirements to the level of competencies and indicators of assessment on a rating scale.

The content of the criteria is based on the competency characteristics defined by the NQF for the bachelor's level of higher education (given below).

***General criteria for achieving learning outcomes
for the 6th qualification level of NQF (bachelor)***

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
<i>Knowleges</i>		
Conceptual scientific and practical knowledge, critical understanding of theories, principles, methods and concepts in the field of professional activity and / or training	The answer is excellent - correct, reasonable, meaningful. Characterizes the presence of: - conceptual knowledge; - high degree of knowledge of the state of the art; - critical understanding of the basic theories, principles, methods and concepts in education and professional activity	95-100
	The answer contains minor errors or omissions	90-94
	The answer is correct, but has some inaccuracies	85-89
	The answer is correct, but has some inaccuracies and is insufficiently substantiated	80-84
	The answer is correct, but has some inaccuracies, insufficiently substantiated and meaningful	74-79
	The answer is fragmentary	70-73
	The answer shows the student's vague ideas about the object of study	65-69
	The level of knowledge is minimally satisfactory	60-64
	The level of knowledge is unsatisfactory	<60
<i>Proficiency/Skills</i>		
In-depth cognitive and practical skills, mastery and innovation at the level required to solve	The answer characterizes the ability to: - identify problems; - formulate hypotheses; - solve problems; - choose appropriate methods and tools;	95-100

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
complex specialized tasks and practical problems in the field of professional activity or training	<ul style="list-style-type: none"> - collect and interpret information logically and clearly; - use innovative approaches to solving problems 	
	The answer characterizes the ability to apply knowledge in practice with minor errors	90-94
	The answer characterizes the ability to apply knowledge in practice, but has some inaccuracies in the implementation of one requirement	85-89
	The answer characterizes the ability to apply knowledge in practice, but has some inaccuracies in the implementation of the two requirements	80-84
	The answer characterizes the ability to apply knowledge in practice, but has some inaccuracies in the implementation of the three requirements	74-79
	The answer characterizes the ability to apply knowledge in practice, but has some inaccuracies in the implementation of the four requirements	70-73
	The answer characterizes the ability to apply knowledge in practice when performing tasks on the model	65-69
	The answer characterizes the ability to apply knowledge in performing tasks on the model, but with inaccuracies	60-64
	The level of skills is unsatisfactory	<60
Communication		
<ul style="list-style-type: none"> ♦ reporting to specialists and non-specialists information, ideas, problems, solutions, own experience and argumentation ♦ data collection, interpretation and application ♦ communication on professional issues, including in a foreign language, orally and in writing 	<p>Fluency in industry issues. Clarity of the answer (report). Language:</p> <ul style="list-style-type: none"> - correct; - clean; - clear; - accurate; - logical; - expressive; - concise. <p>Communication strategy:</p> <ul style="list-style-type: none"> - consistent and consistent development of thought; - the presence of logical own judgments; - appropriate reasoning and its compliance with the defended provisions; - correct structure of the answer (report); - correct answers to questions; - appropriate technique for answering questions; - ability to draw conclusions and formulate proposals; 	95-100
	<p>Sufficient knowledge of industry issues with minor flaws. Sufficient clarity of the answer (report) with minor flaws. Relevant communication strategy with minor flaws.</p>	90-94
	<p>Good knowledge of industry issues. Good clarity of the answer (report) and appropriate communication strategy (three requirements in total are not realized)</p>	85-89

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
	Good knowledge of industry issues. Good clarity of the answer (report) and appropriate communication strategy (four requirements not implemented in total)	80-84
	Good knowledge of industry issues. Good clarity of the answer (report) and appropriate communication strategy (five requirements not implemented in total)	74-79
	Satisfactory knowledge of industry issues. Satisfactory clarity of the answer (report) and appropriate communication strategy (a total of seven requirements have not been implemented)	70-73
	Partial knowledge of industry issues. Satisfactory clarity of the answer (report) and communication strategy with errors (a total of nine requirements are not implemented)	65-69
	Partial knowledge of industry issues. Satisfactory clarity of the answer (report) and communication strategy with errors (a total of 10 requirements are not implemented)	60-64
	The level of communication is unsatisfactory	<60
<i>Autonomy and responsibility</i>		
<ul style="list-style-type: none"> ♦ managing complex technical or professional activities or projects ♦ ability to take responsibility for making and making decisions in unpredictable work and / or learning contexts ♦ formation of judgments that take into account social, scientific and ethical aspects ♦ organization and management of professional development of individuals and groups ♦ ability to continue studies with a significant degree of autonomy 	<p>Excellent command of personal management competencies focused on:</p> <p>1) management of complex projects, which involves:</p> <ul style="list-style-type: none"> - research nature of educational activities, marked by the ability to independently assess various life situations, phenomena, facts, identify and defend a personal position; - ability to work in a team; - control of own actions; <p>2) responsibility for decision-making in unpredictable conditions, including:</p> <ul style="list-style-type: none"> - justification of own decisions by the provisions of the regulatory framework of the industry and state levels; - independence in the performance of tasks; - initiative in discussing problems; - responsibility for relationships; <p>3) responsibility for the professional development of individuals and/or groups of individuals, which involves</p> <ul style="list-style-type: none"> - use of professionally oriented skills; - use of evidence with independent and correct argumentation; - mastery of all types of learning activities; <p>4) the ability to continue learning with a high level of autonomy, which includes</p> <ul style="list-style-type: none"> - the degree of mastery of fundamental knowledge; - independence of evaluative judgments; - a high level of general learning skills; 	95-100

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
	- - independent search and analysis of information sources	
	Good mastery of personality management competencies (two requirements not met)	90-94
	Good mastery of personality management competencies (three requirements not met)	85-89
	Good mastery of personality management competencies (four requirements not met)	80-84
	Good mastery of personality management competencies (six requirements not met)	74-79
	Satisfactory mastery of personality management competencies (seven requirements not met)	70-73
	Satisfactory mastery of personality management competencies (eight requirements not met)	65-69
	The level of responsibility and autonomy is fragmentary	60-64
	The level of autonomy and responsibility is unsatisfactory	<60

7 TOOLS, EQUIPMENT AND SOFTWARE

Technical means of training.

Remote platform MOODLE, MS Teams.

8 RECOMMENDED SOURCES OF INFORMATION

Basic:

1. Електропривод: Навчальний посібник / Закладний О.М., Прокопенко В.В., Закладний О.О. – Київ: Вища школа, 2009.- 351 с.
2. Теорія електропривода: Підручник / М.Г. Попович, М.Г. Борисюк, В.А. Гаврилюк та ін.; за ред. М.Г. Поповича. –К.: Вища шк., 1993. -494 с.
3. Теорія електроприводу: Збірник задач / Булгар В.В. - Одеса: Поліграф, 2006. – 408 с.
4. Колб Ант.А., Колб А.А. Теорія електроприводу [Текст]: навч. посібник. – 2-ге вид., перероб. і доп. – Д.: Національний гірничий університет, 2011. – 565 с.
5. Колб А.А. Основи електроприводу. Методичні рекомендації до виконання лабораторних робіт для бакалаврів спеціальності 141 Електроенергетика, електротехніка та електромеханіка / А.А. Колб, Г.Г. Дяченко, О.В. Садовой; Нац. техн. ун–т. «Дніпровська політехніка». – Д.: НТУ «ДП», 2021. – 50 с.
6. Колб А.А. Основи електроприводу. Методичні рекомендації до практичних занять для бакалаврів спеціальності 141 Електроенергетика, електротехніка та електромеханіка / А.А. Колб, Г.Г. Дяченко, О.В. Садовой; Нац. техн. ун–т. «Дніпровська політехніка». – Д.: НТУ «ДП», 2021. – 83 с.

Additional:

1. Попович М.Г., Лозинський О.Ю., Клепиков В.Б. та інш. Електромеханічні системи автоматичного керування та електроприводи. Навч. посіб. за напрямом «Електромеханіка» / М.Г. Попович, О.Ю. Лозинський, В.Б. Клепиков та інш. – К.: Либідь, 2005. Ч1.– 397 с.; Ч2. – 680 с.

2. Попович М.Г., Ковальчук О.В. Теорія автоматичного керування: Підручник. – К.: Либідь, 1997. – 544 с.

3. Піцан Р., Барадачевський В., Бойчук Б. Збірник задач до курсу «Електропривод». – Львів, Видавництво «Львівська політехніка», 1999. – 426 с

Information resources:

Література на сайті кафедри електропривода:
<https://elprivod.nmu.org.ua/ua/books/automaticED.php>

WORK PROGRAM OF THE ACADEMIC DISCIPLINE
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Authors:
Oleksandr Stepanovych Beshta
Oleksandr Valentynovych Sadovoi

Editorial by the authors

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