

**MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE  
NATIONAL TECHNICAL UNIVERSITY  
«DNIPRO UNIVERSITY OF TECHNOLOGY»**

**DEPARTMENT of ELECTRIC DRIVE**

**«APPROVED»**

**Head of Department**

**Khudolyi S.S.** 

**31.08.2021**

**WORKING PROGRAM**

**«Fundamentals of Electric Drive »**

Field of knowledge.....	14 Electrical engineering
Specialty .....	141 Electric Power Engineering, Electrical Engineering and Electromechanics
Educational level .....	First (bachelor)
Educational program ....	Electric Power Engineering, Electrical Engineering and Electromechanics
Status .....	compulsory
Total volume .....	5 ECTS (150 hours)
Teaching time .....	4th semester (7,8 quarters)
Form of final control ...	exam
Teaching language .....	English, Ukrainian

Professor: Alexander Beshta

Working program of the discipline "Fundamentals of Electric Drive" for bachelors majoring in 141 " Electric Power Engineering, Electrical Engineering and Electromechanics " / Dnipro University of Technology, Dept. electric drive. - D., 2021. - 13 p.

Developer - prof. Beshta A.S.

The work program regulates:

- the purpose of the discipline;
- disciplinary learning outcomes formed on the basis of the transformation of the expected learning outcomes of the educational program;
- basic disciplines;
- the volume and distribution of forms of organization of the educational process and types of classes;
- discipline program (thematic plan by types of classes);
- algorithm for assessing the level of achievement of disciplinary learning outcomes (scales, tools, procedures and evaluation criteria);
- tools, equipment and software;
- recommended sources of information.

The work program is designed to implement a competency-based approach to planning the educational process, teaching discipline, preparing students for control activities, control of educational activities, internal and external quality control of higher education, accreditation of educational programs within the specialty.

Agreed by the decision of the scientific-methodical commission of the specialty 141 Electric Power Engineering, Electrical Engineering and Electromechanics (protocol № 21/22-01 from 30.08.2021).

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## 1 PURPOSE OF THE COURSE

In the educational and professional program of the National Technical University "Dnipro Polytechnic" specialty 141 " Electric Power Engineering, Electrical Engineering and Electromechanics " the distribution of program learning outcomes by organizational forms of the educational process. In particular, the discipline F4 "Fundamentals of electric drive" includes the following learning outcomes:

ΠP03	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
ΠP07	To carry out the analysis of processes in the electric power, electrotechnical and electromechanical equipment, the corresponding complexes and systems
ΠP08	Select and apply suitable methods for analysis and synthesis of electromechanical and electric power systems with specified parameters

**The purpose of the discipline** - the formation of competencies for the construction, principle of operation and analysis of processes in the converters of electric energy for electric drives.

Achieving the goal requires the transformation of program learning outcomes into disciplinary and adequate selection of the content of the discipline according to this criterion.

## 2 EXPECTED DISCIPLINARY LEARNING OUTCOMES

### Basics of electric drive

Code	Disciplinary Learning Outcomes (DLO)	
	Code DLO	Content
ΠP03	ΠP03.1-Φ4	To determine the principles of construction and functioning of elements of electromechanical complexes and systems.
ΠP07	ΠP07.1-Φ4	Assess the operating parameters of electromechanical equipment and related complexes and systems and develop measures to improve their energy efficiency and reliability.
ΠP08	ΠP08.1-Φ4	Demonstrate skills of work with the modern equipment and the software, and also performance of calculations of operating modes of the electromechanical equipment, the corresponding complexes and systems.
ΠP08	ΠP08.2-Φ4	Invent new ways to solve the problem of economic transformation and use of electricity

## 3 BASIC DISCIPLINES

Name of the discipline	Learning outcomes
Б5 Theoretical foundations of electrical engineering	ΠP05.1- Б5 Calculation methods of linear DC circuits at steady state mode.
	ΠP05.4- Б5 Linear circuits of three-phase current in steady-state mode
	ΠP05.6- Б5 Classical and operator methods of analysis of transients in linear circles with lumped parameters

Name of the discipline	Learning outcomes
Φ1 Electric machines	ΠΡ03.1-Φ1 To determine principle of construction and functioning of electric machines units as part of electric power, electrical, and electromechanical complexes, and systems. ΠΡ03.2-Φ1 To assess working parameters of electric machines as part of electrical, electric power, and electromechanical equipment and relevant complexes and systems, and to develop measures of their energy efficiency and reliability improvement..
Φ6 Technical mechanics	ΠΡ06.2-Φ6 Compose and solve equations of motion of material bodies; ΠΡ06.4-Φ6 Use general theorems and principles of dynamics for analysis, mechanical processes in machines and devices of electromechanical equipment;

#### 4 SCOPE AND DISTRIBUTION BY FORMS OF ORGANIZATION OF THE EDUCATIONAL PROCESS AND TYPES OF EDUCATIONAL CLASSES

Type of training	Volume, hours	Distribution by forms of study, hours					
		day		evening		correspondence	
		classroom	classes independent work	classroom	classes independent work	classroom	classes independent work
lecture	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 EDUCATIONAL CLASSES

Code	Types and topics of classes	Volume of components, hours
	<b>Lectures</b>	<b>78</b>
ΠΡ03.1-Φ4	<b>1 Fundamentals of electric drive</b>	9
	The main trends and features of the theory and practice of modern electric drive. The purpose and purpose of the discipline, its content and connection with related disciplines.	
	Kinematic calculation schemes of the mechanical part of the electric drive	
	Equation of motion at constant and variable moments of inertia.	
ΠΡ07.1-Φ4	<b>2. Electromechanical and mechanical characteristics of engines</b>	18
	Electromechanical properties, characteristics, and modes of operation of DC motors	
	Characteristics of DC motors in braking modes	
	Characteristics and braking modes of a series excitation motor	
	Electromechanical properties and characteristics of induction motors	
	Characteristics of an induction motor in braking modes	

Code	Types and topics of classes	Volume of components, hours
	Characteristics and modes of operation of synchronous motors	
ΠΡ07.1-Φ4	<b>3</b> Dynamics of electromechanical systems Transients of the electric drive with the linear mechanical characteristic (start, reverse, braking). Formation of transients in controlled converter - motor systems.	10
ΠΡ07.1-Φ4	4 Adjusting the coordinates of the electric drive Rheostatic speed control of DC and AC motors Parametric means of speed control of induction motors. Typical electric drive structures in coordinate control Features of current and speed control in the system of DC-DC valve converter-motor Features of current and speed regulation in the GD system Features of current and speed control in the system of frequency converter-induction motor Features of regulation of current and speed of synchronous motors	20
ΠΡ08.2-Φ4	<b>5</b> Power of electric drive Electric drive energy. Energy losses in steady state and transient modes.	11
ΠΡ07.1-Φ4	Energy efficiency and indicators of adjustable electric drive Energy characteristics of controlled rectifiers	
	Influence of controlled rectifiers on the power supply network and means of its reduction	
ΠΡ08.1-Φ4	<b>6</b> Principles of calculating the power of the electric drive Classification of modes of operation of electric motors Construction of the loading diagram Methods for selecting and testing the engine for heat	10
	<b>Laboratory classes</b>	<b>49</b>
ΠΡ07.1-Φ4	Experimental determination of the moment of inertia	6
ΠΡ07.1-Φ4	Study of mechanical characteristics of DC motor of independent excitation	8
ΠΡ07.1-Φ4	Study of mechanical characteristics of a DC motor of sequential excitation	8
ΠΡ07.1-Φ4	Study of mechanical characteristics of the induction motor	9
ΠΡ07.1-Φ4	Study of the characteristics of the G-M system	9
ΠΡ07.1-Φ4	Study of the characteristics of the TC-M system	9
	<b>Practical classes</b>	<b>23</b>
ΠΡ08.1-Φ4	Reduction of moments of resistance, moments of inertia and masses to engine speed	6
ΠΡ08.1-Φ4	Reduction of moments of resistance and inertia to a moving mass	6
ΠΡ08.1-Φ4	Construction of mechanical characteristics of a DC motor in motor mode and brake mode	3
ΠΡ08.1-Φ4	Construction of mechanical characteristics of an induction motor in motor mode and brake mode	3
ΠΡ08.1-Φ4	Calculation of engine power according to the load diagram	5
	<b>Total</b>	<b>150</b>

## 6 EVALUATION OF LEARNING OUTCOMES

Certification of student achievement is carried out through transparent procedures based on objective criteria in accordance with the University Regulations "On the evaluation of learning outcomes of higher education."

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

### 6.1 Scales

Assessment of academic achievements of students of NTU "DP" is carried out on a rating (100-point) and conversion scales. The latter is necessary (in the official absence of a national scale) for the conversion (translation) of assessments of higher education students from different institutions.

#### *Scales for assessing the academic achievements of students of NTU "DP"*

Rating	Conversion
90...100	Excellent
74...89	Good
60...73	Satisfactory
0...59	Fail

Credits of the discipline are credited if the student received a final grade of at least 60 points. The lower grade is considered to be academic debt, which is subject to liquidation in accordance with the Regulations on the organization of the educational process of NTU "DP".

### 6.2 Means and procedures

The content of diagnostic tools is aimed at controlling the level of knowledge, skills, communication, autonomy and responsibility of the student according to the requirements of the NRC to the 6th qualification level during the demonstration of learning outcomes regulated by the work program.

The student in the control activities must perform tasks focused solely on the demonstration of disciplinary learning outcomes (Section 2).

Diagnostic tools provided to students at control activities in the form of tasks for current and final control are formed by specifying the initial data and the way of demonstrating disciplinary learning outcomes.

Diagnostic tools (control tasks) for the current and final control of the discipline are approved by the department.

The types of diagnostic tools and assessment procedures for the current and final control of the discipline are given below.

CURRENT CONTROL			FINAL CONTROL	
training session	diagnostic tools	procedures	diagnostic tools	procedures
lectures	control tasks for each topic	performing the task during lectures	comprehensive control work (CCW)	determination of the weighted average result of current controls;
Practical	control tasks for each topic	performing tasks during practical classes		performing CCW during the exam at the request of the student
	or individual task	performing tasks during independent work		
Laboratory	control tasks for each topic or individual task	performing tasks during independent work		

During the current control lectures are evaluated by determining the quality of specific tasks. Practical classes are assessed by the quality of the control or individual task.

If the content of a particular type of lesson is subject to several descriptors, the integral value of the assessment can be determined taking into account the weights set by the teacher.

If there is a level of results of current controls in all types of classes at least 60 points, the final control is carried out without the participation of the student by determining the weighted average of current assessments.

Regardless of the results of the current control, each student during the exam has the right to perform the CCW, which contains tasks that cover key disciplinary learning outcomes.

The number of specified tasks of the CCW should correspond to the allotted time for execution. The number of CCW options should provide individualization of the task.

The value of the assessment for the implementation of the CCW is determined by the average assessment of the components (specified tasks) and is final.

The integral value of the assessment of the implementation of the CCW can be determined taking into account the weights set by the department for each descriptor of the HPK.

### 6.3 Criteria

Actual student learning outcomes are identified and measured relative to what is expected during the follow-up 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 current control of lectures and practical classes as a criterion is used the coefficient of mastery, which automatically adapts the assessment indicator to the rating scale:

$$O_i = 100 a/m,$$



where  $a$  - is the number of correct answers or significant operations performed according to the decision standard;  $m$  - the total number of questions or significant operations of the standard.

Individual tasks and complex tests 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 HPK for the bachelor's level of higher education (below).

***General criteria for achieving learning outcomes for the 6-th qualification level for NQF***

<b>Qualification level descriptors</b>	<b>Requirements for knowledge, skills, communication, autonomy and responsibility</b>	<b>Grade</b>
<b><i>Knowledge</i></b>		
specialized conceptual knowledge acquired in the process of learning and / or professional activity at the level of the latest achievements, which are the basis for original thinking and innovation, in particular in the context of research work; critical understanding of problems in teaching and / or professional activities and at the border of subject areas	The answer is excellent - correct, reasonable, meaningful. Characterizes the presence of: - specialized conceptual knowledge at the level of the latest achievements; - critical understanding of problems in teaching and / or professional activities and at the border of subject areas	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
<b><i>Skills</i></b>		
<ul style="list-style-type: none"> <li>• solving complex problems and problems that require updating and integration of knowledge, often in conditions of incomplete / insufficient information and conflicting requirements;</li> <li>• conducting research and / or innovation activities</li> </ul>	The answer characterizes the ability to: - identify problems; - formulate hypotheses; - solve problems; - update knowledge; - integrate knowledge; - to carry out innovative activity; - to carry out scientific activity	95-100
	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

Qualification level descriptors	Requirements for knowledge, skills, communication, autonomy and responsibility	Grade
	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
<b>Communication</b>		
<ul style="list-style-type: none"> <li>• clear and unambiguous communication of own conclusions, as well as knowledge and explanations that substantiate them, to specialists and non-specialists, in particular to students;</li> <li>• use of foreign languages in professional activities</li> </ul>	Clarity of the answer (report). Language: <ul style="list-style-type: none"> <li>- correct;</li> <li>- clean;</li> <li>- clear;</li> <li>- accurate;</li> <li>- logical;</li> <li>- expressive;</li> <li>- concise.</li> </ul> Communication strategy: <ul style="list-style-type: none"> <li>- consistent and consistent development of thought;</li> <li>- the presence of logical own judgments;</li> <li>- appropriate reasoning and its compliance with the defended provisions;</li> <li>- correct structure of the answer (report);</li> <li>- correct answers to questions;</li> <li>- appropriate technique for answering questions;</li> <li>- ability to draw conclusions and formulate proposals;</li> <li>- use of foreign languages in professional activities</li> </ul>	95-100
	Sufficient clarity of the answer (report) and appropriate communication strategy with minor flaws	90-94
	Good clarity of the answer (report) and appropriate communication strategy (three requirements in total are not realized)	85-89
	Good clarity of response (report) and appropriate communication strategy (four requirements not implemented in total)	80-84
	Good comprehensibility of the answer (report) and appropriate communication strategy (five requirements in total are not fulfilled)	74-79
	Satisfactory clarity of response (report) and appropriate communication strategy (seven requirements not implemented in total)	70-73
	Satisfactory comprehensibility of the answer (report) and communication strategy with errors (a total of nine requirements are not implemented)	65-69

Qualification level descriptors	Requirements for knowledge, skills, communication, autonomy and responsibility	Grade
	Satisfactory comprehensibility 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
<b><i>Autonomy and responsibility</i></b>		
<ul style="list-style-type: none"> <li>responsibility for the development of professional knowledge and practices, assessment of the strategic development of the team;</li> <li>ability to further study, which is largely autonomous and independent</li> </ul>	Excellent competence: <ul style="list-style-type: none"> <li>- use of principles and methods of organizing team activities;</li> <li>- effective distribution of powers in the team structure;</li> <li>- maintaining a balanced relationship with team members (responsibility for the relationship);</li> <li>- stress resistance;</li> <li>- self-regulation;</li> <li>- work activity in extreme situations;</li> <li>- high level of personal attitude to the case;</li> <li>- mastery of all types of educational activities;</li> <li>- appropriate level of fundamental knowledge;</li> <li>- the appropriate level of formation of general educational skills and abilities</li> </ul>	95-100
	Confident mastery of the competencies of autonomy and responsibility with minor flaws	90-94
	Good mastery of autonomy and responsibility competencies (two requirements not met)	85-89
	Good mastery of autonomy and responsibility competencies (three requirements not met)	80-84
	Good mastery of autonomy and responsibility competencies (four requirements not met)	74-79
	Good mastery of autonomy and responsibility competencies (five requirements not met)	70-73
	Good mastery of autonomy and responsibility competencies (six requirements not met)	65-69
	Satisfactory mastery of autonomy and responsibility competencies (fragmentary level)	60-64
	The level of autonomy and responsibility is unsatisfactory	<60

## 7 TOOLS, EQUIPMENT AND SOFTWARE

Technical training.

MOODLE remote platform, MS Teams.

## 8 RECOMMENDED SOURCES OF INFORMATION

### 8.1 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. Гаврилук 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. Піцан Р., Барадачевский В., Бойчук Б. Збірник задач до курсу «Електропривод». – Львів, Видавництво «Львівська політехніка», 1999. – 426 с.

## 8.2 Additional

1. Elektrische Maschinen und Antriebe/ E.Nolle, A.Beshta; National Mining University. – D: NMU, 2013. – 232 p.
2. Попович М.Г., Ковальчук О.В. Теорія автоматичного керування: Підручник. – К.: Либідь, 1997. – 544 с.

## 9 INFORMATION RESOURCES

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

Educational edition

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