


**Ministry of Education and Science of Ukraine**  
**Dnipro University of Technology**

Department of Electric Power Engineering



**«APPROVED»**

Head of Department

Papaika Yu.A.   
« 30 » 08 2022

**WORK PROGRAM OF THE ACADEMIC DISCIPLINE**

**«Electrical Apparatus»**

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.....	3 credits ECTS (90 hours)
Type of summative assessment	differentiated test
Period of study .....	4 semester (8 term)
Language of study .....	English

Lecturers: Prof. Rogoza M.V., Assoc.Prof. Koshelenko E.V.

Prolonged: for 20 \_\_ / 20\_\_ academic year \_\_\_\_\_ (\_\_\_\_\_) " \_\_ " \_\_ 20\_\_.

(Signature, name, date)

for 20 \_\_ / 20\_\_ academic year \_\_\_\_\_ (\_\_\_\_\_) " \_\_ " \_\_ 20\_\_.

(Signature, name, date)

Dnipro  
DNIPROTECH  
2022

Work program of the academic discipline «Electrical Apparatus» 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 Power Engineering. – D.: DNIPROTECH, 2022 – 13 p.

Authors:

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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 Ф8 «Electrical apparatus»:

PLO03	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
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**The aim of the discipline** – to develop competencies in developing reliable, safe and economic power supply systems that will ensure high-quality electricity for its consumers in accordance with industrial production technology.

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	contents
PLO 03	PLO3.1-Ф8	to determine the structure and principles of operation of electrical apparatus of high and low voltage switchgear and electric drive devices, as well as the design of units of devices, modes of their operation, operational characteristics
	PLO3.2-Ф8	substantiate the choice of electric drive system, methods of their design taking into account the requirements of technology and operating conditions, as well as calculate and select the main elements of electric drive and control systems

## 3 BASIC DISCIPLINES

Title of the discipline	Achieved learning outcomes
Б1 «Higher Mathematics»	PLO07 To carry out the analysis of processes in the electric power, electrotechnical and electromechanical equipment, the corresponding complexes and systems PLO08 To select and apply suitable methods for analysis and synthesis of electromechanical and electric power systems with specified parameters
Б2 «General physics»	
Б5 «Theoretical foundations of electrical engineering»	PLO05 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
Б6 «Electrical materials»	PLO07 To carry out the analysis of processes in the electric power, electrotechnical and electromechanical equipment, the corresponding complexes and systems
Ф1 «Electric Machines»	PLO 03.1-Ф1 To determine principle of construction and functioning of electric machines units as part of electric power, electrical, and electromechanical complexes, and systems. PLO 03.2-Ф1 To assess working parameters of electric machines as part of electrical, electric power, and

Title of the discipline	Achieved learning outcomes
	<p>electromechanical equipment and relevant complexes and systems, and to develop measures of their energy efficiency and reliability improvement.</p> <p>PLO 03.3-Φ1 To solve professional tasks on designing and maintenance of electric machines.</p> <p>PLO 03.4-Φ1 To master methods of electric machines with specified properties synthesis.</p> <p>PLO 03.5-Φ1 To carry out tasks of technical maintenance of electric machines as part of electromechanical systems, electric power stations, substations, systems, and networks electrical equipment by means of relevant instructions and practical skills.</p> <p>PLO 03.6-Φ1 To carry out new ways for solving problems of economic conversion, distribution, transmission, and application of electrical energy by means of electric machines.</p>
Φ3 «Fundamentals of metrology and electrical measurements »	<p>PLO02 To know and understand the theoretical foundations of metrology and electrical measurements, the principles of automatic control devices, relay protection and automation, have the skills to perform appropriate measurements and use these devices to solve professional problems.</p> <p>PLO18 To be able to learn independently, acquire new knowledge and improve skills in working with modern equipment, measuring equipment and application software.</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		Part-time		Extramural	
		Classes (C)	Individual work (IW)	Classes (C)	Individual work (IW)	Classes (C)	Individual work (IW)
lectures	50	16	34	-	-	4	46
practical	-	-	-	-	-	-	-
laboratory	40	16	24	-	-	4	36
seminars	-	-	-	-	-	-	-
TOTAL	90	32	58	-	-	8	82

#### 5 DISCIPLINE PROGRAM BY TYPES OF CLASSES

Code DLO	Types and topics of classes	Volume of components, hours
	<b>LECTURES</b>	<b>50</b>
PLO3.1-Φ8	<b>1 Introduction. General provisions on electrical apparatus (EA)</b>	5
PLO3.2-Φ8	Classification EA	
	Protective shells EA	
	Influence of climatic factors on EA	
	Requirements to EA	
PLO3.1-Φ8	<b>2 Electrical contacts</b>	5
PLO3.2-Φ8	Terms. The process of electric current flowing between the contacts.	
	Transient shrinkage resistance and resistance of contact films	
	Modes of operation of contacts	

<b>Code DLO</b>	<b>Types and topics of classes</b>	<b>Volume of components, hours</b>
	Contact materials	
	Solid metal contacts	
	Liquid metal contacts	
PLO3.1-Φ8 PLO3.2-Φ8	<b>3 Switching off electrical circuits</b>	5
	Conditions of occurrence and combustion of an electric arc. Electric arc of direct and alternating current	
	Voltage recovery process	
	Means of extinguishing an electric arc	
	Electric arc extinguishers and types of high and low voltage circuit breakers	
PLO3.1-Φ8 PLO3.2-Φ8	<b>4 Starting and regulating devices</b>	5
	Controllers	
	Command devices	
	Resistors and rheostats	
PLO3.1-Φ8 PLO3.2-Φ8	<b>5 Contactors and magnetic starters</b>	5
	Terms	
	Features of designs of contactors of a direct current and alternating current	
	Magnetic starters	
PLO3.1-Φ8 PLO3.2-Φ8	<b>6 Contactless switching devices (CSD)</b>	5
	Schematic implementations of CSD are possible	
	The main types of modern thyristor starters and regulators	
PLO3.1-Φ8 PLO3.2-Φ8	<b>7 Low voltage automatic air switches (automatic)</b>	5
	Terms	
	The main structural units of air switches	
	The main types of modern air switches	
PLO3.1-Φ8 PLO3.2-Φ8	<b>8 High voltage switchgear</b>	5
	High voltage AC switches	
	Disconnectors	
	Separators and short circuits	
PLO3.1-Φ8 PLO3.2-Φ8	<b>9 Restrictive devices</b>	5
	Reactors	
	Dischargers	
PLO3.1-Φ8 PLO3.2-Φ8	<b>10 Measuring devices</b>	5
	Current transformers	
	Voltage transformers	
	<b>LABORATORY CLASSES</b>	<b>40</b>
PLO3.1-Φ8	<b>1 Investigation of designs of oil switches</b>	6
PLO3.2-Φ8	<b>2 Investigation of a design and the principle of action of electromagnetic switches</b>	6
	<b>3 Investigation of the design and principle of operation of fuses</b>	8
	<b>4 Investigation of a design and the principle of action of disconnectors, separators and short-circuits</b>	8
	<b>5 Investigation of a design and the principle of action of vacuum switches</b>	6
	<b>6 Investigation of a design and the principle of action of SF6 switches</b>	6
	<b>TOTAL</b>	<b>90</b>

To implement a mixed form of student education, an electronic distance learning resource is used in the discipline at the following address:  
<https://do.nmu.org.ua/course/view.php?id=3405>

## 6 EVALUATION OF LEARNING RESULTS

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 6<sup>th</sup> 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;
laboratory works	control questions for each topic	performing tasks during individual work		performing CCW during the differentiated test at the request of the student

During the formative assessments, lectures are evaluated by determining the quality of control specific tasks. Laboratory classes are evaluated by the quality of the task in accordance with the report.

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 and laboratory 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 6<sup>th</sup> qualification level of NQF (bachelor)***

<b>Description of qualification level</b>	<b>Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility</b>	<b>Indicator evaluation</b>
<b><i>Knowleges</i></b>		
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
<b><i>Proficiency/Skills</i></b>		
In-depth cognitive and practical skills, mastery and innovation at the level required to solve complex specialized tasks and practical problems in the field of professional activity or training	The answer characterizes the ability to: - identify problems; - formulate hypotheses; - solve problems; - choose appropriate methods and tools; - collect and interpret information logically and clearly; - use innovative approaches to solving problems	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
	The answer characterizes the ability to apply knowledge in	74-79

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
	practice, but has some inaccuracies in the implementation of the three requirements	
	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>♦ reporting to specialists and non-specialists information, ideas, problems, solutions, own experience and argumentation</li> <li>♦ data collection, interpretation and application</li> <li>♦ communication on professional issues, including in a foreign language, orally and in writing</li> </ul>	<p>Fluency in industry issues. Clarity of the answer (report). Language:</p> <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> <p>Communication strategy:</p> <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> </ul>	95-100
	Sufficient knowledge of industry issues with minor flaws. Sufficient clarity of the answer (report) with minor flaws. Relevant communication strategy with minor flaws.	90-94
	Good knowledge of industry issues. Good clarity of the answer (report) and appropriate communication strategy (three requirements in total are not realized)	85-89
	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	65-69

<b>Description of qualification level</b>	<b>Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility</b>	<b>Indicator evaluation</b>
	communication strategy with errors (a total of nine requirements are not implemented)	
	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
<b><i>Autonomy and responsibility</i></b>		
<ul style="list-style-type: none"> <li>♦ managing complex technical or professional activities or projects</li> <li>♦ ability to take responsibility for making and making decisions in unpredictable work and / or learning contexts</li> <li>♦ formation of judgments that take into account social, scientific and ethical aspects</li> <li>♦ organization and management of professional development of individuals and groups</li> <li>♦ ability to continue studies with a significant degree of autonomy</li> </ul>	Excellent command of personal management competencies focused on: 1) management of complex projects, which involves: - 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; 2) responsibility for decision-making in unpredictable conditions, including: - 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; 3) responsibility for the professional development of individuals and/or groups of individuals, which involves - use of professionally oriented skills; - use of evidence with independent and correct argumentation; - mastery of all types of learning activities; 4) the ability to continue learning with a high level of autonomy, which includes - the degree of mastery of fundamental knowledge; - independence of evaluative judgments; - a high level of general learning skills; - - independent search and analysis of information sources	95-100
	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 training.

MOODLE remote platform, Office 365, Microsoft Teams platform.

## **8 RECOMMENDED SOURCES OF INFORMATION**

1. Рогоза М.В. Електричні апарати: Навч. посібник – Дніпропетровськ: Національний гірничий університет, 2012. – 208 с./ Rogoza MV Electrical apparatus: Textbook. manual - Dnepropetrovsk: National Mining University, 2012. - 208 p.
2. Клименко Б.В. Електричні апарати комутації та захисту. Загальний курс: навчальний посібник. – Харків. Вид-во «Точка». 2012. – 340 с./Klimenko BV Electrical switching and protection devices. General course: textbook. - Kharkiv. View "Point". 2012. - 340 p.
3. Клименко Б.В. Комутаційна апаратура, апаратура керування, запобіжники. Терміни, тлумачення, коментарі. – Навчальний посібник. – Х.: Вид-во «Талант», 2008. – 228 с. / Klymenko B.V. Switching equipment, control equipment, fuses. Terms, interpretation, comments. - Tutorial. - Kh.: "Talent" publishing house, 2008. - 228 p.
4. Клименко Б.В. Електричні та магнітні пристрої, електричні аксесуари, електричні установки. Терміни, тлумачення, коментарі. – Навчальний посібник. – Х.: Вид-во «Точка», 2009. – 272 с./ Klymenko B.V. Electrical and magnetic devices, electrical accessories, electrical installations. Terms, interpretation, comments. - Tutorial. - Kh.: "Tochka" Publishing House, 2009. - 272 p.

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141 Electrical energetics, electrical engineering and electromechanics

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