

Ministry of Education and Science of Ukraine
Dnipro University of Technology

Department of Electric Power Engineering



«APPROVED»

Dean of FEE

Rogoza M.V. 

«30» August 2022

WORK PROGRAM OF THE ACADEMIC DISCIPLINE

«Electrical equipment of stations and substations»

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	5, 6 semesters (10-12 terms)
Language of study	English

Lecturer: Prof. Papaika Yu.A.

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 equipment of stations and substations» 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.

Author:

– Papaika Yuri Anatoliiovych – Professor, Doctor of Technical Sciences, Head of the Department of Electric Power Engineering.

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 Ф9 «Electrical equipment of stations and substations»:

PLO01	To know and understand the principles of operation of electrical systems and networks, power equipment of power plants and substations, protective earthing and lightning protection devices and be able to use them to solve practical problems in professional activities
PLO17	To solve complex specialized problems in the design and maintenance of electromechanical systems, electrical equipment of power plants, substations, systems and networks

The aim of the discipline - formation of competencies in the calculation and analysis of electrical equipment of power plants and substations, practical skills in choosing power electrical equipment with the requirements of economy, reliability and quality of electricity.

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 of PLO	Disciplinary learning outcomes (DLO)	
	Code of DLO	content
PLO 01	PLO01.1-Ф9	Know the construction and principles of electrical equipment of stations and substations
	PLO01.2-Ф9	Know the design features of lightning protection systems and grounding of electrical installations
PLO 17	PLO17.1-Ф9	To analyze the modes of operation of elements of power plants and substations for the development of energy-saving solutions
	PLO17.2-Ф9	Choose the main parameters, characteristics, features of structures and schemes of power plants and substations

3. BASIC DISCIPLINES

Title of the discipline	Achieved learning outcomes
Ф5 «Basics of electricity production, distribution and consumption»	PLO01-Ф5 Know and understand the main purpose, principles of operation, structure of electrical systems and networks, modes of operation of the neutral of electrical installations of different voltage classes and be able to use them to solve practical problems in professional activities, taking into account trends in the innovative development of relevant systems. PLO04 To know the principles of bioenergy, wind, hydro and solar power plants. PLO13 To understand the importance of traditional and renewable

	energy for successful economic development of the country PLO19 To apply suitable empirical and theoretical methods to reduce electricity losses during its production, transportation, distribution and use
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

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	
		Class work	Individual work	Class work	Individual work	Class work	Individual work
lectures	100	46	54	-	-	8	92
practical	-	-	-	-	-	-	-
laboratory	50	23	27	-	-	8	42
seminars	-	-	-	-	-	-	-
TOTAL	150	69	81	-	-	16	134

5 DISCIPLINE PROGRAM BY TYPES OF CLASSES

Code of DLO	Types and topics of classes	Volume of components, hours
	LECTURES	100
PLO 01.1-Φ9 PLO 17.1-Φ9	PREFACE Basic requirements for power plant and substation schemes The role of electrical substations in the power industry Classification of electrical substations	8
PLO 17.1-Φ9 PLO 17.2-Φ9	1. CALCULATIONS OF SHORT-CIRCUIT CURRENTS IN SCHEMES OF STATIONS AND SUBSTATIONS 1.1. Choice of short-circuit current calculation method 1.2. Assumptions and initial conditions 1.3. Drawing up substitution schemes 1.4. Calculations of short-circuit current components 1.5. Calculation of the short-term thermal pulse	14
PLO 01.1-Φ9 PLO 17.1-Φ9 PLO 17.2-Φ9	2. SELECTION OF POWER TRANSFORMERS 2.1. Types and classification of power transformers 2.2. Winding connection diagrams 2.3. Thermal modes of power transformers 2.4. Choice of number and power of power transformers	14
PLO 01.1-Φ9 PLO 17.1-Φ9 PLO 17.2-Φ9	3. TYPICAL DIAGRAMS OF ELECTRICAL STATIONS AND SUBSTATIONS 3.1. Typical NPP schemes 3.2. Typical hydropower schemes 3.3. Typical schemes of thermal power plants 3.4. Typical schemes of solar and wind power plants 3.5. Dead-end, through and nodal electrical substations	14
PLO 01.1-Φ9 PLO 01.2-Φ9	4. CHOICE OF ELECTRICAL EQUIPMENT OF POWER STATIONS AND SUBSTATIONS	14

Code of DLO	Types and topics of classes	Volume of components, hours
PLO 17.1-Φ9 PLO 17.2-Φ9	4.1. Choice of hard tires 4.2. Choice of high voltage switches 4.3. Choice of disconnectors and load break switches 4.4. Selection of busbar insulators 4.5. Choice of power cables 4.6. Choice of surge limiters	
PLO 17.1-Φ9 PLO 17.2-Φ9	5. SYSTEM OF MEASUREMENT AND CONTROL OF ELECTRICITY IN SCHEMES OF SUBSTATIONS 5.1. Required volume of measuring instruments 5.2. Accuracy classes of measuring instruments 5.3. Selection of measuring current and voltage transformers	14
PLO 01.1-Φ9 PLO 01.2-Φ9 PLO 17.1-Φ9 PLO 17.2-Φ9	6. LAYOUT OF POWER STATIONS AND SUBSTATIONS 6.1. Complete high voltage switchgear 6.2. Schematic solutions of open switchgear 6.3. Block substations 6.4. SF6 complete switchgear (CDEE)	12
PLO 01.2-Φ9 PLO 17.1-Φ9	7. OWN NEEDS OF POWER STATIONS AND SUBSTATIONS 7.1. Sources of own needs of stations and substations 7.2. Choice of transformers of own needs 7.3. Schematic solutions of the system of own needs of stations and substations 7.4. Sources of operational current	10
	LABORATORY CLASSES	50
PLO 01.1-Φ9	Investigation of parameters of measuring current and voltage transformers	8
PLO 17.1-Φ9	Study of design and circuit solutions of closed switchgear	10
PLO 01.1-Φ9 PLO 01.2-Φ9	Study of design and circuit solutions of open switchgear	8
PLO 17.1-Φ9 PLO 17.2-Φ9	Research of control circuits of high voltage switches	8
PLO 17.1-Φ9 PLO 17.2-Φ9	Research of control circuits of disconnectors, separators and short-circuits	8
PLO 17.1-Φ9 PLO 17.2-Φ9	Operational switches in schemes of power stations and substations	8
TOTAL		150

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=1242>

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 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 tools and evaluation procedures

FORMATIVE ASSESSMENT			SUMMATIVE ASSESSMENT	
training sessions	diagnostic tools	procedures	diagnostic tools	procedures
lectures	control tasks for each topic	performing the task during lectures		determination of the average result of formative

laboratory work	control tasks for each topic	performing the task during individual work	complex control work (CCW)	assessments; performing of CCW during the exam at the request of the student
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During the formative assessment, lecture classes are evaluated by determining the quality of performance of control specific tasks. Laboratory classes are evaluated by the quality of the task according to 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 exam 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 decision 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 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 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

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
	The level of skills is unsatisfactory	<60
Communication		
♦ 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	Fluency in industry issues. Clarity of the answer (report). Language: - correct; - clean; - clear; - accurate; - logical; - expressive; - concise. Communication strategy: - 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
	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 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
Autonomy and responsibility		
♦ managing complex	Excellent command of personal management competencies	95-100

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
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	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	
	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 tools.

Moodle remote platform, Office 365, MS Teams.

8. RECOMMENDED SOURCES OF INFORMATION

1. Правила улаштування електроустановок. – Київ, 2017. -617 с.
2. Перехідні процеси в системах електропостачання: підручник / Г.Г. Півняк, І.В. Жежеленко, Ю.А. Папаїка, Л.І. Несен; за ред. Г.Г. Півняка; М-во освіти і науки України, Нац. Гірн. Ун-т. – 5-те вид., доопрац. і допов. –Дніпро: НГУ, 2016. – 600 с.
3. Електромагнітна сумісність у системах електропостачання: Підручник / І.В. Жежеленко, А.К. Шидловський, Г.Г. Півняк, Ю.Л. Саєнко. – Д.: Нац. гірнич. ун-т, 2009. – 319 с.: іл.
4. Півняк Г.Г., Шидловский А.К., Кігель Г.А., Рыбалко А.Я., Хованська О.І. Особливі режими електричних мереж. – Дніпропетровськ: НГА України, 2004. – 375 с.
5. Г.Г. Півняк, М.М. Білий, Г.М. Бажін. Електропостачання гірничих підприємств: Довідковий посібник. – Д.: Національний гірничий університет, 2008, - 550 с.
6. Півняк Г.Г., Волотковська Н.С., Кігель Г.А. Розрахунки електричних мереж систем електропостачання. – НГУ, 2011.
7. Кігель Г.А, Півняк Г.Г. Електричні мережі систем електропостачання. – НГУ, 2011.
8. Експлуатація електроустановок: Навч. посібник / Г.Г. Півняк, А.В. Журахівський, Г.А. Кігель, Б.М. Кінаш, А.Я. Рибалко, Ф.П. Шкрабець, З.М. Бахор; За ред. академіка НАН України Г.Г. Півняка. –Дніпропетровськ, НГУ, 2005.

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Author:

Yurii Anatoliiovych Papaika

Editorial by the author

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49005, Dnipro, Dmytra Yavornytskoho Ave. 19