

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

«Relay protection and automation»

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.....	3,5 credits ECTS (105 hours)
Type of summative assessment	differentiated test
Period of study	7 semester (13-14 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 «Relay protection and automation» 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 Yurii 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 PURPOSE OF THE COURSE

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 Ф14 «Relay protection and automation».

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
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The aim of the discipline – development of higher education students' competencies in the construction, operation and analysis of processes in relay protection and automation systems.

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 02	PLO 02-Ф14	Know and understand the principles of operation, circuit implementations, structure and configuration of relay protection and automation devices based on electromechanical and microprocessor devices, have the skills to calculate the protection parameters of the main elements of power supply systems and consumers

3 BASIC DISCIPLINES

Title of the discipline	Achieved learning outcomes
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
Ф9 «Electrical equipment of stations and substations»	PLO17 To solve complex specialized problems in the design and maintenance of electromechanical systems, electrical equipment of power plants, substations, systems and networks

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

Type of training sessions	Volume, hours	Distribution by forms of study, hours					
		Full-time		Part-time		Extramural	
		Class work	Individual work	Class work	Individual work	Class work	Individual work
lectures	58	26	32	-	-	8	38
practical	20	13	7	-	-	2	21

laboratory	27	20	7	-	-	2	34
seminars	-	-	-	-	-	-	-
TOTAL	105	59	56	-	-	12	93

5 DISCIPLINE PROGRAM BY TYPES OF EDUCATIONAL CLASSES

Code of DLO	Types and topics of training sessions	Volume of components, hours
	Lectures	58
PLO 02-Φ14	Introduction "Basic principles of relay devices"	8
	Purpose of relay protection devices and main properties.	
	Relay principle of operation and basic elements of electromechanical relays.	
	Types of relays (measuring, logic and combined).	
PLO 02-Φ14	Analysis of emergency modes and types of protection	10
	Varieties of abnormal and emergency modes of equipment operation.	
	Vector diagrams of normal, abnormal and emergency modes of operation of electrical equipment.	
	Types and scope of protection depending on the object.	
PLO 02-Φ14	Measuring circles of protection	10
	Measuring transducers (current and voltage transformers).	
	Properties and modes of operation of measuring transducers.	
	Wiring diagrams of measuring transducers.	
PLO 02-Φ14	Logic circuits of relay protection and automation	10
	Implementation of basic logic functions based on relay-contact circuits.	
	LD and FBD language for PLC programming.	
	The use of logical constructions for the implementation of simple network automation systems.	
PLO 02-Φ14	Relay protection terminals	10
	The principle of operation of the microprocessor relay protection.	
	Configuring the relay protection terminal.	
	Removal of the log of accidents and oscillograms from the microprocessor relay protection.	
PLO 02-Φ14	Removal and analysis of vector diagrams from the microprocessor relay protection terminal.	10
	Calculation of relay protection settings	
	Calculation of three-stage maximum current protection.	
	Calculation protection of minimum voltage.	
	Calculation of distance protection.	
	Calculation of transformer differential protection.	
	Construction of selectivity maps.	
	LABORATORY CLASSES	27
PLO 02-Φ14	Investigation of the return coefficient of the electromagnetic relay current (PT-40) and voltage (PH-54).	5
PLO 02-Φ14	Investigation of the operation of current relays with dependent	7

Code of DLO	Types and topics of training sessions	Volume of components, hours
	characteristics (RT-80).	
PLO 02-Φ14	Study of the microprocessor protection terminal (P3JI-01) (configuration, setting and testing of relay protection settings, connection of secondary circuits of the terminal).	8
PLO 02-Φ14	Loading of vector diagrams and terminal log from (PC-83AB2).	7
	PRACTICAL CLASSES	20
PLO 02-Φ14	Calculation of currents of emergency modes of operation.	4
PLO 02-Φ14	Calculation overload protection.	4
PLO 02-Φ14	Calculation distance protection.	4
PLO 02-Φ14	Construction of selectivity maps.	4
PLO 02-Φ14	Calculation differential protection of transformer.	4
	TOTAL	105

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=3051>

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 session	diagnostic tools	procedures	diagnostic tools	procedures
lectures	control tasks for each topic	performing the task during lectures	complex control work (CCW)	determination of the average result of formative assessments;
practical	control tasks for each topic	performing the task during practical classes		performing of CCW during the differentiated test at the request of the student
	an individual task	performing the task during individual work		
laboratory work	control tasks for each laboratory work	performing the task during laboratory work		

During the formative assessment, lectures are evaluated by determining the quality of specific control tasks. Practical classes are assessed by the quality of the control and individual task. Laboratory classes are assessed by the quality of the control task.

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 differentiated test 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, practical 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 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

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
	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
Proficiency/Skills		
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
	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	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;	95-100

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
professional issues, including in a foreign language, orally and in writing	- 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;	
	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
<i>Autonomy and responsibility</i>		
♦ 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,	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;	95-100

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
scientific and ethical aspects ♦ organization and management of professional development of individuals and groups ♦ ability to continue studies with a significant degree of autonomy	- 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, MS Teams, MS Excel, LabVIEW, RZA_Config_v4_95, RZA_Oscillogv2_15, Relsis config V3_2.

8 RECOMMENDED SOURCES OF INFORMATION

1. Кідиба В.П. Релейний захист електроенергетичних систем: Підручник. – Львів: Видавництво Національного університету "Львівська політехніка", 2013. – 533 с.
2. Букович Н.В. Автоматика електроенергетичних систем: Навч. посіб. – К.: ІЗМН, 1998. — 280 с.
3. Шелепетень Т.М. Захисна автоматика електричних мереж: Навч. посібник для студентів спеціальностей 7.090602 та 8.090602 "Електричні системи та мережі" всіх форм навчання. – Львів, 2002. - 157 с.
4. Релейний захист і автоматика: Навч. посібник / С. В. Панченко, В. С. Блиндюк, В. М. Баженов та ін.; за ред. В. М. Баженова. – Харків: УкрДУЗТ, 2020. – Ч. 1. – 250 с.
5. Яндульський О. С., Дмитренко О. О. Релейний захист. Цифрові пристрої релейного захисту, автоматики та управління

- електроенергетичних систем: навч. посіб. Київ: НТУУ «КПІ», 2016. 102 с.
6. Protective Relaying: Principles and Applications J. Lewis Blackburn and Thomas J. Domin, 2014. 482 p
 7. Ramesh Bansal. Power system protection in smart grid environments: taylor & francis, 2018. 624 p.

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