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

«Transients in power supply systems»

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..…….	6 credits ECTS (180 hours)
Type of summative assessment	exam
Period of study ……	5, 6 semesters (9-12 terms)
Language of study ……..	English

Lecturers: Acad.NAS Pivniak G.G.

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 «Transients in power supply systems» 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 – 14 p.

Author:

– Pivniak Gennadii Gryhorovych – Academician of the National Academy of Sciences of Ukraine, Doctor of Technical Sciences, Professor 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).

CONTENT

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 Ф18 «Transients in power supply systems»:

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
SLO01	To analyze and calculate steady-state and transient processes to prevent and eliminate accidents in power systems and facilities, to ensure static and dynamic stability

The aim of the discipline – formation of higher education students' knowledge in electromagnetic and electromechanical transients in power systems, the impact of these processes on the modes of operation of electrical equipment; ability to form models that reflect electromagnetic transients in power supply systems, for the calculation of currents and voltages in symmetric and asymmetric modes in normal and emergency states; about static and dynamic stability of the simplest system; ability to form models that reflect electromechanical transients in power supply systems in order to assess the static and dynamic stability of the system; ability to analyze results and draw conclusions.

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**
PLO07	PLO07-Ф18	apply the results of analysis and calculation of sustainable and transient processes to prevent and eliminate accidents in power systems and facilities
PLO08	PLO08-Ф18	evaluate the parameters of electrical, electromechanical equipment in transient modes to develop measures to improve energy efficiency and reliability
SLO01	SLO01-Ф18	calculate the static and dynamic stability of the power system, as well as the conditions for self-starting electric motors with a voltage above 1000 V

3 BASIC DISCIPLINES

Title of the discipline	**Achieved learning outcomes**
Б1 «Higher Mathematics»	PLO07.1-Б1 Know the basics and principles of linear and vector algebra, analytical geometry, differential and integral calculus. PLO07.2-Б1 Be able to use a mathematical apparatus for objective analysis of processes in electromechanical equipment.

	PLO08.1-Б1 Know the principles of solving technical problems based on mathematical analysis, construction and solution of differential equations.
Б2 «General physics»	PLO07.2-Б2 To analyze physical mechanisms that are essential when considering processes in electric power, electrotechnical and electromechanical equipment, relevant complexes and systems. PLO07.3-Б2 Formation of abilities to generalize, analyze, perceive information, set a scientific problem and choose a way to solve it. PLO08.2-Б2 Apply knowledge of the basic fundamental laws of classical and modern physics to solve electrical engineering problems. PLO08.3-Б2 Correctly reproduce physical ideas and correctly apply the principles and laws of physics for the analysis and synthesis of electromechanical and electric power systems with specified indicators.
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
Ф1 «Electric Machines»	PLO03 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
Ф4 «Fundamentals of Electric Drives»	PLO07.1-Ф4 Evaluate the parameters of electromechanical equipment and corresponding complexes and systems and develop measures to increase their energy efficiency and reliability. PLO08.1-Ф4 Demonstrate skills in working with modern equipment, as well as performing calculations of modes of operation of electromechanical equipment, corresponding complexes and systems.

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	120	73	47	-	-	10	110
practical	60	30	30	-	-	8	52
laboratory	-	-	-	-	-	-	-
seminars	-	-	-	-	-	-	-
TOTAL	180	103	77	-	-	18	162

5 DISCIPLINE PROGRAM BY TYPES OF CLASSES

Code of DLO	**Types and topics of classess**	**Volume of components,** *hours*
	LECTURES	**120**
PLO07-Ф18 PLO08-Ф18	1 Basic principles of analysis of transients. General information about transients	2
	2 Calculation of short circuit parameters	4
	3 Parameter characteristics of synchronous machines	4

Code of DLO	Types and topics of classess	Volume of components, *hours*
PLO07-Ф18 PLO08-Ф18	4 Mains short circuit	6
	5 Transients in three-phase short circuits. Calculation of short circuit currents	8
	6 Calculations of transients in three-phase short circuits (generators). Calculations of transients at three-phase short circuits (load node)	6
PLO07-Ф18 PLO08-Ф18	7 Short circuit in electrical installations with voltage up to 1 kV	6
	8 Transients in symmetry breaking in a three-phase network	6
	9 Calculation of transverse asymmetry currents	10
	10 Current and short-circuit power levels	6
SLO01-Ф18	11 Transients taking into account electromagnetic compatibility	6
	12 Tasks of analysis and characteristics of electromechanical processes.	4
	13 Static stability of the power system mode	8
	14 Dynamic stability of the power system mode.	8
SLO01-Ф18	15 The resulting stability of the power system	6
	16 Methods of analysis and calculation of static stability	4
	17 Static stability of an adjustable electrical system	4
	18 Stability of the load nodes regime at weak perturbations	6
	19 Calculation of parameters of dynamic stability of the mode	8
	20 Calculation of the parameters of the resulting stability of the mode	4
	21 Stability of load nodes under strong perturbations	4
	PRACTICAL CLASSES	**60**
PLO07-Ф18 PLO08-Ф18 SLO01-Ф18	1 Ways to reduce the parameters of the elements in the substitution schemes EPS: accurate and approximate reduction; named and relative units of measurement.	2
	2 Calculation of initial, shock and constant short-circuit currents: the method of equivalent emf, components of short-circuit current, vector diagram of short-circuit voltages and currents.	4
	3 Calculation of the periodic component of short-circuit current at t> 0 using typical curves for generators, motors.	6
	4 Taking into account local sources of replenishment of the short circuit. Condition of local sources: power supply from engines; power from reactive power sources; power supply from generalized load.	4
	5 Calculation of asymmetric short-circuit currents.	6
	6 Calculation of short circuits in electrical installations with voltage up to 1 kV	4
	7 Calculation of current and short-circuit power limitation.	4
	8 Calculation of the ideal actual power limit	3
	9 Calculation of static stability of the power supply mode in EPS	12
	10 Calculation of dynamic stability of power modes in EPS:	12
	11 Calculations of measures to increase the stability of the regime in the EPS of enterprises.	3
	TOTAL	**180**

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=2111**

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 6^{th} 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	
Educational class	**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; performing of CCW during the exam at the request of the student
practical	an individual task	performing the task during individual 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 individual 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 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 practical classes the coefficient of mastery is used as a criterion, which automatically adapts the assessment indicator to the rating scale:

$$O_i = 100\ a/m,$$

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

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

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

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

Description of qualification level	**Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility**	**Indicator evaluation**
	Knowleges	
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
	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	85-89

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
	practice, but has some inaccuracies in the implementation of one requirement	
	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 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

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
	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 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	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	70-73

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
	competencies (seven requirements not met)	
	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 e-platform, MS Teams.

8 RECOMMENDED SOURCES OF INFORMATION

1. 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. / Transition processes in power supply systems: a textbook / G.G. Pivnyak, I.V. Zhezhelenko, Y.A. Papaika, L. I. Necen; under the editorship of G.G. Pivnyak; Ministry of Education and Science of Ukraine, NMU – 5th ed., revised. and add. - Dnipro: NMU, 2016. - 600 p.
2. Перехідні процеси в системах електропостачання. Підручник. Вид. 2-е, 3-є, доопрац. та допов. / Г.Г.Півняк, В.М.Віновлавський, А.Я.Рибалко, Л.І.Несен / за ред. академіка НАН України Г.Г.Півняка. – Дніпропетровськ: НГАУ, 2000, 2003. – 597 с. / Transients in power supply systems: Textbook / G.G. Pivnyak, V. N. Vynoslavskyi, A. Ya. Rybalko, L. I. Necen; under the editorship of G.G. Pivnyak. – Dnipropetrovsk: NMU, 2000, 2003 - 597 p.
3. Transients in Electric Power Supply Systems. Textbook for institutions of higher education: under the editorship of G.G.Pivnyak / G.G.Pivnyak, I.V.Zhezhelenko, Y.A.Papaika; Ministry of Education and Science of Ukranian, National Mining University – 5-th edition, revised and expanded: Translation from Ukranian. – Trans Tech Publications Ltd, Switzerland, 2016. – 382 p.
4. Transients in Electric Power Supply Systems. Volume 1: the textbook for institutions of higher education / G. Pivnyak, V. Vinoslavskiy, A. Rybalko, L. Nesen; under the general editorship of G. Pivnyak, Academician of National Academy of Sciences of Ukraine. Editorship of the English version and terminology by Professors O. Ivanov and S. Kostritskaya – 4th edition: Translation from Ukrainian. – Dnipropetrovsk: National Mining University. – 2005. – 248 pp.
5. Transients in Electric Power Supply Systems. Textbook for institutions of higher education / G. Pivnyak, V. Vinoslavskiy, A. Rybalko, L. Nesen, V. Procopenko; under the general editorship of G. Pivnyak, Academician of National Academy of Sciences of Ukraine. Editorship of the English version and terminology by Professors O. Ivanov and S. Kostritskaya – 5th edition: Translation from Ukrainian. – Dnipropetrovsk: National Mining University. – 2009. – 406 pp.

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Editorial by the author

Prepared for publication
Dnipro University of Technology.
Certificate of registration in the State Register ДК № 1842
49005, Dnipro, Dmytra Yavornytskoho Ave. 19