Ministry of Education and Science of Ukraine
Dnipro University of Technology

Department of Electrical Engineering

«APPROVED»
Head of Department
Tsyplenkov D.V. _____
«30» August 2022

WORK PROGRAM OF THE ACADEMIC DISCIPLINE

«Theoretical foundations of electrical engineering»

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	9 credits ECTS (270 hours)
Type of summative assessment	exam
Period of study	2-4 semesters (3-7 terms)
Language of study	English

Lecturer: Prof. Khilov V.S.

Prolonged: to 20__/20__ a.y. _____ (_____) «__»____ 20__y.
(Signature, name, date)

to 20__/20__ a.y. _____ (_____) «__»____ 20__y.
(Signature, name, date)

to 20__/20__ a.y. _____ (_____) «__»____ 20__y.
(Signature, name, date)

DNIPRO
DNIPROTECH
2022

Work program of the academic discipline «Theoretical foundations of electrical engineering» 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 Electrical Engineering. – D.: DNIPROTECH, 2022 – 18 p.

Author:

– Khilov Viktor Serhiiovych – Professor, Doctor of Technical Sciences, Professor of the Department of Electrical 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).

CONTENTS

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 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

The aim of the discipline – development of future professionals' competencies in solving practical problems involving the methods of mathematics, physics and electrical engineering, as well as complex specialized tasks and practical problems related to the operation of electrical systems and networks, electrical parts of stations and substations and high voltage engineering by mastering the basics of electromagnetic field theory, methods of calculating electrical circuits and acquiring skills in their use.

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	**content**
PLO05	PLO05.1-Б5	Know the methods for calculating DC electrical circuits and be able to use them to solve specialized problems
	PLO05.2-Б5	Know the methods for calculating single-phase alternating current electrical circuits and be able to use them to solve specialized problems
	PLO05.3-Б5	Know the methods of calculating three-phase alternating current electrical circuits and be able to use them to solve specialized problems and practical problems
	PLO05.4-Б5	Know the methods of analysis and calculation of nonlinear electrical circuits and be able to use them to solve specialized problems and practical problems
	PLO05.5-Б5	Know the fundamentals of the theory of four-pole circuits, passive filters and circuits with distributed parameters and be able to use them to solve specialized tasks and practical problems
	PLO05.6-Б5	Know the fundamentals of electromagnetic field theory and be able to use them to solve specialized tasks and practical problems
	PLO05.6-Б5	Master the methods of analyzing transients in electrical circuits and be able to use them to solve specialized problems and practical problems

3 BASIC DISCIPLINES

Discipline name	**Learning outcomes obtained**
Б3 «Computing and programming»	PLO06 To apply application software, microcontrollers and microprocessor technology to solve practical problems in professional activities

Discipline name	Learning outcomes obtained
	PLO18 To be able to learn independently, acquire new knowledge and improve skills in working with modern equipment, measuring equipment and application software

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

Types of classes	Distribution by forms of education, *hours*							
	Full-time			Part-time		Extramural		
	Volume	Classes (C)	Individual work (IW)	Classes (C)	Individual work (IW)	Volume	Classes (C)	Individual work (IW)
lectures	128	78	50			128	18	110
practical	63	30	33			63	8	55
laboratory	79	37	42			79	8	71
seminars	-	-	-			-	-	-
Total	270	145	125			270	34	236

5 DISCIPLINE PROGRAM BY TYPES OF CLASSES

Code DLO	Types and topics of training sessions	Volume of components, *hours*
PLO05.1-Б5	**LECTURES**	**128**
	1. Linear DC circuits at steady state mode	14
	1.1. Introduction. Current, voltage, power, resistance, conductivity	
	1.2. Voltage and current sources	
	1.3. Dropping voltage across the section of the circle. Ohm's law.	
	1.4. Power balance in an electric DC circuit.	
	1.5. Methods for calculating resistive circuits.	
	1.6. Conclusions	
PLO05.2-Б5	2. Linear circuits of single-phase current at steady state mode	14
	2.1. Harmonic oscillations	
	2.2. Instant, average and rms value of harmonic voltages and currents	
	2.3. Representation of harmonic functions by vectors and complex numbers	
	2.4. Harmonic oscillations in elementary resistive, inductive and capacitive circuits	
	2.5. Harmonic oscillations in series-connected RLC elements	
	2.6. Harmonic oscillations in parallel-connected RLC elements	
	2.7. Phase calculation method for branched circles with harmonic oscillations	
	2.8. Power balance in an AC circuit.	
	2.9. Resonance in AC electrical circuits.	
	2.10. Conclusions	
PLO05.2-Б5	3. Magnetically coupled linear circuits of single-phase current in a steady-state mode	10
	3.1. The phenomenon of mutual inductance. Coefficient of mutual induction.	
	3.2. Series connection of magnetically coupled coils	
	3.4. Parallel connection of magnetically coupled coils	
	3.5. Methods for calculating circles with magnetically cou-	

	pled elements	
	3.6. Power balance in circles with magnetically coupled elements.	
	3.7. Conclusions	
PLO05.3-Б5	4. Linear circuits of three-phase current in constant mode	10
	4.1. Multiphase electric circuits	
	4.2. Wye connection in three-phase circuits	
	4.3. Delta connection in three-phase circuits	
	4.4. Power balance in three-phase circuits. Power measurement of a three-phase circuit.	
	4.5. Method of symmetrical components	
	4.6. Conclusions	
PLO05.2-Б5 PLO05.3-Б5	5. Linear circuits of polyharmonic current in steady state mode	10
	5.1. Representation of polyharmonic currents and voltages by Fourier series	
	5.2. Calculation of circuits in the presence of polyharmonic currents and voltages sources	
	5.3. The rms value of polyharmonic currents and voltages	
	5.4. Power balance in circuits with polyharmonic currents and voltages	
	5.5. Resonance in electrical circuits with polyharmonic currents and voltages	
	5.6. Polyharmonic currents and voltages in three-phase circuits	
	5.7. Conclusions	
PLO05.6-Б5	6. Classical and operator methods of analysis of transients in linear circles with lumped parameters	14
	6.1. The emergence of transients	
	6.2. Laws of switching in electric circuits	
	6.3. Transients, forced and natural processes in electrical circuits	
	6.4. Definition of the characteristic equation	
	6.5. Definition of integration constants	
	6.6. The order of calculation by the classical method of transients	
	6.6.1. Analysis of transients in linear circuits by the classical method with one and two energy storage devices	
	6.7. Analysis of transients in linear circles by the operator method	
	6.7.1. Conversion originals to images	
	6.7.2. Laws of electric circuits in operator form	
	6.7.2. Calculation of operator equvalent circuits	
	6.7.3. The order of calculation by the operator method of transients	
	6.7.4. Analysis of transients in linear circles by the operator method	
	6.7.5. Conversion images to originals	

	6.8. Calculation of the response of the circle to the signal of any shape	
	6.8.1. Using the Duhamel integral when connecting a circuit to a signal of arbitrary shape	
	6.9. Conclusions	
PLO05.1-Б5	7. Nonlinear DC circuits in steady state mode	10
	7.1. Graphical representation of volt-ampere characteristics of nonlinear elements	
	7.2. Static and dynamic resistances of nonlinear elements	
	7.3. Calculation of nonlinear circuits with series, parallel and mixed connection of elements	
	7.4. Calculation of electrical circuits by the method of equivalent generator	
	7.5. Calculation of electrical circuits by the method of two nodes	
	7.6. Conclusions	
PLO05.2-Б5	8. Nonlinear AC circuit in steady state mode	8
	8.1. Features of periodic processes in nonlinear circuits with inertial elements	
	8.2. Coil with a steel cell powered by a harmonic voltage source. Equivalent harmonic currents and voltages	
	8.3. Equivalent circuit and vector diagram of coils with steel core	
	8.4. Ferroresonance phenomenon	
	8.5. Ferroresonant voltage stabilizers, magnetic power amplifiers, harmonic ferromagnetic separators	
	8.6. Features of the analysis of circuits with semiconductor diodes	
	8.7. Conclusions	
PLO05.6-Б5	9. Analysis methods of transients in nonlinear circuits	8
	9.1. Stability of operation mode of nonlinear circles	
	9.2 Method of piecewise-linear approximation of the self-oscillating circle	
	9.3. Methods for calculating transients in a coil with a steel core	
	9.4. Representation of transients in the phase plane	
	9.5. Conclusions	
PLO05.5-Б5	10. Fundamentals of the theory of two-port circuits	9
	10.1. The equation of two-port circuits	
	10.2. Modes of open and short circuit of two-port circuits	
	10.3. Determining the parameters of two-port circuits	
	10.4. Matched impedance and propagation coefficient of symmetric two-port circuits	
	10.5. Two-port circuits transfer functions and feedback	
	10.6. Conclusions	
PLO05.5-Б5	11. Passive reactive filters	8
	11.1 Basic properties of reactive filters	
	11.2. Frequency characteristics of filters	
	11.3. Low frequency filters	

	11.4. High frequency filters	
	11.5. Band pass filters	
	11.6. Band stop filters	
	11.7. Conclusions	
PLO05.5-Б5	12. Circles with distributed parameters	
	12.1. Lumped and distributed parameters of electrical circuits	8
	12.2. Equation of a homogeneous line	
	12.3. Solving homogeneous line equations in stationary modes	
	12.4. Running and standing waves	
	12.4. Voltage and current distribution along a long line	
	12.5. Transients in homogeneous lines	
	12.6. Conclusions	
PLO05.6-Б5	13. Electrostatic field in a dielectric medium	4
	13.1. Vortex-free nature of the electrostatic field	
	13.2. Gauss's theorem	
	13.3. Poisson and Laplace equations	
	13.4. Boundary conditions	
	13.5. Electrostatic field energy density	
	13.6. Elementary electrostatic fields	
	13.7. Conclusions	
PLO05.6-Б5	14. The magnetic field of direct current	4
	14.1. The law of total current. Scalar magnetic potential	
	14.1. Vector magnetic potential	
	14.2. Boundary conditions	
	14.3. Magnetic field energy density	
	14.4. Elementary magnetic fields	
	14.5. Conclusions	
PLO05.6-Б5	15. Alternating electromagnetic field in a stationary medium	4
	15.1. Displacement current	
	15.2. Maxwell's equation	
	15.3. Poiting's theorem	
	15.4. Flat waves in a homogeneous dielectric	
	15.5. Conclusions	
	LABORATORY CLASSES	**79**
PLO05.1-Б5	1. Linear DC circuits in steady state mode	10
	Research of a branched circle by the method of trans-formations	
	Power transmission from active to passive one-port circuits	
PLO05.2-Б5	2. Linear circuits of single-phase current in steady state mode	10
	Series connection of elements	
	Parallel connection of elements	
	Series resonance	
	Parallel resonance	
PLO05.2-Б5	3. Magnetically coupled linear circuits of single-phase current in steady state mode	2
	Series and parallel connection of magnetically coupled	

	coils	
PLO05.3-Б5	4. Linear circuits of three-phase current in steady state mode	6
	Symmetrical three-phase source and symmetrical load connected in a symmetrical and asymmetrical wye	
	Symmetrical three-phase source and symmetrical load connected in a symmetrical and asymmetrical delta	
	Asymmetric three-phase source and symmetrical load connected to a symmetrical wye	
PLO05.2-Б5 PLO05.3-Б5	5. Linear circuits of polyharmonic current in steady state mode	8
	Polyharmonic currents and voltages in single-phase circuits	
	Polyharmonic currents and voltages in three-phase circuits	
PLO05.6-Б5	6. Classical and operator methods of analysis of transients in linear circles with lumped parameters	10
	Transients in the resistive-inductive circuit	
	Transients in the resistive-capacitive circuit	
	The discharge of the capacitor on the resistive-inductive circuit	
PLO05.4-Б5	7. Nonlinear DC circuits in steady state mode	5
	Branched nonlinear DC circuit	
PLO05.4-Б5	8. Nonlinear alternating current circuits in steady state mode	5
	Inductor with steel core on alternating current	
PLO05.6-Б5	9. Methods of analysis of transients in nonlinear circles	5
	Self-oscillation in a nonlinear circle	
PLO05.5-Б5	10. Fundamentals of the theory of two-port circuits	5
	Parameters of an asymmetric two-port circuits	
PLO05.5-Б5	12. Circles with distributed parameters	5
	Homogeneous long line	
PLO05.6-Б5	13. Electrostatic field in a dielectric medium	5
	Electrostatic field modeling	
PLO05.6-Б5	14. The magnetic field of direct current	5
	Magnetic field around a current-carrying conductor	
	PRACTICAL TRAINING	**63**
PLO05.1-Б5	1. Linear DC circuits in steady state mode	6
PLO05.2-Б5	2. Linear circuits of single-phase current in steady state mode	6
PLO05.2-Б5	3. Magnetically coupled linear circuits of single-phase current in steady state mode	6
PLO05.3-Б5	4. Linear circuits of three-phase current in steady state mode	6
PLO05.2-Б5	5. Linear circuits of polyharmonic current in steady state mode	6
PLO05.6-Б5	6. Classical and operator methods of analysis of transients in linear circles	6
PLO05.4-Б5	7. Nonlinear DC circuits in steady state mode	6
PLO05.4-Б5	8. Nonlinear alternating current circuits in steady state	6

	mode	
PLO05.5-Б5	9. Fundamentals of the theory of two-port circuits	5
PLO05.5-Б5	10. Passive reactive filters	5
PLO05.5-Б5	11. Circles with distributed parameters in steady state modes	5
	TOTAL	**270**

For the implementation of the mixed form of education of students, the electronic resources of the e-learning platform in the discipline are used: **https://do.nmu.org.ua/course/view.php?id=2632**

6 EVALUATION OF LEARNING OUTCOMES

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

<table>
<tr><th colspan="3">FORMATIVE ASSESSMENT</th><th colspan="2">SUMMATIVE ASSESSMENT</th></tr>
<tr><th>training sessions</th><th>diagnostic tools</th><th>procedures</th><th>diagnostic tools</th><th>procedures</th></tr>
<tr><td>Lectures</td><td>control tasks for each topic</td><td>performing the task during lectures</td><td rowspan="3">complex control work (CCW)</td><td rowspan="3">determination of the weighted average result of formative assessments;

performing CCW during the differentiated test (2, 3 semesters), exam (4 semester) at the request of the student</td></tr>
<tr><td>Practical lessons</td><td>control tasks for each topic</td><td>performing tasks during practical classes</td></tr>
<tr><td>Laboratory lessons</td><td>individual task</td><td>performing tasks during individual work, defence of laboratory works</td></tr>
</table>

During the current control, lectures are evaluated by determining the quality of control specific tasks. Practical classes are assessed by the quality of the control (individual) task. Laboratory classes are evaluated by the quality of performance and defense of laboratory work.

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 (differentiated test and 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, laboratory 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	The answer characterizes the ability to: - identify problems; - formulate hypotheses; - solve problems; - choose appropriate methods and tools; - collect and interpret information logically and	95-100

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
practical problems in the field of professional activity or training	clearly; - use innovative approaches to solving problems	
	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 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	80-84

Description of qualification level	Requirements for knowledge, proficiency/skills, communication, autonomy and responsibility	Indicator evaluation
	implemented in total)	
	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 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

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

№ works (code)	Work title	Tools, equipment and software used in the work
TFEE-1	Linear DC circuits in steady state mode. Research of a branched circle by the method of transformations	Study-research laboratory stand УЛЛС-2, multimeter, oscilloscope
TFEE-2	Linear DC circuits in steady state mode. Power transmission from active to passive two-port circuits	Study-research laboratory stand УЛЛС-2, multimeter, oscilloscope
TFEE-3	Linear circuits of single-phase AC in steady state mode. Series connection of elements, voltage resonance.	Study-research laboratory stand УЛЛС-2, multimeter, oscilloscope
TFEE-4	Linear circuits of single-phase AC in steady state mode. Parallel connection of elements, resonance of currents.	Study-research laboratory stand УЛЛС-2, multimeter, oscilloscope
TFEE-5	Linear circuits of single-phase AC in steady state mode. Magnetically coupled linear circuits of single-phase current in steady state mode.	Study-research laboratory stand УЛЛС-2, multimeter, oscilloscope
TFEE-6	Linear circuits of three-phase current AC in steady state mode. Symmetrical three-phase source and symmetrical load connected in a symmetrical and asymmetrical wye	Study-research laboratory stand УЛЛС-2, multimeter, oscilloscope
TFEE-7	Linear circuits of three-phase current AC in steady state mode. Symmetrical three-phase source and symmetrical load connected in a symmetrical and asymmetrical delta	Study-research laboratory stand УЛЛС-2, multimeter, oscilloscope
TFEE-8	Linear circuits of three-phase current AC in steady state mode. Asymmetrical three-phase source and symmetrical load connected in symmetrical wye.	Study-research laboratory stand УЛЛС-2, multimeter, oscilloscope
TFEE-9	Linear circuits of polyharmonic current in steady state. Polyharmonic currents and voltages in single-phase circuits.	Study-research laboratory stand УЛЛС-2, multimeter, oscilloscope
TFEE-10	Linear circuits polyharmonic Polyharmonic currents and voltages in three-phase circuits in steady state.	Study-research laboratory stand УЛЛС-2, multimeter, oscilloscope
TFEE-11	Classical and operator methods of analysis of transients in linear circuits with concentrated pa-	Study-research laboratory stand УЛЛС-2, multimeter, oscilloscope

	rameters. Transients in the resistive-inductive circuit	
TFEE-12	Classical and operator methods of analysis of transients in linear circles with concentrated parameters. Transients in the resistive-capacitive circuit.	Study-research laboratory stand УІЛС-2, multimeter, oscilloscope
TFEE-13	Classical and operator methods of analysis of transients in linear circles with concentrated parameters. The discharge of the capacitor on the resistive-inductive circuit	Study-research laboratory stand УІЛС-2, multimeter, oscilloscope
TFEE-14	Branched nonlinear DC circuit.	Study-research laboratory stand УІЛС-2, multimeter, oscilloscope
TFEE-15	Inductance coil with steel core for alternating current	Study-research laboratory stand УІЛС-2, multimeter, oscilloscope
TFEE-16	Self-oscillation in a nonlinear circle	Study-research laboratory stand УІЛС-2, multimeter, oscilloscope
TFEE-17	Parameters of an asymmetric quadrupole	Study-research laboratory stand УІЛС-2, multimeter, oscilloscope
TFEE-18	Homogeneous long line	Study-research laboratory stand УІЛС-2, multimeter, oscilloscope
TFEE-19	Electrostatic field modeling	Study-research laboratory stand УІЛС-2, multimeter, oscilloscope
TFEE-20	Magnetic field around a current-carrying conductor	Study-research laboratory stand УІЛС-2, multimeter, oscilloscope

8. RECOMMENDED SOURCES OF INFORMATION

1 Khilov V.S. Theoretical fundamentals of electric engineering. Підручник. / В. С. Хілов – Д., 2018. – 467 с.

2 Теоретичні основи електротехніки. Електричні кола: навч. посібник / В.С. Маляр. – Львів: Видавництво Львівської політехніки, 2012. – 312 с.

3 Теоретичні основи електротехніки. Усталені режими лінійних електричних кіл із зосередженими та розподіленими параметрами : підручник / Ю. О. Карпов, С. Ш. Кацив, В. В. Кухарчук, Ю. Г. Ведміцький ; під ред. проф. Ю. О. Карпова – Вінниця : ВНТУ, 2011. – 377 с.

4 Теоретичні основи електротехніки: Частина 1. Електричні кола постійного та змінного струму. Чотириполюсники [Електронний ресурс]: навч. посіб. для студ. спеціальності 141 «Електроенергетика, електротехніка та електромеханіка»/ КПІ ім. Ігоря Сікорського; уклад.: Ю. В. Перетятко, А. А. Щерба– Електронні текстові дані (1 файл: 21.7 Мбайт). – Київ : КПІ ім. Ігоря Сікорського, 2021. – 115 с

5 Овчаров В.В. Теоретичні основи електротехніки, частина 1. Мелітополь : Видавничо-поліграфічний центр «Люкс», 2007. 389 с.

6 Collection of methodical materials for laboratory work on discipline «Theoretical fundamentals of electrical engineering» for full-time students' majoring in 141 – Electric Power, Electrical Engineering and Electromechanical. Part 1 "Fundamentals of the theory of DC circuits"; "Fundamentals of the theory of harmonic sin-

gle-phase currents" / V.S.Khilov; Dnipro University of Technology – D.: Dnipro-Tech, 2021. – 35 p.

7 Collection of methodical materials for laboratory work on discipline «Theoretical fundamentals of electrical engineering» for full-time students' majoring in 141 – Electric Power, Electrical Engineering and Electromechanical. Part 1 "Three-phase circuits", "Polyharmonic currents and voltages in single-phase and three-phase circuits", "Transients in linear electric circuits" / V.S.Khilov; Dnipro University of Technology – D.: DniproTech, 2021. – 52 p.

8 Collection of methodical materials for laboratory work on discipline «Theoretical fundamentals of electrical engineering» for full-time students' majoring in 141 – Electric Power, Electrical Engineering and Electromechanical. Part 3 "Nonlinear electric circuits of direct and alternating currents", "Magnetic circuits", "Transients in circuits with nonlinear elements" / V.S.Khilov; Dnipro University of Technology – D.: DniproTech, 2021. – 30 p.

9 Collection of methodical materials for to independent and practical works on discipline «Theoretical fundamentals of electrical engineering» for full-time students' majoring in 141 – Electric Power, Electrical Engineering and Electromechanical. Part 1 «Theory fundamentals of dc and single-phase harmonic ac circuits» / V.S.Khilov; Dnipro University of Technology – D.: DniproTech, 2021. – 44 p.

10 Collection of methodical materials for to independent and practical works on discipline «Theoretical fundamentals of electrical engineering» for full-time students' majoring in 141 – Electric Power, Electrical Engineering and Electromechanical. Part 2 «Three–phase circuits, Polyharmonical voltages and currents in circuit, Transient analisis of a linear circuits» / V.S.Khilov; Dnipro University of Technology – D.: DniproTech, 2021. – 99 p.

11 Collection of methodical materials for to independent and practical works on discipline «Theoretical fundamentals of electrical engineering» for full-time students' majoring in 141 – Electric Power, Electrical Engineering and Electromechanical. Part 3 « DC and AC nonnlinear circuits, Magnetic circuits, Transients into circuits with nonlinear elements» / V.S.Khilov; Dnipro University of Technology – D.: DniproTech, 2021. – 35 p.

WORK PROGRAM OF THE ACADEMIC DISCIPLINE
«Theoretical foundations of electrical engineering » for bachelors
of the educational and professional program «Electrical energetics, electrical engineering and electromechanics» of the specialty 141 Electrical energetics, electrical engineering and electromechanics

Author:
Viktor Serhiiovych Khilov

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