MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

Dnipro University of Technology

Department of Electrical Engineering

«ЗАТВЕРДЖЕНО»
Завідувач кафедри
Ципленков Д.В. _____
«14» 07 2022 року

EDUCATIONAL DISCIPLINE WORK PROGRAM

«**Theoretical foundations of electrical engineering**»

Knowledge area …….	14 Electrical Engineering
Specialty …….....	141 Electrical energetics, electrical engineering and electromechanics
Level of higher education ……...	second (master's degree)
Degree …….	bachelor
Educational and professional program …	Electrical energetics, electrical engineering and electromechanics
Specialization ……..	–
Status ……..	normative
Total of hours (credits)..……..	9 credits ECTS (270 hours)
Form of final control ……..	Exam
Term of teaching ….……	2, 3 and 4 semesters
Language of instruction ……..	English

Lecturer: Doctor of Technical Sciences, Professor Khilov V.S.

Prolonged: to 20__/20__ s.y. _____ (_____) «__»____ 20__y.
(підпис, ПІБ, дата)

to 20__/20__ s.y. _____ (_____) «__»____ 20__y.
(підпис, ПІБ, дата)

to 20__/20__ s.y. _____ (_____) «__»____ 20__y.
(підпис, ПІБ, дата)

DNIPRO
Dnipro University of Technology
2022

Working program of the normative educational discipline "Theoretical foundations of electrical engineering" for bachelors speciality in 141 "Electrical energetics, electrical engineering and electromechanics" / Dnipro University of Technology, Department of Electrical Engineering. - D.: Dniprotech, 2022. - 19 p.

Developer – Doctor of Technical Sciences, Professor Khilov V.S.

The work program regulates:

– the purpose of the discipline;
– disciplinary learning outcomes formed on the basis of the transformation of the expected learning outcomes of the educational program;
– basic disciplines;
– the amount and distribution of forms of organization of the educational process and types of training sessions;
– program of the discipline (thematic plan by types of classes);
– algorithm for assessing the level of achievement of disciplinary learning outcomes (scales, tools, procedures and evaluation criteria);
– tools, equipment and software;
– recommended sources of information.

The work program is designed to implement a competency-based approach to planning the educational process, teaching discipline, preparing students for control activities, monitoring the implementation of educational activities, internal and external control of quality assurance in higher education, accreditation of educational programs within the specialty.

Agreed by the decision of the scientific-methodical commission of the specialty 141 Electrical energetics, electrical engineering and electromechanics (protocol № 21/22-07 from 14.07.2022).

CONTENT

1 THE PURPOSE OF THE EDUCATION DISCIPLINE

In the educational-professional program of the Dnipro University of Technology specialty 141 "Electrical energetics, electrical engineering and electromechanics" the distribution of program learning outcomes by organizational forms of educational process. In particular, the discipline Б5 "Theoretical foundations of electrical engineering" includes the following learning outcomes:

Code ПРН	**Learning outcomes**
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 purpose of the discipline is to form in future professionals competencies in the field of normative-basic discipline "Theoretical foundations of electrical engineering".

Achieving the goal requires the transformation of program learning outcomes into disciplinary and adequate selection of the content of the discipline according to this criterion.

2 EXPECTED DISCIPLINARY LEARNING OUTCOMES

Code ПРН	**Disciplinary learning outcomes (DLO)**	
	Code ДРН	**content**
PLO05	PLO05.1- Б5	Calculation methods of linear DC circuits at steady state mode.
	PLO05.2- Б5	Linear circuits of single-phase current at steady state mode
	PLO05.3- Б5	Magnetically coupled linear circuits of single-phase current in a steady-state mode
	PLO05.4- Б5	Linear circuits of three-phase current in steady-state mode
	PLO05.5- Б5	Linear circuits of polyharmonic current in steady state mode
	PLO05.6- Б5	Classical and operator methods of analysis of transients in linear circles with lumped parameters
	PLO05.7- Б5	Nonlinear DC and AC circuits in steady state mode
	PLO05.8- Б5	Analysis methods of transients in nonlinear circuits
	PLO05.9- Б5	Fundamentals of the theory of two-port circuits
	PLO05.10- Б5	Passive reactive filters
	PLO05.11- Б5	Circles with distributed parameters
	PLO05.12- Б5	Electrostatic field in a dielectric medium
	PLO05.13- Б5	The magnetic field of direct current
	PLO05.14- Б5	Alternating electromagnetic field in a stationary medium

3 BASIC DISCIPLINES

Discipline name	Learning outcomes obtained
33 Foreign language for professional purposes (English, German, French)	PLO11 To communicate freely on professional issues in state and foreign languages orally and in writing, discuss the results of professional activities with specialists and non-specialists, argue their position on debatable issues
Б1 Higher mathematics Б2 General Physics	PLO07 To carry out analysis of processes in electrical, electrical and electromechanical equipment, relevant complexes and systems.
	PLO08 To Select and apply suitable methods for analysis and synthesis of electromechanical and electrical systems with specified parameters.
Б3 Computer science	PLO06 To apply application software, microcontrollers and microprocessor technology to solve practical problems in professional activities
	PLO18 To be able to learn independently, acquire new knowledge and improve skills in working with modern equipment, measuring equipment and application software.

4 AMOUNT AND DISTRIBUTION BY FORMS OF ORGANIZATION OF THE EDUCATIONAL PROCESS AND TYPES OF EDUCATIONAL CLASSES

Types of classes	**Distribution between forms of educational process,** hours							
	Daytime learning			**evening learning**		**Distance learning**		
	Volume	Classroom lessons	Self-study	Classroom lessons	Self-study	Volume	Classroom lessons	Self-study
lectures	128	104	24			128	18	110
practical	63	24	39			142	16	126
laboratory	79	53	26					
seminars	-	-	-					
Total	270	181	89			270	34	236

5 DISCIPLINE PROGRAM BY TYPES OF EDUCATIONAL CLASSES

Code ДРН	Types and topics of training sessions	Volume of components, hours
PLO05.1- Б5	**Lectures**	128
PLO05.2- Б5	1. Linear DC circuits at steady state mode	14
PLO05.3- Б5	1.1. Introduction. Current, voltage, power, resistance, conductivity	
PLO05.4- Б5	1.2. Voltage and current sources	
PLO05.5- Б5	1.3. Dropping voltage across the section of the circle. Ohm's law.	
PLO05.6- Б5	1.4. Power balance in an electric DC circuit.	
PLO05.7- Б5	1.5. Methods for calculating resistive circuits.	
PLO05.8- Б5	1.6. Conclusions	
PLO05.9- Б5	2. Linear circuits of single-phase current at steady state mode	14
PLO05.10- Б5		

PLO05.11- Б5 PLO05.12- Б5 PLO05.13- Б5 PLO05.14- Б5	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	
	3. Magnetically coupled linear circuits of single-phase current in a steady-state mode	9
	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 coupled elements	
	3.6. Power balance in circles with magnetically coupled elements.	
	3.7. Conclusions	
	4. Linear circuits of three-phase current in constant mode	9
	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	
	5. Linear circuits of polyharmonic current in steady state mode	9
	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	
	6. Classical and operator methods of analysis of transients in linear circles with lumped parameters	13
	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	
	7. Nonlinear DC circuits in steady state mode	8
	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	
	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	
	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	
	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	
	11. Passive reactive filters	9
	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	
	12. Circles with distributed parameters	
	12.1. Lumped and distributed parameters of electrical circuits	9
	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	
	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	
	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	
	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	
PLO05.1- Б5	**Laboratory classes**	79
PLO05.2- Б5	1. Linear DC circuits in steady state mode	10
PLO05.3- Б5	Research of a branched circle by the method of trans-	
PLO05.4- Б5	formations	
PLO05.5- Б5	Power transmission from active to passive one-port	
PLO05.6- Б5	circuits	
PLO05.7- Б5	2. Linear circuits of single-phase current in steady state	10
PLO05.8- Б5	mode	
PLO05.9- Б5	Series connection of elements	
PLO05.10- Б5	Parallel connection of elements	
PLO05.11- Б5	Series resonance	
PLO05.12- Б5	Parallel resonance	
PLO05.13- Б5	3. Magnetically coupled linear circuits of single-phase	6
PLO05.14- Б5	current in steady state mode	8
	Series and parallel connection of magnetically coupled coils	
	4. Linear circuits of three-phase current in steady state mode	
	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	
	5. Linear circuits of polyharmonic current in steady state mode	10
	Polyharmonic currents and voltages in single-phase circuits	
	Polyharmonic currents and voltages in three-phase cir- cuits	
	6. Classical and operator methods of analysis of transi- ents in linear circles with lumped parameters	12
	Transients in the resistive-inductive circuit	
	Transients in the resistive-capacitive circuit	
	The discharge of the capacitor on the resistive-inductive circuit	
	7. Nonlinear DC circuits in steady state mode	5
	Branched nonlinear DC circuit	
	8. Nonlinear alternating current circuits in steady state mode	5
	Inductor with steel core on alternating current	
	9. Methods of analysis of transients in nonlinear circles	5
	Self-oscillation in a nonlinear circle	
	10. Fundamentals of the theory of two-port circuits	5
	Parameters of an asymmetric two-port circuits	
	12. Circles with distributed parameters	5

	Homogeneous long line	
	13. Electrostatic field in a dielectric medium	5
	Electrostatic field modeling	
	14. The magnetic field of direct current	5
	Magnetic field around a current-carrying conductor	
PLO05.1- Б5 PLO05.2- Б5 PLO05.3- Б5 PLO05.4- Б5 PLO05.5- Б5 PLO05.6- Б5 PLO05.7- Б5 PLO05.8- Б5 PLO05.9- Б5 PLO05.10- Б5 PLO05.11- Б5 PLO05.12- Б5 PLO05.13- Б5 PLO05.14- Б5	**PRACTICAL TRAINING**	63
	1. Linear DC circuits in steady state mode	
	2. Linear circuits of single-phase current in steady state mode	
	3. Magnetically coupled linear circuits of single-phase current in steady state mode	
	4. Linear circuits of three-phase current in steady state mode	
	5. Linear circuits of polyharmonic current in steady state mode	
	6. Classical and operator methods of analysis of transi-ents in linear circles	
	7. Nonlinear DC circuits in steady state mode	
	8. Nonlinear alternating current circuits in steady state mode	
	9. Fundamentals of the theory of two-port circuits	
	10. Passive reactive filters	
	11. Circles with distributed parameters in steady state modes	
	TOTAL	270

6 EVALUATION OF LEARNING OUTCOMES

Certification of student achievement is carried out through transparent procedures based on objective criteria in accordance with the Regulations of the University "On the evaluation of learning outcomes of higher education."

The achieved level of competencies relative to the expected ones, which is identified during the control activities, reflects the real result of the student's study in the discipline.

6.1 Scales

Assessment of academic achievements of students of Dnipro University of Technology is carried out on a rating (100-point) and conversion scales. The latter is necessary (in the official absence of a national scale) for the conversion (translation) of grades of higher education students of different institutions.

Scales for assessing the academic achievements of DNIPROTECH students

Rating	Conversion
90…100	відмінно / Excellent
74…89	добре / Good
60…73	задовільно / Satisfactory
0…59	незадовільно / Fail

Credits of the discipline is accounted if the student received a final mark of at least 60 points. The lower mark 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 Means and procedures

The content of diagnostic tools is aimed at controlling the level of knowledge, skills, communication, autonomy and responsibility of the student according to the requirements of the HPK to the 7th qualification level during the demonstration of learning outcomes regulated by the work program.

The student in the control activities must perform tasks focused solely on the demonstration of disciplinary learning outcomes (Section 2).

Diagnostic tools provided to students at control activities in the form of tasks for current and final control, are formed by specifying the initial data and the method of demonstrating disciplinary learning outcomes.

Diagnostic tools (control tasks) for the current and final control of the discipline are approved by the department.

The types of diagnostic tools and assessment procedures for the current and final control of the discipline are given below.

Diagnostic tools and assessment procedures

<table>
<tr><th colspan="3">CURRENT CONTROL</th><th colspan="2">FINAL CONTROL</th></tr>
<tr><th>training session</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 current controls;

performing CCW during the exam at the request of the student</td></tr>
<tr><td>Practical lessons</td><td>control tasks for each topic or individual task</td><td>performing tasks during practical classes</td></tr>
<tr><td>Laboratory lessons</td><td>control tasks for each topic or individual task</td><td>performing tasks during practical classes</td></tr>
</table>

During the current control, lectures are evaluated by determining the quality of control specific tasks. Laboratory classes and practical lessonsare evaluated by the quality of the control or individual task.

When content of definite type of lessons includes several components of qualification level description, the integrated score can be determined considering the weight factors that are assigned by an instructor.

When level of current monitoring results on all lesson types is not less than 60 points, the final control is performed without a student participation by determination an average weighted score based on the obtained current scores.

Regardless of results of the current monitoring, each the student has the right to carry out the integrated control work which includes the tasks covering the key discipline study results.

Number of concretized integrated tasks should meet the time allocated for its fulfillment. Number of the integrated task options must provide the task individualization.

A score for the integrated control task is determined as an average score for the task components (i.e., the concretized tasks) and is the final

A score for the integrated control task ca be also determined considering the weight factors for the task components which are set by the department for each a component of qualification description level of the integrated control task.

6.3 Criteria

Factual results of a student's learning are identified and measured relative to the results expected at the assessment procedure with the help of criteria describing actions of a student on demonstration his/her study results.

For assessment control tasks during current control at lectures and practical lessons, the material assimilation factor, that adapts the scores to the rating scale, is used as a criterium:

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

where a – the number of proper answers or essential operations with regards to the solution standard; m – the total number of questions or essential reference operations.

Individual tasks and integrated control works are assessed using criteria characterizing the relationship between requirements to competence levels and indices by the rating scale.

Criteria content is based on competence characteristics defined by NQF for the bachelors' level of higher education which is given below.

General criteria of achievement learning results for the 6th qualification level by the NQF

Description qualification equal	**Requirements to knowledge, skills/abilities, communications, responsibility, and autonomy**	**Score values**
	Knowledge	
♦ conceptual scientific and practical knowledges critical comprehending of theories, principles, methods, and concepts in the field of professional activity/learning	The answer is excellent – correct, substantiated, comprehensive. It is characterized by availability of - conceptual knowledge - high level mastering the state of the matter - critical comprehension the main theories, principles, methods, and concepts in the field of learning and professional activity.	95-100

Description qualification equal	Requirements to knowledge, skills/abilities, communications, responsibility, and autonomy	Score values
	The answer contains minor errors or elapses	90-94
	The answer is correct but has some inaccuracies	85-89
	The answer is correct but has some inaccuracies, and is not sufficiently substantiated and comprehensive	80-84
	The answer is correct but has some inaccuracies, is not sufficiently substantiated and comprehensive	74-79
	The answer is fragmentary	70-73
	The answer demonstrates fuzzy ideas about the object under study	65-69
	Level of knowledge is minimum satisfactory	60-64
	Level of knowledge is unsatisfactory	<60
	Skills/abilities	
♦ 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 adequate methods and tools - collect and logically and clearly interpret information - use innovative approaches to solving the problem	95-100
	The answer characterizes the ability / skills to apply knowledge in practice with minor errors	90-94
	The answer characterizes the ability / skills to apply knowledge in practice, but has some inaccuracies in the implementation of one requirement	85-89
	The answer characterizes the ability / skills to apply knowledge in practice, but has some inaccuracies in the implementation of the two requirements	80-84
	The answer characterizes the ability / skills to apply knowledge in practice, but has some inaccuracies in the implementation of the three requirements	74-79
	The answer characterizes the ability / skills to apply knowledge in practice, but has some inaccuracies in the implementation of the four requirements	70-73
	The answer characterizes the ability / skills to apply knowledge in practice when performing tasks on the model	65-69
	The answer characterizes the ability / skills to apply knowledge when performing tasks on the model, but with inaccuracies	60-64
	the level of skills is unsatisfactory	<60

Description qualification equal	Requirements to knowledge, skills/abilities, communications, responsibility, and autonomy	Score values
	Communication	
♦ reporting to specialists and non-specialists information, ideas, problems, solutions, personal experience, and argumentation ♦ collection, interpretation, and application of data ♦ communication on professional issues, including in a foreign language, orally and in writing	Free possession of 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 - relevant 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 mastery of industry issues with minor flaws. Sufficient clarity of the answer (report) with minor errors. Appropriate communication strategy with minor flaws	90-94
	Good mastery of industry issues. Good clarity of the answer (report) and appropriate communication strategy (a total of three requirements are not implemented)	85-89
	Good mastery of industry issues. Good clarity of response (report) and appropriate communication strategy (four requirements not implemented in total)	80-84
	Good mastery of industry issues. Good clarity of response (report) and appropriate communication strategy (five requirements not implemented in total)	74-79
	Satisfactory mastery of industry issues. Satisfactory comprehensibility of the answer (report) and appropriate communication strategy (a total of seven requirements have not been implemented)	70-73
	Partial ownership of industry issues. Satisfactory comprehensibility of the answer (report) and communication strategy with errors (a total of nine requirements are not implemented)	65-69
	Fragmentary mastery of industry issues. Satisfactory comprehensibility of the answer (report) and communication strategy with errors (a total of 10 requirements are not implemented)	60-64

Description qualification equal	Requirements to knowledge, skills/abilities, communications, responsibility, and autonomy	Score values
	The level of communication is unsatisfactory	<60
	Responsibility and autonomy	
♦ managing complex technical or professional activities or projects ♦ ability to take responsibility for making and approvement decisions in unpredictable work and / or learning contexts ♦ formation of judgments that consider 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 mastery of personal management competencies focused on: 1) management of complex projects, which provides: - research nature of educational activities, marked by the ability to independently assess various life situations, phenomena, facts, to identify and defend a personal position - ability to work in a team - control of own actions 2) responsibility for making decisions in unpredictable conditions, including: - substantiation of own decisions by provisions of normative base of branch and state levels - independence in performing tasks - initiative in discussing problems - responsibility for the relationship 3) responsibility for professional development of individuals and / or groups of persons, which includes: - use of professional-oriented skills - use of evidence with independent and correct argumentation - mastery of all types of educational activities 4) the ability to further study with a high level of autonomy, which includes: - degree of possession of fundamental knowledge - independence of evaluative judgments - high level of formation of general educational skills and abilities - independent search and analysis of information sources	95-100
	Confident mastery of personal management competencies (two requirements are not met)	90-94
	Good mastery of personal management competencies (three requirements are not met)	85-89
	Good mastery of personal management competencies (four requirements not met)	80-84
	Good mastery of personal management competencies (six requirements not met)	74-79
	Satisfactory mastery of personal management competencies (seven requirements not met)	70-73
	Satisfactory mastery of personal management competencies (eight requirements not met)	65-69
	The level of responsibility and autonomy is fragmentary	60-64
	The level of responsibility and autonomy 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 УЛС-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 УЛС-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 УЛС-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 УЛС-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 УЛС-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 delta and asymmetrical wye	Study-research laboratory stand УЛС-2, multimeter, oscilloscope
TFEE-7	Linear circuits of three-phase current AC in steady state mode. A symmetrical three-phase source and asymmetrical load connected in delta and wye.	Study-research laboratory stand УЛС-2, multimeter, oscilloscope
TFEE-8	Linear circuits of three-phase current in steady state mode. Asymmetric three-phase source and symmetrical load connected to a symmetrical wye	Study-research laboratory stand УЛС-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 УЛС-2, multimeter, oscilloscope
TFEE-11	Linear circuits polyharmonic Polyharmonic currents and voltages in three-phase circuits th current in steady state.	Study-research laboratory stand УЛС-2, multimeter, oscilloscope
TFEE-13	Classical and operator methods of analysis of transients in linear circles with concentrated parameters. Transients in the resistive-inductive circuit	Study-research laboratory stand УЛС-2, multimeter, oscilloscope
TFEE-14	Classical and operator methods of analysis of transients in linear circles with concentrated parameters. Transients in the resistive-capacitive circuit.	Study-research laboratory stand УЛС-2, multimeter, oscilloscope
TFEE-15	Classical and operator methods of analysis of transients in linear circles	Study-research laboratory stand УЛС-2, multimeter, oscilloscope

	with concentrated parameters. The discharge of the capacitor on the resistive-inductive circuit	
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 single-phase currents" / V.S.Khilov; Dnipro University of Technology – D.: DniproTech, 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 «The-

oretical 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.

Working program
of the normative educational discipline
"**THEORETICAL FOUNDATIONS OF ELECTRICAL ENGINEERING**"
for bachelors speciality in 141 " Electrical energetics, electrical engineering and electromechanics"

Developer: Khilov V.S.

Edited by the author