MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

Dnipro University of Technology

Department of Electrical Engineering

«APPROVED»
Head of Department
Tsyplenkov D.V. _____
31.08.2021

EDUCATIONAL DISCIPLINE WORK PROGRAM

«Fundamentals of electric engineering»

Knowledge area ……..…	14 Electrical Engineering
Specialty ……...	141 Electric Power Engineering, Electrical Engineering and Electromechanics
Level of higher education …….	first (bachelor's)
Degree ……	bachelor
Educational and professional program	Electric Power Engineering, Electrical Engineering and Electromechanics
Status ……	compulsory
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
DNIPROTECH
2021

Working program of the educational discipline "Fundamentals of electric engineering" for bachelors speciality in 141 " Electric Power Engineering, Electrical Engineering and Electromechanics " (cycle of special training: basic disciplines in the field of knowledge) / Dnipro University of Technology, Department of Electrical Engineering. - D.: Dniprotech, 2021. - 17 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.

The work program will be useful for the formation of the content of professional development of research and teaching staff of university departments.

Agreed by the decision of the scientific-methodical commission of the specialty 141 Electric Power, Electrical Engineering and Electromechanics (protocol № 21/22-01 from 30.08.2021).

CONTENT

1 The purpose of the education discipline

In the educational-professional program of the Dnipro University of Technology specialty 141 " Electric Power Engineering, Electrical Engineering and Electromechanics " (cycle of special training: basic disciplines in the field of knowledge) the distribution of program learning outcomes by organizational forms of educational process. In particular, the discipline Б5 "Fundamentals of electric engineering" includes the following learning outcomes:

Code ПРН	**Learning outcomes**
ПР05	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 "Fundamentals of electric 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**
ПР05	ПР05.1- Б5	Calculation methods of linear DC circuits at steady state mode.
ПР05	ПР05.2- Б5	Linear circuits of single-phase current at steady state mode
ПР05	ПР05.3- Б5	Magnetically coupled linear circuits of single-phase current in a steady-state mode
ПР05	ПР05.4- Б5	Linear circuits of three-phase current in steady-state mode
ПР05	ПР05.5- Б5	Linear circuits of polyharmonic current in steady state mode
ПР05	ПР05.6- Б5	Classical and operator methods of analysis of transients in linear circles with lumped parameters
ПР05	ПР05.7- Б5	Nonlinear DC and AC circuits in steady state mode
ПР05	ПР05.8- Б5	Analysis methods of transients in nonlinear circuits
ПР05	ПР05.9- Б5	Fundamentals of the theory of two-port circuits
ПР05	ПР05.10- Б5	Passive reactive filters
ПР05	ПР05.11- Б5	Circles with distributed parameters
ПР05	ПР05.12- Б5	Electrostatic field in a dielectric medium
ПР05	ПР05.13- Б5	The magnetic field of direct current

Code ПРН	Disciplinary learning outcomes (DLO)	
	Code ДРН	content
ПР05	ПР05.14- Б5	Alternating electromagnetic field in a stationary medium

3 BASIC DISCIPLINES

Discipline name	Learning outcomes obtained
Foreign Language	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 issues of discussion
General Physics	ПР07.1-Б2 Know: basic laws and concepts of classical (including relativistic) and quantum mechanics, thermodynamics and statistical physics, electrodynamics, theory of oscillations and waves, physics of atoms, molecules, atomic nucleus and condensed state. ПР08.2-Б2 Formulate physical ideas, solve problems, estimate quantities, operate with physical models and understand the limits of their applications
Higher mathematics	ПР07 Carry out analysis of processes in electrical, electrical and electromechanical equipment, relevant complexes and systems. ПР08 Select and apply suitable methods for analysis and synthesis of electromechanical and electrical systems with specified parameters
Computing and programming	To use application software, microcontrollers and microprocessor technology to solve practical problems in professional activities.
	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

Type of training	Amount, *hours*	Distribution by forms of education, *hours*					
		full-time form of study		evening form of study		extramural form of study	
		Classroom studies	independent work	Classroom studies	independent work	Classroom studies	independent work
lectures	128	78	50			-	-
practical	63	24	39			-	-
laboratory	79	21	58			-	-
seminars	-	-	-				
Total	270	123	147			-	-

5 DISCIPLINE PROGRAM BY TYPES OF EDUCATIONAL CLASSES

Code ДРН	Types and topics of training sessions	Volume of components, hours
ПР05.1- Б5 ПР05.2- Б5 ПР05.3- Б5 ПР05.4- Б5 ПР05.5- Б5 ПР05.6- Б5 ПР05.7- Б5 ПР05.8- Б5 ПР05.9- Б5 ПР05.10- Б5 ПР05.11- Б5 ПР05.12- Б5 ПР05.13- Б5 ПР05.14- 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	
	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	
	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	
ПР05.1- Б5	**Laboratory classes**	79
ПР05.2- Б5	1. Linear DC circuits in steady state mode	10
ПР05.3- Б5 ПР05.4- Б5	Research of a branched circle by the method of transformations	
ПР05.5- Б5 ПР05.6- Б5	Power transmission from active to passive one-port circuits	
ПР05.7- Б5	2. Linear circuits of single-phase current in steady state mode	10
ПР05.8- Б5	Series connection of elements	
ПР05.9- Б5	Parallel connection of elements	
ПР05.10- Б5	Series resonance	
ПР05.11- Б5	Parallel resonance	
ПР05.12- Б5	3. Magnetically coupled linear circuits of single-phase current in steady state mode	6 8
ПР05.13- Б5	Series and parallel connection of magnetically coupled coils	
ПР05.14- Б5	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 circuits	

	6. Classical and operator methods of analysis of transients 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	
ПР05.1- Б5 ПР05.2- Б5 ПР05.3- Б5 ПР05.4- Б5 ПР05.5- Б5 ПР05.6- Б5 ПР05.7- Б5 ПР05.8- Б5 ПР05.9- Б5 ПР05.10- Б5 ПР05.11- Б5 ПР05.12- Б5 ПР05.13- Б5 ПР05.14- 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 transients 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 DNIPROTECH 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

CURRENT CONTROL			**FINAL CONTROL**	
training session	**diagnostic tools**	**procedures**	**diagnostic tools**	**procedures**
Lectures	control tasks for each topic	performing the task during lectures	complex control work (CCW)	determination of the weighted average result of current controls; performing CCW during the exam at the request of the
Practical	control tasks for each topic or individual task	performing tasks during practical classes		

Laboratory	control tasks for each topic or individual task	performing tasks during independent work		student

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

If the content of a certain type of classes is subject to several descriptors, the integral value of the assessment can be determined taking into account the weights set by the teacher.

If the level of results of current controls in all types of classes is not less than 60 points, the final control is carried out without the participation of the student by determining the weighted average of current assessments.

Regardless of the results of the current control, each student during the exam has the right to perform the CCW, which contains tasks that cover key disciplinary learning outcomes.

The number of specified tasks CCW should correspond to the allotted time for performance. The number of CCW options should provide individualization of the task.

The value of the assessment for the implementation of the CCW is determined by the average assessment of the components (specified tasks) and is final.

The integral value of the assessment of the performance of CCW can be determined taking into account the weights set by the department for each descriptor НРК.

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 current control role of lectures and practical classes as a criterion is used the coefficient of mastering, which automatically adapts the assessment indicator to the rating scale:

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

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

Individual tasks and complex tests are evaluated 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 НРУ for the bachelor's degree (higher below).

General criteria for achieving learning outcomes for the 6th qualification level for НРК

	Requirements for knowledge, skills, communication, autonomy and responsibility	Indicator evaluation
	Skills	
♦ specialized conceptual knowledge acquired in the process of learning and / or professional activity at the level of the latest achievements, which are the basis for original thinking and innovation, in particular in the context of research; ♦ critical understanding of problems in teaching and / or professional activities and at the boundaries of subject areas	The answer is excellent - correct, wrapped, meaningful. Characterizes the provision of: - specialized conceptual knowledge at the levels of new and previous achievements; - critical understanding of the problem in teaching and / or professional activities and at the border of subject areas	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
	Skills	
♦ solving complex problems and problems that require updating and integration of knowledge, often in conditions of incomplete / insufficient information and conflicting requirements; ♦ conducting research and / or innovation activities	The answer characterizes the ability to: - identify problems; - formulate hypotheses; - solve problems; - update knowledge; - integrate knowledge; - to carry out innovative activity; - to carry out scientific activity	95-100
	The answer characterizes the ability to apply knowledge in practice with minor errors	90-94
	The answer characterizes the ability to apply knowledge in practice, but has some inaccuracies in the implementation of one requirement	85-89
	The answer characterizes the ability to apply knowledge in practice, but has some inaccuracies in the implementation of the two requirements	80-84
	The answer characterizes the ability to apply knowledge in practice, but has some inaccuracies in the implementation of the three requirements	74-79
	The answer characterizes the ability to apply knowledge in practice, but has some inaccuracies in the implementation of the four requirements	70-73
	The answer characterizes the ability to apply knowledge in practice when performing tasks on the model	65-69

	Requirements for knowledge, skills, communication, autonomy and responsibility	Indicator evaluation
	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	
♦ clear and unambiguous communication of own conclusions, as well as knowledge and explanations that substantiate them, to specialists and non-specialists, in particular to students; ♦ use of foreign languages in professional activities	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; - - use of foreign languages in professional activities	95-100
	Sufficient clarity of the answer (report) and appropriate communication strategy with minor flaws	90-94
	Good clarity of the answer (report) and appropriate communication strategy (three requirements in total are not realized)	85-89
	Good clarity of response (report) and appropriate communication strategy (four requirements not implemented in total)	80-84
	Good comprehensibility of the answer (report) and appropriate communication strategy (five requirements in total are not fulfilled)	74-79
	Satisfactory clarity of response (report) and appropriate communication strategy (seven requirements not implemented in total)	70-73
	Satisfactory comprehensibility of the answer (report) and communication strategy with errors (a total of nine requirements are not implemented)	65-69
	Satisfactory comprehensibility 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	
♦ responsibility for the development of professional knowledge and practices, assessment of the strategic development of the team;	Excellent competence: - use of principles and methods of organizing team activities; - effective distribution of powers in the team structure; - maintaining a balanced relationship with team members (responsibility for the relationship); - stress resistance;	95-100

	Requirements for knowledge, skills, communication, autonomy and responsibility	Indicator evaluation
♦ ability to further study, which is largely autonomous and independent	- self-regulation; - work activity in extreme situations; - high level of personal attitude to the case; - mastery of all types of educational activities; - appropriate level of fundamental knowledge; - - the appropriate level of formation of general education-al skills and abilities	
	Confident mastery of the competencies of autonomy and responsibility with minor flaws	90-94
	Good mastery of autonomy and responsibility competencies (two requirements not met)	85-89
	Good mastery of autonomy and responsibility competencies (three requirements not met)	80-84
	Good mastery of autonomy and responsibility competencies (four requirements not met)	74-79
	Satisfactory mastery of autonomy and responsibility com-petencies (five requirements not met)	70-73
	Satisfactory ownership of autonomy and responsibility competencies (six requirements not met)	65-69
	Satisfactory mastery of autonomy and responsibility com-petencies (fragmentary level)	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 УИЛС-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 УИЛС-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 УИЛС-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 УИЛС-2, multimeter, oscilloscope
TFEE-5	Linear circuits of single-phase AC in steady state mode. Magnetically cou-pled linear circuits of single-phase current in steady state mode.	Study-research laboratory stand УИЛС-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 УИЛС-2, multimeter, oscilloscope
TFEE-7	Linear circuits of three-phase current	Study-research laboratory stand УИЛС-2,

	AC in steady state mode. A symmetrical three-phase source and asymmetrical load connected in delta and wye.	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 УІЛС-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 УІЛС-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 УІЛС-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 УІЛС-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 УІЛС-2, multimeter, oscilloscope
TFEE-15	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-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

Basic

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

Auxiliary.

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.

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