National Technical University of Ukraine
Igor Sikorsky Kyiv Polytechnic Institute "

Department of theoretical electrical engineering

THEORETICAL FOUNDATIONS OF ELECTRICAL ENGINEERING. PART 2. THREE-PHASE ELECTRICAL CIRCUITS AND TRANSIENT PROCESSES

Working program of the academic discipline (Syllabus)

Details of the academic discipline

Level of higher education	***First (undergraduate)***
Discipline	*14 "Electrical engineering"*
Specialty	*141 "Electric power engineering, electrical engineering and electromechanics"*
Educational program	*"ELECTROMECHANICAL AUTOMATION SYSTEMS, ELECTRIC DRIVES AND ELECTRIC MOBILITY", "ELECTRICAL MACHINES AND APPARATUS"*
Discipline status	*Language obligation (normative)*
Form of education	*daytime*
Year of training, semester	*2nd year, autumn semester*
Scope of the discipline	*5 ECTS credits /1 50 hours* *classroom hours - 72 hours:* *lectures – 36 hours; practices – 18 hours; laboratory work - 18 hours;* *independent work - 7 8 hours*
Semester control/ control measures	*Exam/MKR, RGR*
Class schedule	*1 lecture (2 hours) once a week;* *1 practical session (2 hours) once every 2 weeks;* *1 laboratory work (4 hours) once every 2 weeks.*
Language of teaching	*Ukrainian*
Information about the head of the course / teachers	Lecturer: *Ph.D., Assoc . Lyudmila Yuriivna Spinul , 0503838643, e - mail : spinul 20@ gmail . com* *Practical* : *Ph.D. , Assoc. Lyudmila Yuriivna Spinul , 0503838643, e - mail : spinul 20@ gmail . com* Laboratory: academic degree, academic title, full name, contact information
Placement of the course	https://classroom.google.com/c/NjQ5Njg2NzY1NTcx?cjc=tddhqej

Curriculum discipline

1. Description of the educational discipline, its purpose, subject of study and learning outcomes

The program of the educational discipline "Theoretical foundations of electrical engineering. Part 2" was compiled in accordance with the educational and professional training program for a bachelor's degree in the field of knowledge 14 "Electrical engineering" in the specialty 141 "Electric power engineering, electrical engineering and electromechanics".

The goal of the educational discipline is the formation and consolidation of students the following competencies: **K01** . Ability to abstract thinking , analysis and synthesis , **K 02** . Ability apply knowledge in practical situations , **K05** . Ability to search , process and analyze information from various sources , **K06.** Ability identify , set and solve problems , **K07** . Ability work in a team , **K08** . Ability work autonomous , **K12**

. Ability solve practical tasks from involvement methods of mathematics, physics and electrical engineering .

The tasks of studying the discipline are:

- obtaining scientific knowledge on the theory of electric circuits and methods of their calculation;
- application of acquired knowledge in the study of special disciplines and their use in further practical activities in production;
- acquisition of skills in the ability to use electrotechnical terminology, symbols and electrical measuring devices.

The subject of the educational discipline is the laws of the theory of linear electric circuits, typical mathematical methods of analysis of electric circuits of alternating single-phase and three-phase currents.

Program learning outcomes for the formation and improvement of which the discipline is aimed at: PR05 Know the basics of electromagnetic field theory, methods of calculating electric circuits and be able to use them to solve practical problems in professional activity, **PR07** Carry out process analysis in electric power, electrotechnical and electromechanical equipment, relevant complexes and systems . **PR08** Choose and apply suitable methods for the analysis and synthesis of electromechanical and electric power systems with specified indicators.

2. Pre-requisites and post-requisites of the discipline (place in the structural and logical scheme of training according to the relevant educational program)

To successfully master the discipline, the student must possess the theoretical base of the disciplines "Higher Mathematics", "General Physics", "Theoretical Foundations of Electrical Engineering. Part 1". Discipline "Theoretical foundations of electrical engineering. Part 2" precedes the study of "Electric machines", " Electric drive ".

3. Content of the academic discipline

Chapter 3. Linear electrical circuits of periodic alternating current

Topic 3.1. Three-phase electric circuits and their calculations

Topic 3.2 . Electric circuits of non-sinusoidal periodic current

Chapter 4 . Calculation of transient processes in linear electric circuits

Topic 4.1. The classical method of calculating transient processes

Topic 4.2. Calculation of transient processes under the action of EMF of arbitrary form

Topic 4.3. Operator method of calculation of transient processes

Topic 4. 4 . Calculation of transient processes using the Duhamel integral

4. Educational materials and resources

Main information resources:

1. Painter V.S. Theoretical basics of electrical engineering: Textbook: – Lviv: Lviv Polytechnic Publishing House , 2018. – 416 p.
2. Matvienko M. P. Fundamentals of electrical engineering and electronics. Textbook. - K.: Lira-K Publishing House, 2017. - 504 p.
3. Khilov V.S. Theoretical foundations of electrical engineering: Dnipro: National Technical University "Dnipro Polytechnic", 2021. -433 p.
4. Karpov Yu.O. , Katsiv S.Sh. , Kuharchuk V.V. , Vedmitsky Yu.G. Theoretical foundations of electrical engineering. stable modes of linear electric circuits with concentrated and distributed parameters . Textbook . – Kherson: " Oldi -Plus+", 2019. – 326 p.

5. Panachevnyi B.I., Svergun Y.F. General electrical engineering . Textbook . - K.: "Caravela", 2018. - 296 p.

6. "Theoretical foundations of electrical engineering. Collection of problems: study guide" / incl . O.V. Koroshchenko , V.F. Dennyk , O.A. Zhuravel , etc.; according to general ed . O.V. Koroshchenko . -Donetsk, DVNZ " DonNTU ", 2012. -673 p.

7. Gurzhii A.M., Meshchaninov S.K., Nelga A.T., Spivak V.M. Electrical engineering and basics of electronics: Textbook. -Kyiv: Litera LTD, 2020. - 288 .

8. Distance course "Theoretical electrical engineering " https://classroom.google.com/c/NjQ5Njg2NzY1NTcx?cjc=tddhqej

Additional:

1. Educational and methodological manual "Methods of analysis of transient processes in linear and non-linear electric circuits" / incl . Chibelis V.I., Grudska V.P., Spinul L.Yu. - K.: NTUU "KPI". - 2018. -300 p.

2. Theoretical foundations of electrical engineering - 2: Laboratory practice [Electronic resource]: teaching . help for bachelor's degree holders in the educational program "Electrotechnical devices and electrotechnological complexes", "Non-traditional and renewable energy sources", "Electrical stations", "Electromechanical automation systems and electric drive", "Electrical machines and devices", "Electrical systems and networks", "Management, protection and automation of power systems" specialty 141 "Power engineering, electrical engineering and electromechanics" / M. P. Buryk , L. Yu. Spinul , V. Yu. Lobodzinskyi ; N. V. Belenok , Yu. M. Chunyak ; KPI named after Igor Sikorsky. – Electronic text data (1 file: 7.89 MB). – Kyiv: KPI named after Igor Sikorskyi, 2022. – 96 p. https://ela.kpi.ua/handle/123456789/48828 .

3. Theoretical foundations of electrical engineering. Part 2 [Electronic resource]: study guide for bachelor's degree holders in the educational programs "Electrical systems and networks", "Electrical stations" "Electrical machines and devices", "Control, protection and automation of power systems" "Electromechanical automation systems, electric drive and electric mobility ", "Electrotechnical devices and electrotechnological complexes" "Non-traditional and renewable energy sources" specialty 141 "Electric power, electrical engineering and electromechanics" / KPI named after Igor Sikorskyi; structure. : Spinul L.Yu., Buryk M.P., Lobodzinskyi V.Yu., Biletskyi O.O.. - Electronic text data (1 file: 3.51 MB). – Kyiv: KPI named after Igor Sikorskyi, 2022. – 166 p. https://ela.kpi.ua/handle/123456789/48889.

4. Theoretical fundamentals of electrical engineering . Linear network theory [Electronic resource] : tutorial for bachelor's degree programs for specialty "141 Electricity , electrical engineering and electromechanics " / Ju . V. Peretyatko , LY Spinul ; Igor Sikorsky Kyiv Polytechnic Institute . – Electronic text data (1 file: 759 KB). – Kyiv : Igor Sikorsky Kiev Polytechnic Institute , 2019. - 44 p. – https://ela.kpi.ua/handle/123456789/42066

5. Theoretical fundamentals of electrical engineering . Single phase AC circuits [Electronic resource] : tutorial for students doing Bachelor's degree programs in specialty "141 Electric Power Engineering , Electrical Engineering and Electromechanics " / Yuliia Peretyatko , Liudmyla Spinul , Maksym Shcherba ; Igor Sikorsky Kyiv Polytechnic Institute . – Electronic text data (1 file: 1.62 MB). – Kyiv : Igor Sikorsky Kyiv Polytechnic Institute , 2020. - 62 p. https://ela.kpi.ua/handle/123456789/42070

6. Theoretical fundamentals of electrical engineering . Part 1 [Electronic resource] : tutorial for students doing Bachelor's degree programs in specialty "141 Electric Power Engineering , Electrical Engineering and Electromechanics " / Yuliia Peretyatko , Liudmyla Spinul , Maksym Shcherba ; Igor Sikorsky Kyiv Polytechnic Institute . – Electronic text data (1 file: 2.79 MB). – Kyiv : Igor Sikorsky Kyiv Polytechnic Institute , 2021. – 137 p. https://ela.kpi.ua/handle/123456789/42069

Educational content

5. Methods of mastering an educational discipline (educational component)

Lecture classes

No s/p	*The name of the topic of the lecture and a list of main questions (list of didactic tools, links to information sources)*
Section 3. *LINEAR ELECTRIC CIRCUITS OF PERIODIC ALTERNATING CURRENT*	
1.	**Basic definitions and classification of multiphase systems. Calculation of a symmetrical three-phase circuit.** Basic definitions of multiphase systems. Time and vector diagrams of E.R.S. and the principle of operation of a three-phase synchronous generator. Calculation scheme for the phase of a symmetrical 3-phase circuit. Determination of currents and voltages in the calculation scheme and in all phases of the circuit. Calculation example. Combined vector diagram of currents and voltages of a symmetrical 3-phase circuit.
2	**Calculation of an asymmetric three-phase circuit.** Calculation of an asymmetric three-phase circuit with a known system of phase EMFs of the generator, with a known system of line voltages of the generator. Examples of calculations. Vector diagrams of currents and voltages .
3	**Powers of a three-phase circuit.** Complex power of a 3-phase generator with a known system of phase or line voltages . Measurement of the active power of a 3-phase circuit with one, two or three wattmeters.
4	**Rotating magnetic field.** Formation of a rotating magnetic field.
5	**The method of symmetrical components.** Symmetric components of a 3-phase system. Properties of a three-phase circuit in relation to symmetrical components. Supports of a symmetrical 3-phase circuit for direct, reverse and zero sequences; calculation schemes.
6	**The method of symmetrical components.** Calculation of a three-phase circuit by the method of symmetrical components for various types of asymmetry .
7	**Determination of instantaneous values of currents in a linear circuit with non-sinusoidal EMF.** Decomposition of a periodic non-sinusoidal EMF into a trigonometric Fourier series is . Calculation of instantaneous currents.
8	**Determination of effective values of currents in a linear circuit with a non-sinusoidal EMF. Powers of a non-sinusoidal current circuit and coefficients characterizing non-sinusoidal currents (voltages).** Determination of effective values of currents and voltages . Active, reactive and full power non-sinusoidal current. Distortion power. Coefficients characterizing non-sinusoidal currents (voltages). Influence of circuit parameters on the shape of current curves at non-sinusoidal voltages.
9	**Higher harmonics in a three-phase circuit.** Systems of direct, reverse and zero phase sequences in non-sinusoidal phase and line voltages and currents of a symmetrical three-phase circuit when connected in a star or triangle. Relationship between phase and line voltages and currents
Chapter 4. CALCULATION OF TRANSIENT PROCESSES IN LINEAR ELECTRICAL CIRCUITS.	
10	**Transitional, forced and free modes of the electric circuit.**

	Causes of transient processes. Laws of commutation. Initial conditions. Transitional, forced and free modes of the electric circuit.
1 1	**The sequence of calculating the transient process of an electric circuit by the classical method.** The procedure for calculating the transient process by the classical method. Transient processes in the *RL* circuit: characteristics of the free mode, turning on the circuit to constant and sinusoidal EMF.
1 2	**Transient processes in a circuit with one energy store.** Transient processes in *the R C* circuit: characteristics of the free mode, turning on the circuit with an uncharged capacitor to constant and sinusoidal EMF. Short circuit *R C* circuit.
1 3	**Capacitor discharge on circuit *R , L.*** Aperiodic capacitor discharge: equations for current and voltage on circuit elements, time graphs of current and voltage . Oscillating discharge of a capacitor: conditions for the occurrence of an oscillating discharge, equations for current and voltage on circuit elements, time graphs of current and voltage .
1 4	**Capacitor discharge on circuit *R , L.*** Limit aperiodic capacitor discharge: equations for current and voltage on circuit elements, time graphs of current and voltage . Turning on *the RL C* circuit to a source of constant emf. Peculiarities of the calculation of the transient process with an instantaneous change in the inductance or capacitance of the circuit.
1 5	**The direct Laplace transform and its main properties.** Operator representation of a function, its derivative and integral; image of the voltage on the inductance and capacitance with a known image of the current. Ohm's law and Kirchhoff's laws in operator form. Operating schemes.
1 6	**Calculation of the transient process in an electric circuit by the operator method.** Transition from images of currents to originals. Decomposition formula. The procedure for calculating the transient process by the operator method. **Transient and impulse characteristics of an electric circuit.** Single and pulsed single function. Transient characteristic of a circuit element, transient conductivity, impulse characteristic of a circuit with a series connection *R , L* and *R ,* C.
17	**Transient and impulse characteristics of an electric circuit.** Duhamel's integral . Use of Duhamel's integral when acting on an EMF circuit that has discontinuities.
18	**Calculation of the transient process in an electric circuit by the frequency method**

Practical classes

No. z/p	*Summary of the practical lesson*
Section 3. *LINEAR ELECTRIC CIRCUITS OF PERIODIC ALTERNATING CURRENT*	
1.	**Calculation of a symmetrical three-phase circuit when consumers are connected by a star and a triangle.**
2.	**Calculation of an asymmetric three-phase circuit when consumers are connected by star or triangle.** Calculation of an asymmetric three-phase circuit when consumers are connected by a star: a) with a neutral wire; b) without a neutral wire. Calculation of an asymmetric three-phase circuit when consumers are connected by a triangle. Construction of vector diagrams of voltages and currents.
3	**Calculation of an asymmetric three-phase circuit when consumers are connected by a star and a triangle.** Using the method of equivalent transformations to simplify a 3-phase circuit. Calculation of a simplified circuit and finding currents and voltages in the output circuit. Compilation of the power balance of a 3-phase circuit, construction of combined vector diagrams.
4	**Using the method of symmetrical components to calculate an asymmetrical three-phase circuit with a dynamic load.** Determination of symmetrical components of an asymmetrical stress system . Construction of calculation schemes for symmetrical components. Compilation of basic equations according to calculation schemes and additional equations under the condition of asymmetry . Determination of currents and voltages of symmetrical components and calculation of resulting currents and voltages . **MKR part 1**
Chapter 4. *CALCULATION OF TRANSIENT PROCESSES IN LINEAR ELECTRICAL CIRCUITS* .	
5	**Calculation of the transient process in a circuit with one energy storage device under the action of constant energy sources .** Calculation of stable modes before and after switching. Drawing up the characteristic equation of a circle and determining its roots. Calculation of initial conditions for currents and voltages . Finding solutions for free component currents and voltages and general solutions . Construction of time diagrams of transient currents and voltages .
6	**Calculation of the transient process in a circuit with one energy storage device with the simultaneous action of a constant source and a sinusoidal current source .** Peculiarities of the calculation of stable modes before and after switching with the simultaneous action of several sources with different time characteristics . Calculation of initial conditions and finding solutions for free components of currents and voltages . Compilation of general solutions for transient currents and voltages .
7	**Calculation of transient process in *RLC* energy circles under the influence of constant energy sources .** Calculation of stable modes before and after switching. Drawing up the characteristic equation of the circuit and determining its roots. Peculiarities of calculating initial conditions for currents and voltages in a circuit with two energy storage devices. Finding solutions for free components

	with real and complex conjugate roots. Recording of general solutions , construction of time graphs of transient currents and voltages .
8	**The operator method of calculating the transient process in a circuit with two energy storage devices.** Calculation of the steady state before switching and determination of independent initial conditions. Construction of operator calculation scheme. Formulation of equations for images of currents (voltages) and finding images of the required quantities. Finding the originals of currents (voltages).
9	**Calculation of the transient process when the circuit is connected to an EMF source of arbitrary shape. MKR part 2**

Laboratory work

No s/p	*Summary of laboratory work*
Section 3. LINEAR ELECTRIC CIRCUITS OF PERIODIC ALTERNATING CURRENT	
1	Study of a passive four-pole alternating current. Video: https://toe.fea.kpi.ua/laboratory_tasks_10.html
2	Study of a three-phase electric circuit when the source and consumer are connected by a star with a neutral wire. Video: https://toe.fea.kpi.ua/laboratory_tasks_10.html
3	Study of a three-phase electric circuit with a star connection of the source and consumer without a neutral wire. Video: https://toe.fea.kpi.ua/laboratory_tasks_10.html
4	Study of a resistive three-phase electric circuit when the consumer is connected by a triangle Video: https://toe.fea.kpi.ua/laboratory_tasks_10.html
5	Research of a resistive -reactive three-phase electric circuit when the consumer is connected by a triangle Video: https://toe.fea.kpi.ua/laboratory_tasks_10.html
Chapter 4. *CALCULATION OF TRANSIENT PROCESSES IN LINEAR ELECTRICAL CIRCUITS .*	
6	Study of transient process in *RC* circuit . Video: https://toe.fea.kpi.ua/laboratory_tasks_10.html
7	Study of the transient process in *the RL* circuit . Video: https://toe.fea.kpi.ua/laboratory_tasks_10.html
8	Study of the transient process in *the RL C* circuit . Video: https://toe.fea.kpi.ua/laboratory_tasks_10.html
9	***Protection works***

6. Student's independent work

No. z/p	Type of independent work	
1	Calculations based on primary data obtained in laboratory classes	15
2	Preparation for practical classes	9
3	Preparation for MKR	9
4	Preparation of RGR	15
5	Preparation for the exam	30

Policy and control

7. Policy of academic discipline (educational component)

The system of requirements that the teacher sets before the student:

- rules for attending classes: in accordance with Order 1-273 dated 14.09.2020, it is prohibited to evaluate the presence or absence of the winner at the classroom class, including the awarding of incentive or penalty points. According to the RSO of this discipline, points are awarded for the corresponding types of educational activity.
- rules of behavior in classes: the student has the opportunity to receive points for the appropriate types of educational activity in lectures, practical and laboratory classes, provided for by RSO disciplines. The use of means of communication to search for information on the teacher's Google Drive, on the Internet, in a distance course on the Sikorsky platform is carried out at the instruction of the teacher;
- laboratory work protection rules: laboratory work is protected individually.
- rules for the protection of individual tasks: the protection of calculation and graphic work in the discipline is carried out individually;
- rules for assigning incentive points: incentives are not included in the main scale of RSO, and their sum does not exceed 10% of the starting scale. Incentive points are awarded for participation in university and All-Ukrainian Olympiads in the discipline "Theoretical Basics of Electrical Engineering", participation in faculty and institute scientific conferences.
- policy of deadlines and rescheduling: untimely completion of RGR and untimely protection of laboratory works foresee a reduction of the maximum score for a certain type of activity to 75%. The minimum score does not change. If the student did not pass or did not appear at the MKR, his/her result is evaluated at 0 points. In this case, it is possible to write the MKR, but the maximum score for it will be 75% of the maximum. The rescheduling of the protection of laboratory works, RGR and MKR is not provided for;
- policy on academic integrity: the Code of Honor of the National Technical University of Ukraine "Kyiv Polytechnic Institute" https://kpi.ua/files/honorcode.pdf establishes general moral principles, rules of ethical behavior of individuals and provides a policy of academic integrity for persons working and studying at the university, which they should be guided by in their activities, including when studying and preparing control measures in the discipline "Theoretical foundations of electrical engineering-2"; Laboratory works, RGR and MKR, which do not meet the requirements of the current Regulation on the system of prevention of academic plagiarism in KPI named after Igor Sikorskyi, are rated at 0 points. In this case, the laboratory work or RGR can be redone with a change of option. The maximum score will be reduced by 30%.
- when using digital means of communication with the teacher (mobile communication, e-mail, correspondence on forums and social networks, etc.), it is necessary to observe generally accepted ethical norms, in particular, to be polite and limit communication to the working hours of the teacher.

8. Types of control and rating system for evaluating learning outcomes (RSO)

Current control : MKR, independent work in practical classes, laboratory work.
Calendar control : is carried out twice a semester as a monitoring of the current state of meeting the requirements of the syllabus .
Conditions for successful completion of the calendar control **:** at least 50% of points for the implementation of the curriculum of the discipline on the control date, which involves the performance and protection of laboratory work, the performance of independent work, MKR .

Semester control : exam
Conditions for admission to the semester control : a minimum positive grade for the MKR, enrollment in all laboratory work , a starting rating of at least 35 points .

WARNING! *Students who, at the time of the pre-exam consultation, have not passed the completed assignments are not allowed to take the main exam and are preparing for a retake.*

Table of correspondence of rating points to grades on the university scale:

Number of points	*Rating*
95-100	*Perfectly*
85-94	*Very good*
75-84	*Good*
65-74	*Satisfactorily*
60-64	*Enough*
Less than 60	*Unsatisfactorily*
Less than 30	*Not allowed*

The student's overall rating after the end of the semester consists of points obtained for:

- Completion of 3 independent works in practical classes;
- execution and protection of 8 laboratory works;
- implementation and protection of the RGR in two parts;
- implementation of the ICR in two parts.

No. z/p	Control measure	Max. point	How many	In total
1.	MKR	6	2	12
2.	Independent work	3	3	9
3.	RGR	7.5	2	15
5.	Laboratory work	3	8	24
6.	Exam	40	1	40
	TOGETHER			100

Independent work in practical classes

During the semester, the student performs three independent works on the topics: **" Calculation of three-phase electric circuits of sinusoidal current** ", **"Calculation of an electric circuit under the action of non-sinusoidal EMF",** " **Calculation of transient processes in a linear electric circuit ".**

Weight score – 3.

The maximum number of points for independent work is 9 points.

The minimum number of points for independent work is 9 points *60% = 5.4 points.

Evaluation criteria:

- correctness of calculations and neatness of registration (execution of the full volume of calculations and analysis of the correctness of the results, high-quality design of text and graphic material) - (0.9..1)*3 points;
- correctness of calculations and neatness of design (execution of the full volume of calculations with insignificant errors and partial explanations of individual stages of the solution, checking of the obtained results) (0.89..0.75)*3 points ;
- the correctness of the calculations and the neatness of the design (execution of the full amount of calculations with partial errors, lack of explanations of individual stages of the solution or verification of the obtained results) (0.74..0.6)*3 points ;

- correctness of calculations and neatness of registration (incomplete completion of the task) 0 .

Performance and protection of laboratory work

Weight score – 3.

The maximum number of points for all laboratory work is 3 points * 8 = 24 points.

The minimum number of points for laboratory work is 4 points * 8 * 60% = 19.2 points.

Rules for drawing up a protocol for laboratory work

the presence of a reporting protocol of the established model, which must include: a) a title page; b) purpose of work; c) progress of work; d) calculation formulas used in the performance of the work task; e) conclusions based on experimental data and graphs; e) correct and neat processing of the results of experiments (tables, drawings, electrical diagrams with the parameters of the elements must be presented in accordance with the rules of the EUKD and DSTU, and when drawing up the equations, the given order must be observed, namely: - formula in letter designations; - formula in numbers; - answer (all finite expressions for complexes should be given in algebraic and exponential forms); - units of measurement in the Si system

A student is allowed to defend laboratory work if he has issued a work protocol in accordance with the above rules.

Evaluation criteria:

Results issued in the form of a protocol:

- excellent preparation for laboratory work (availability of the protocol, knowledge of the purpose of the work, knowledge of the main theoretical provisions that are being tested), active participation in the implementation of research, correct and neat processing of the results of experiments - (0.9..1) * 1, 5 points
- good preparation for laboratory work, active teaching in conducting research, minor errors in processing the results of experiments - (0.89..0.75) * 1, 52 points
- satisfactory preparation for laboratory work, passive participation in research, significant errors in processing the results of experiments - (0.74..0.6) * 1.5 points;

Job protection:

- complete answers to control questions on the topic of the work - (0.9..1) * 1.5 points
- incomplete answers to control questions - (0.89..0.75) * 1.52 points
- partial answers to control questions or lack of answers to individual questions, provided that the general purpose of the work and the main stages of the research are understood - (0.74..0.6) * 1.52 points;
- incorrect answers to most control questions on the topic of the work - 0 points.

Individual semester assignment (SAM)

According to the working curriculum, each student performs calculation and graphic work. RGR consists of two parts : " Calculation of a complex electric circuit of direct current", " Calculation of a single-phase electric circuit of sinusoidal current".

The maximum number of points for each part of the RGR is 7.5 points, the minimum is 4.5 points.

The final grade for the RGR consists of the points received for the preparation of the work and its defense.

Evaluation criteria:

Completed work results:

- correct execution of calculations with a full explanation, verification of solution results, correct construction of the diagrams (graphs) indicated in the condition – (0.9..1) * (3.25) points;
- correct execution of calculations with a partial explanation, verification of the obtained results, insignificant errors in calculations and construction of diagrams (graphs) - (0.89..0.75) * (3.25) points;
- correct execution of calculations with an incomplete explanation, errors in solving and constructing diagrams (graphs), lack of verification of the obtained results - (0.74..0.6) * (3.25) points;
- performance of work with fundamental errors or absence of a significant part of it, absence of diagrams (graphs) specified in the condition - 0 points.

Job protection:

- complete answers to the questions regarding the stages of work execution - (0.9..1) *(3.25) points;
- incomplete answers to questions about the stages of work performance - (0.89..0.75) * (3.25) points;
- lack of answers to individual questions regarding the stages of work performance, provided that the general purpose and main stages of performance are understood - (0.74..0.6) * (3.25) points;
- lack of answers to most questions regarding the stages of work performance, lack of understanding of its general purpose - 0 points.

Modular control work

The modular control work consists of two parts: **" Calculation of three-phase electric circuits of sinusoidal current** ", " **Calculation of transient processes in a linear electric circuit ",** respectively.

The weighted score of each part of the MKR is 6 points.

The maximum score for MKR is 2 *6=12 points, the minimum is 7.2 points.

Evaluation criteria

- - correct execution of calculations with a full explanation, checking the results of the solution, building the diagrams specified in the condition - (0.9.. 1)*6 points;
- - correct execution of calculations with incomplete explanation , verification of the obtained results, construction of the diagrams specified in the condition - (0.89.. 0.75)* 6 points;
- - correct execution of calculations, absence explanations , lack of verification of the obtained results and the diagrams indicated in the condition - (0.74..0.6)*6 - points;
- - performing calculations with errors - 0 .

Calendar control is based on the current rating. A condition for a positive assessment is the value of the student's current rating of at least 50% of the maximum possible at the time of assessment.

9. Additional information on the discipline (educational component)

List of questions submitted for semester control (as Appendix 1 to the syllabus)

Working program of the academic discipline (syllabus):

Folded associate professor of the Department of Theoretical Electrical Engineering of the FEA, Ph.D. , Assoc. Spinul L.Yu.

Approved by the Department of Theoretical Electrical Engineering of the FEA (protocol No. 15 dated June 19, 2024)

Agreed by the Methodical Commission of the faculty [1](protocol No. 10 of June 20, 2024)