National Technical University of Ukraine
Igor Sikorsky Kyiv Polytechnic Institute "

Department of electrical networks and systems

ELECTRICAL NETWORKS and SYSTEMS

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 drive and electric mobility.*
Discipline status	*Normative educational components. Cycle of general training.*
Form of education	*daytime*
Year of training, semester	*III year, spring semester*
Scope of the discipline	*1 50 hours / 5 ECTS credits*
Semester control/ control measures	*Exam/MCR, RR*
Class schedule	*http://rozklad.kpi.ua*
Language of teaching	*Ukrainian*
Information about the head of the course / teachers	Lecturer: *senior teacher Yankovska O.M.* *Laboratory* classes: *Ph.D. , Senior Lecturer V.A. Khalikov , assistant Mossakovsky V.I.*
Placement of the course	https://classroom.google.com/c/MjYzNTU2MzEzNDgy?cjc=2c5mhmr

Program academic discipline

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

The syllabus of the study discipline " Electrical systems and networks " is compiled in accordance with the educational program of bachelors " Electromechanical systems of automation, electric drive and electromobility ", " Electric machines and devices " specialty 141 - Electric power, electrical engineering and electromechanics.

The purpose of the educational discipline *there is the formation and consolidation of students' general competencies: : (Z K01) Ability to abstract thinking, analysis and synthesis; (ZK07) Ability to work in a team; professional competences: (FK03). The ability to solve complex specialized tasks and practical problems related to the operation of electrical systems and networks, the electrical part of stations and substations, and high- voltage equipment ; (FK06) Ability to solve complex specialized problems and practical problems related to problems of production, transmission and distribution of electric energy; (FK09). Awareness of the need to improve efficiency electric power, electrotechnical and electromechanical equipment; (F K11). Operational ability to take effective measures in emergency (emergency) situations in electric power and electromechanical systems.*

The subject of the educational discipline *is production, transmission, distribution, consumption of electric energy , calculation of operating modes of electric networks, parameters of elements of substitution schemes.*

Program learning outcomes: (*PRN01) Know and understand the principles of operation of electrical systems and networks, power equipment of electrical stations and substations, protective grounding and lightning protection devices and be able to use them to solve practical problems in professional activities; (PR N07) To analyze processes in electric power, electrotechnical and electromechanical equipment, relevant complexes and systems; (PRN09) Be able to evaluate the energy efficiency and reliability of electric power, electrotechnical and electromechanical systems; (PRN17) Solve complex specialized*

problems in the design and maintenance of electromechanical systems, electrical equipment of power stations, substations, systems and networks; (PRN19) Apply suitable empirical and theoretical methods to reduce losses of electrical energy during its production, transportation, distribution and use.

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 educational components "Theoretical foundations of electrical engineering", "Electric machines", "Electrical part of stations and substations". Competencies, knowledge and skills acquired during the study of the educational component are necessary for further study of the educational components "Relay protection and automation of power systems", as well as "Pre-diploma practice" and "Diploma design ".

3. **Content of the academic discipline**

Chapter 1. General information about energy systems.
Topic 1.1. Energy systems and their structure
Chapter 2. Sources power supply in energy systems
Topic 2.1 Traditional electric stations
Topic 2.2. Non-traditional electrical stations and installations
Chapter 3 Consumers of electric energy
Topic 3 . 1 . System characteristics of consumers electricity
Section 4. Electrical networks
Topic 4.1. Purpose and *classification of* electrical networks
Topic 4 . 2 . *Modes of operation of the neutral of electrical networks.*
Topic 4.3. *Basic information about aerial power transmission*
Topic 4.4. *Structural elements of overhead lines power transmission*
Topic 4.5. *Basic information about cable power transmission lines*
Topic 4.6. *Structures of cables of power transmission lines*
Section 5. Substitution schemes and parameters of electrical network elements.
Topic 5.1. *Schemes of replacing elements of electrical networks*
Topic 5.2. *Longitudinal parameters of power transmission line replacement schemes*
Topic 5.3. *Transversal parameters of power transmission line substitution schemes.*
Topic 5.4. Parameters of substitution schemes of two-winding power transformers.
Topic 5.5. Replacement schemes of three-winding power transformers.
Topic 5.6. Schemes *of replacement of power transformers with shortened and split windings, autotransformers.*
Section 6. Operating modes of electrical networks and systems
Topic 6.1. General concepts about the operation modes of the electric power system.
Topic 6.2. The power of a three-phase alternating current system. Active power. Full power.
Topic 6.3. General characteristics of power losses in electrical networks.
Topic 6.4. Energy losses in electrical networks.
Topic 6.5. Calculation of substation and power plant loads on high voltage buses.
Topic 6.6. Calculation of the voltage regime in the electrical network according to the conditions of the beginning and end of power transmission.
Topic 6.7. Determination of voltage on sections of the network diagram in electrical engineering calculations.
Topic 6. 8. Algorithm for calculating the mode of operation of an open network circuit.
Topic 6.9. Balancing points of settlement schemes.
Topic 6.10 ***.*** *Analysis of methods for calculating modes of closed electrical networks.*
Topic 6.11. Calculation of the steady mode of operation of the network by the method of contour equations

4. Educational materials and resources

Main information resources:

1. *Kyryk, V. V. Electric networks. Textbook [Electronic resource]: a textbook for bachelor's degree holders in specialty 141 "Electroenergetics, electrical engineering and electromechanics" / V. V. Kyryk; KPI named after Igor Sikorsky. - Electronic text data (1 file: 5.84 MB). - Kyiv: KPI named after Igor Sikorskyi, 2024. - 281 p.*
2. *Kyryk V. V. Electrical systems and networks. Modes of operation of open networks [Text]: Study guide/ Comp. V.V. Kyryk .-K.: NTUU "KPI", 2014.-130p.*
3. *Kyryk V. V. Electric networks and systems. Operating modes of open networks. = Electrical power networks and systems . Operation modes of open networks : training Manual ./ V.V. Kyryk, T.B. Maslova. - Kyiv: NTUU "KPI", 2015. - 256p. – ISBN 978-966-622-737-2*
4. *Kyryk V. V. Electric networks and systems: textbook / V. V. Kyryk. – Kyiv: KPI named after Igor Sikorskyi, Polytechnic Publishing House, 2021. – 324 p. – ISBN 978-966-990-031-9*
5. *Kyryk, V. V. Electric networks and systems. Laboratory practicum [Electronic resource]: teacher . help for bachelor's degree holders in the "Electrical Systems and Networks" educational program, specialty 141 "Electroenergetics, electrical engineering and electromechanics" / V. V. Kyryk, V. A. Khalikov , V. I. Mossakovskii ; KPI named after Igor Sikorsky. – Electronic text data (1 file: 2.18 MB). – Kyiv: KPI named after Igor Sikorskyi, 2022. – 31 p.*
6. *Electrical networks and systems. Calculation and graphic work [Electronic resource]: teacher . help for bachelor's degree holders in the educational program "Electrical systems and networks" specialty 141 "Electric power, electrical engineering and electromechanics" / KPI named after Igor Sikorskyi; structure. V. V. Kyryk. – Electronic text data (1 file: 754.58 Kbytes). – Kyiv: KPI named after Igor Sikorskyi, 2022. – 23 p.*
7. *Katsadze T.L., Kyryk V.V. Calculation and analysis of stable modes of electric power systems: Study guide for students of all forms of education and foreign students of specialty 141 "Electric power, electrical engineering and electromechanics" - Kyiv: KPI named after Igor Sikorskyi, 2018.*
8. *Electrical networks and systems [Electronic resource] : R computational and graphic work for studies specialty 141 "Electric power engineering, electrical engineering and electromechanics", educational program "Electrical systems and networks" / KPI named after Igor Sikorskyi; compiled by: V. V. Kyryk – Electronic text data (1 file: 0.395 MB). – Kyiv: KPI named after Igor Sikorskyi, 2022. – 23 p.*
9. *Electric networks [Electronic resource] : A collection of test tasks for the MKR for execution . modular control work for studies specialty 141 "Electric power, electrical engineering and electromechanics", educational program "Electrical systems and networks" / KPI named after Igor Sikorskyi; compiled by: V. V. Kyryk – Electronic text data (1 file: 0.587 MB). – Kyiv: KPI named after Igor Sikorskyi, 2022. – 4 2 p.*
10. *Electrical systems and networks: Laboratory practicum [Electronic resource]: training . help for studies specialties 141 "Electroenergetics, electrical engineering and electromechanics" / KPI named after Igor Sikorskyi; comp.: V.V. Kirik, S.V. Kazanskyi, T.L. Katsadze , O.B. Bessarabian – Kyiv: KPI named after Igor Sikorskyi, 2018. – 92 p.*
11. *Szegeda . Electrical systems and networks: Textbook / M. S. Szegeda . - Lviv: Publishing House of the National University "Lviv Polytechnic", 2007. - 488 p. – ISBN 978-966-553-602-*

Supporting literature :

1. *Malogulko Y.V., Burykin O.B., Katsadze T.L., Netrebskyi V.V. under the editorship Lezhnyuk P.D. Electrical systems and networks. Part 1: Study guide - Vinnytsia: VNTU, 2020.-206 p.*
2. *Sarma MS Power Quality : VAR Compensation in Power Systems / SR Vedam , MS Sarma , - CRS Press , 2008.-304 p.*
3. *Davydenko V.A. Methodical instructions for the performance of individual tasks in the educational discipline "Electrical systems and networks" - Rivne: NUVHP, 2017.*
4. *Kuchyn V.V. Electrical networks and systems. Operating modes of open networks: Training manual - Kyiv: Polytechnic Publishing House, 2014.*

5. *GrigsbyL.L.Power systems / L. L. Grigsby . - CRC Press , 2007. - 452 pp . – ISBN 978-0-8493-9288-7.*
6. *Dale R. Electrical power systems technology / Dale R. Patrick , Stephen W. Fardo . – The Fairmont Press , 2009. – 486 pp . - ISBN 0-88173-585-X.*

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 (a list of didactic tools, references to the literature and tasks on the SRS)*
1.	*Topic 1.1. Energy systems and their structure.* *Basic questions: basic concepts and definitions. United energy systems (UES). Technical and economic substantiation of the feasibility of creating a UES. UES of Ukraine and its connections with power systems of Russia and Eastern Europe. OES abroad. Prospects and main problems of development and operation of energy systems.* *Literature [1], [4]*
2.	*Topic 2.1 Traditional electric stations* *Main issues: traditional thermal electric power stations on organic fuel: steam turbine (condensing and heating), gas turbine, steam gas, diesel. Analysis of technological schemes of electricity production, technical, economic and environmental characteristics. Prospects for the development of thermal stations.* *Power stations on nuclear fuel (NPP). NPP on thermal and fast neutrons. Analysis of NPP technological schemes, technical, economic and environmental characteristics. Prospects of NPP development. Hydraulic power plants (TES and GAES). Dam and derivative hydropower plants . HPP in energy systems. Analysis of technological schemes and modes of operation of hydroelectric power stations and hydroelectric power stations. Technical and economic, ecological characteristics and development prospects.* *Literature [1], [2], [4]*
3.	*Topic 2.2. Non-traditional electrical stations and installations.* *Main issues: solar thermodynamic stations and semiconductor installations for direct conversion of solar energy into electricity. Wind, geothermal.* *Marine electrical stations and installations. Wave, surf and thermal installations. Direct conversion of thermal energy into electrical energy. Stations with MHD - generators.* *Analysis of electricity generation technology, technical, economic and environmental characteristics, as well as identification of the possibility, efficiency and prospects of working in the power systems of electrical stations and installations with non-traditional means of electricity generation.* *Literature [1], [2], [4]*
4.	*Topic 3 . 1 . System characteristics of consumers electricity* *Main issues: Classification of consumers. Categories of consumers. Characteristics and requirements for electricity supply to consumers of various categories.* *Consumer load schedules and their analysis. Definition of graph zones and calculation of indicators. The participation of power plants of various types in the coverage of load schedules.* *Literature [[1], [2], [4]*
5.	*Topic 4.1. Purpose and classification of electrical networks* *The main ones question : AC and DC power supply.* *Requirements for electrical networks. Quality of electrical energy.* *Classification by type of current, configuration, nominal voltage, purpose.* *Literature: [1], [2], [3], [4] , [7]*

6.	*Topic 4 . 3 . Modes of operation of the neutral of electrical networks.* *The main ones question : Modes of operation of the neutral of the electric network up to 1000 V.* *Methods of grounding the neutral of the power transformer. Features of functioning. Modes of operation of the neutral of high-voltage networks.* *Methods of grounding the neutral of the power transformer. Features of functioning* *Literature : [1], [2], [4], [7]*
7	*Topic 4.3. Basic information about aerial power transmission* *Basic questions: Basic definitions. Constructive performance. Overall dimensions. fly by Single- and double-circuit power lines. Lines with split phases. The main structural elements of the lines.* *Literature: [1], [2], [4], [7]*
8	*Topic 4.4. Structural elements of overhead lines power transmission* *Main questions: Wires and cables of PL, their purpose, structural and electrical characteristics. Brands of wires and cables. Supports Special types of supports. Structures of supports for lines of different voltages . Insulation. Pin and hanging insulation. Fittings PL. Overhead lines x shielded wires. Literature: [1], [2], [4], [7]*
9.	*Topic 4.5. Basic information about cable power transmission lines* *Main issues: Cable power transmission lines of different voltage classes* *Cable networks. Cable couplings. Cable structures.* *Literature: [1], [2], [3], [4]*
10	*Topic 4.6. Structures of cables of power transmission lines* *Main issues: Cable constructions, cable types, insulation, characteristics. Brands of wires, cables and cords. Laying of cables of different voltage classes* *Power lines and wiring.* *Literature: [1], [2], [3], [4]*
11	*Topic 5.1. Schemes of replacing elements of electrical networks* *The main ones question : Use of substitution schemes for network elements in phase coordinates and symmetrical components. Longitudinal and transverse elements.* *Literature: [1], [2], [4], [6]*
12	*Topic 5.2. Longitudinal parameters of power line replacement schemes* *Main questions: Active resistance of the power transmission line . Inductive resistance of the power transmission line . Physical content, calculation of resistance, influence of construction on parameters.* *Literature: [1], [2], [4], [6]*
13	*Topic 5.3. Transversal parameters of power line replacement schemes.* *Main questions: Active transverse conduction of the power transmission line . Capacitive transversal conduction of the power transmission line* *Physical content, influence of construction on parameters.* *Literature: [1], [2], [4], [6]*
1 4	*Topic 5.4. Parameters of replacement schemes of two-winding power transformers Main questions: Schemes of displacement, transverse and longitudinal elements, their calculation* *Literature: [1], [3], [4]*
15	*Topic 5.5. Replacement schemes of three-winding power transformers.* *The main ones question : Schemes of displacement, transverse and longitudinal elements, their calculation. Peculiarities of tests of non-working operation and short circuit.* *Literature: [1], [2], [4], [6]*
16	*Topic 5.6. Schemes of replacement of power transformers with shortened and split windings, autotransformers.*

	The main ones question : Schemes of displacement, transverse and longitudinal elements, their calculation. Peculiarities of tests of non-working operation and short circuit. *Literature: [1], [2], [4], [6]*
17	*Topic 6.1 General notions of power system operation modes* *Main questions: Parameters of power system modes. Types of transient modes: electromagnetic transient modes; electromechanical transient modes; long transient modes. Symmetric, asymmetric, sinusoidal and non-sinusoidal modes. Requirements for modes of electric power systems. Approaches to the classification of regimes. Normal established mode, normal transitional mode, emergency transitional mode, post-emergency established mode, repair established mode.* *Literature: [1], [2], [4], [7], [9]*
18	*Topic 6.2 Power of a three-phase alternating current system.* *Main issues: Active power. Full power. Features of determining the total and reactive power of the alternating current system. Sources of active power in electrical networks and systems. Sources of reactive power in electrical networks and systems.* *Literature: [1], [3], [4], [7], [9]*
19.	*Topic 6.3 General characteristics of power losses in electrical networks.* *Main issues: Characteristics of power losses in electrical networks. Determination of power losses in power transmission lines .* *Determination of power losses in power transformers and autotransformers.* *Literature: [1], [3], [4], [7], [9]*
20.	*Topic 6.4. Energy losses in electrical networks.* *Main issues: Determination of energy losses in electrical networks. Quadratic load graphs. Time of maximum losses.* *Literature: [1], [3], [4], [7], [9]*
21.	*Topic 6.5. Calculation of substation and power plant loads on high voltage buses* *Main issues: Calculated load of the substation. The reduced load of the substation. Reduced load of the power plant. The calculated load of the power plant. Losses of active (reactive power) in transverse conductances two- or three-winding transformers.* *Literature: [1], [3], [4], [7], [9]*
22.	*Topic 6.6. Calculation of the voltage regime in the electrical network according to the conditions of the beginning and end of power transmission* *Main questions: Powers of beginnings, ends and average linear power of sections of the electrical network. Determination of power flows in sections of the network diagram. Calculation of the voltage regime in the electrical network according to the conditions of the beginning and end of power transmission.* *Literature: [1], [4], [7]*
2 3	*Topic 6.7. Determination of voltage on sections of the network diagram in electrical engineering calculations* *Main questions: Calculation of voltage at network points. Voltage drops and losses. Longitudinal and transverse components of voltage drop. Calculation of voltage losses in various schemes of open networks. Comparison of the methods of determining the network voltage regime under different initial conditions: according to the operating current of the power transmission (according to Kirchhoff's and Ohm's second laws); voltage and power flow at the beginning and end of the section.* *Literature: [1], [4], [7]*
24	*Topic 6.8. Algorithm for calculating the mode of operation of an open network circuit* *Main questions: Sequences of procedures for calculating the mode of operation of the electric network scheme. Graph -analytic notation of flow distribution parameters on the network diagram. Designation on the flow distribution scheme when using average line capacities. The*

	main stages of the approximate calculation of the stable modes of electric networks operating according to an open circuit. The main assumption in the approximate calculation of power losses in the longitudinal resistances of the replacement scheme of the open electrical network. Literature: [1], [2], [4], [7]
25	*Topic 6.9. Balancing points of settlement schemes* *Main issues: Balance and reserve of active and reactive capacities in energy systems. Selection of balancing points (BP) of the system. Principles of selection of balancing points in low-voltage consumer networks. Technical limitations that are imposed on BP.* *Literature: [1] [7]*
26	*Topic 6.10 . Analysis of methods for calculating modes of closed electrical networks.* *Main questions: Advantages and disadvantages of complex networks. Calculation of the steady state of ring networks. Definition of homogeneous networks. Calculation of the mode of operation of the power transmission line with two-way power. Determination of current separation and flow separation points . Non-coincidence of flow separation points by active and reactive powers .* *Literature: [1], [2], [4], [7]*
27	*Topic 6.11. Calculation of the steady mode of operation of the network by the method of contour equations* *Main questions: Method of contour equations. Principles of construction of systems of contour equations. The resulting flow distribution capacities by the method of contour equations.* *Literature: [1], [2], [4], [7]*

Laboratory classes:

No. z/p	*List of laboratory works*
1	*Modes of operation of neutrals of electrical networks*
2	*Research of grounding devices*
3	*Study of the daily power system load schedule and its coverage*
4	*Construction and heating of power cables*
5	*Calculations of stable modes of simple closed electrical networks*
6	*Research of devices for finding places of damage at K.3. in case of damage to the 6-750 kV PL*
7	*Switching equipment of power supply systems 0.4 kV*
8	*Protection and commutation of electric motors*
9	*Relay devices in power supply systems*

6. Student's independent work

No. z/p	*Type of independent work*	*Number hours of SRS*
1	*Preparation for lectures*	*18*
2	*Preparation and execution of MKR*	*6*
3	*Preparation and implementation of RR*	*6*
4	*Preparation for laboratory work*	*18*
5	*Preparation for the exam*	*30*
	EVERYTHING	*78*

Policy and control

7. Policy of academic discipline (educational component)

The system of requirements that the teacher sets for the student/graduate student:

- *rules for attending classes: the presence or absence of the student in a classroom class, including the awarding of incentive or penalty points, is not evaluated by the teacher in accordance with Order 1-273 dated 09/14/2020. Points are awarded for educational activity in lecture classes in accordance with the RSO of this discipline ;*
- *rules of behavior in classes: it is allowed and welcomed to demonstrate the student's educational activity in lecture classes in order to determine certain levels of mastery of the material. 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 on the condition that the teacher instructs;*
- *rules for assigning incentive and penalty points: incentive and penalty points 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 faculty and institute olympiads in the discipline, scientific conferences, and for preparing reviews of scientific papers and articles. Penalty points are awarded for improper completion of an individual semester assignment - MKR. Timely completion of the modular control work is a necessary condition for admission to the exam;*
- *policy of deadlines and rescheduling: if a student did not pass or did not appear at the MKR, his result is evaluated at 0 points. Recompilation of MKR results 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 "Electrical networks and systems";*
- *the use of digital means of communication with the teacher (mobile communication, e-mail, correspondence on forums and social networks, etc.) requires compliance with 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 *: express survey at lectures, MKR, RR, performance of laboratory work.*
Calendar control *: is carried out twice a semester as a monitoring of the current state of meeting the requirements of the syllabus .*
Semester control: *exam.*
Conditions for admission to semester control *: completed and protected laboratory work, semester rating of more than 30 points.*
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:

- *express survey during lectures;*

- *performance and protection of laboratory work;*
- *implementation calculation work (RR);*
- *execution of modular control work (MCR);*
- *performance of examination control work.*

Express survey during lectures	*Laboratory work*	*RR*	*MKR*	*Exam*
5	*27*	*8*	*20*	*40*

Answers during express surveys at lectures and lecture classes

Weight score 5.

Modular control work

***The weighted score is* 20 .**

The modular control work is performed by students to determine the level of knowledge and consists of two parts:

according to sections 1-4 - weighted score is 10 points

according to section 6 - the weighted score is 10 points.

Evaluation criteria for modular test work:

MKR evaluation criteria

- *complete answer to all questions (more than 90% of the material) - coefficient 0.9 -1;*
- *incomplete answer to all questions (from 60 to 90% of the material) - 0.6-0.9;*
- *the answer contains less than 60% of the necessary information - 0 points.*

Retaking the MKR and taking it in unspecified terms is counted with a factor of 0.5.

Calculation work

Weight score – 8 .

Calculation work is performed by students according to section 5,

Evaluation criteria RR

- error-free performance with a high level of completeness of the presentation of the material and design of the text part in accordance with DSTU 3008-2015 - 8 points

- generally correct execution of the control work with minor shortcomings in calculations and/or after instructional assistance with shortcomings in the design of the text part - 6 points;

- incomplete execution of the control work with gross errors subject to processing and/or the design does not meet the requirements of DSTU 3008-2015; - 4 points;

- the work is not credited (the task was completed incorrectly, or the work was not submitted, or plagiarism was detected) 0 points.

-1 penalty point is charged for each week of delay in submitting the DKR. Handing in work outside the semester is counted with a factor of 0.5.

Completion of the RR is a mandatory condition for admission to the exam.

Laboratory work

Weight score 27.

Evaluation criteria

- *full performance of the work (more than 90% of the material) - coefficient 0.9-1;*
- *incomplete performance of the work (from 60 to 90% of the material) - 0.6-0.9;*
- *performance of the work contains less than 60% of the necessary information - 0 points.*

-1 penalty point is charged for each week of delay in handing in work. Handing in work outside the semester is counted with a factor of 0.5.

Completion and defense of all laboratory work is a mandatory condition for admission to the exam.

Calendar control is based on the current rating. The condition of positive attestation is the value of the current rating of the applicant at least 60% of the maximum possible at the time of attestation.

Additional (bonus) points

The rating system provides additional points, which are awarded for active work in lectures , answering questions and/or creative work . One student cannot receive more than 6 bonus points in a semester.

The form of semester control is an exam

The maximum number of points for work in the semester is 60. A necessary condition for admission to the exam is the performance and defense of laboratory work, a modular control work (which consists of two parts), a calculation work, a semester rating of at least 30 points.

At the exam, students perform a written examination test. Each task of the examination control paper contains two components: theoretical and practical. The theoretical component is aimed at checking the students' knowledge acquired as a result of studying the educational component in the form of two theoretical questions, the weighting point of the theoretical component is 30 points, the weighting point of each question is 15 points. Practical component aimed at testing the ability to solve complex specialized tasks and practical problems related to the operation of electrical systems and networks , using the acquired knowledge, the weighted score is 10 points .

Evaluation criteria of the theoretical component

The theoretical question is assessed at 15 points according to the following criteria:

- complete answer (at least 90% of the required information) - 13-15 points;

- complete answer (at least 75% of the required information) with minor inaccuracies – 11-13 points;

- "satisfactory", incomplete answer (at least 60% of the required information) - 9-11 points;

- "unsatisfactory", an unsatisfactory answer (does not meet the requirements for "sufficient") - 0 points.

Evaluation criteria of the practical component

A practical question is evaluated at 10 points according to the following criteria:

- complete, error-free solution of the problem with explanations – 9-10 points;

- solving the problem with minor inaccuracies – 6-8 points;

- the problem is not fully solved and/or with errors - 4-5 points;

- the problem was solved incorrectly or not solved - 0

Working program of the academic discipline (syllabus):

Folded *senior lecturer of the Department of Electrical Networks and Systems, Assoc. Bogomolova. O.S.*

Approved *Department of EMC (protocol No. from*

Agreed *Methodical commission of the faculty (protocol No from)*