

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
Federal State Autonomous Educational Institution for Higher Education

«North-Caucasus Federal University»

APPROVED BY

Dean of FPE of NCFU

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ASSESSMENT TOOLS
FOR THE STATE FINAL ATTESTATION

Field of study:	13.04.02 "Electric Power Engineering and Electrical Engineering"
Specialization (Profile)	Training Program of Electrical Engineering
Mode of study:	Full-time
Academic plan:	2026

Stavropol 2026

Foreword

1. The assessment tools for the State Final Assessment are designed to assess the level of competency formation of master's students in the field of study 13.04.02 "Electric Power Engineering and Electrical Engineering" during the State Final Assessment, which includes a state comprehensive examination and the defense of the final qualifying work.

2. The assessment tools for the final assessment are compiled on the basis of the SFA Program in the field of study 13.04.02 "Electric Power Engineering and Electrical Engineering" in accordance with the educational program in the field of study 13.04.02 "Electric Power Engineering and Electrical Engineering."

3. Developers: Kononov Yu.G., Head of the Department of Automated Electric Power Systems and Power Supply; Kostyukov D.A., Senior Lecturer of the Department of Automated Electric Power Systems and Power Supply; Martusenko V.E., Senior Lecturer of the Department of Automated Electric Power Systems and Power Supply.

4. The assessment tools have been reviewed and approved at a meeting of the Department of Automated Electric Power Systems and Power Supply.

5. Expert review of the assessment tools has been conducted. Members of the expert group that conducted the internal review:

Chairperson: Kononov Yu.G., Head of the Department of Automated Electric Power Systems and Power Supply

Members of the expert group:
Morozova T.F., Associate Professor of the Department of Automated Electric Power Systems and Power Supply
Petrov A.V., Associate Professor of the Department of Automated Electric Power Systems and Power Supply
Demin M.S., Associate Professor of the Department of Automated Electric Power Systems and Power Supply

6. The validity period of the assessment tools is 2 years.

1. List of Competencies to Be Mastered by Students as a Result of Completing the Educational Program

Competency Code	Formulation
UC-1	Capable of conducting critical analysis of problem situations based on a systems approach and developing an action strategy
UC-2	Capable of managing a project at all stages of its life cycle
UC-3	Capable of organising and leading a team, developing a team strategy to achieve the set objective
UC-4	Capable of applying modern communication technologies, including in foreign language(s), for academic and professional interaction
UC-5	Capable of analysing and accounting for cultural diversity in the process of intercultural interaction
UC-6	Capable of identifying and realising the priorities of one's own activities and ways of improving them based on self-assessment
GPC-1	Capable of formulating research objectives and tasks, identifying task-solving priorities, and selecting evaluation criteria
GPC-2	Capable of applying modern research methods, evaluating and presenting the results of completed work
PC-1	Capable of participating in research and development activities in the field of electrical power engineering
PC-2	Capable of participating in the design of objects of professional activity
PC-3	Capable of managing the power system operating mode of an electrical power supply system using digital technologies

2. Passport of the Assessment Tools for Conducting Final (State Final) Assessment

№	Module, Section	Controlled Competencies	Assessment tools	
			Type of Assessment Tool	Number of Assignment Variants
1	State Final Attestation	UC-1 UC-2 UC-3 UC-4 UC-5 UC-6 GPC-1 GPC-2 PC-1 PC-2 PC-3	Examination tickets; Individual assignments for the completion of the FQW	21; 20

3. Description of Indicators and Criteria for Assessing Competencies, as well as Assessment Scales

3.1 Description of Indicators

Competency Code	Levels of Competency Formation	Indicators	Descriptors			
			2 points	3 points	4 points	5 points
UC-1	Basic	Know about the connection of the discipline with other disciplines studied; about the history of the development of electric power engineering.;	Can formulate contemporary problems of electric power engineering and electrical engineering	Formulates connections between the disciplines being studied	Knows the connections between the disciplines being studied, the history of the development of electric power engineering	

		Be able to use the acquired knowledge in mastering the educational material of subsequent disciplines.	Is able to select literature	Is able to find the required information	Is able to partially use the acquired knowledge in mastering the educational material of subsequent disciplines	
		Possess skills in preparing abstracts (reviews) on various issues of science, engineering, and technology	The prepared abstract contains material from 1–2 sources	The prepared abstract contains material from 3–5 sources, the material is not systematized	The prepared abstract contains material from 6–10 modern sources, the material is systematized	
	Advanced	Know about the connection of the discipline with other disciplines studied; about the history of the development of electric power engineering;				Knows the connections between the disciplines studied, the history of the development of electric power engineering, and contemporary problems of electric power engineering
		Be able to use the acquired knowledge in mastering the educational material of subsequent disciplines				Is able to use the acquired knowledge in mastering the educational material of subsequent disciplines
		Possess skills in preparing abstracts (reviews) on various issues of science, engineering, and technology				When preparing the abstract, a large number of modern sources have been studied; the abstract contains systematized material and the author's own conclusions
	UC-2	Knowledge: knowledge of the structure of cognitive activity and the conditions for its organization	Knowledge of the structure of cognitive activity exists, but it is fragmented and unsystematic	Knows the structure of cognitive activity	Knows the structure of cognitive activity and the conditions for its organization	
		Skill: ability to set goals and objectives for professional and personal self-education	Is able to set goals for typical situations with errors	Is able to set goals but is unable to achieve them	Is able to set and achieve goals and objectives for professional and personal self-education	
		Skills: skills in building an individual trajectory of intellectual, general cultural, and professional development	Possesses basic skills in building an individual trajectory of general cultural development	Possesses basic skills in building an individual trajectory of intellectual, general cultural, and professional development	Confidently possesses skills in building an individual trajectory of intellectual, general cultural, and professional development	
		Advanced Knowledge: knowledge of the structure of cognitive activity and the conditions for its organization				Knows the structure of cognitive activity and the conditions for its organization, is able to apply his/her knowledge

		Skill: ability to set goals and objectives for professional and personal self-education				Is able to set goals and objectives for professional and personal self-education, and adjust them, if necessary, in the process of achieving them
		Skills: skills in building an individual trajectory of intellectual, general cultural, and professional development				Uses a creative approach in building an individual trajectory of intellectual, general cultural, and professional development
UC-3	Basic	Know the main scientific schools, directions, concepts, sources of knowledge, and methods of working with them	Names the key issues of some scientific schools	Lists the main scientific schools, directions, concepts, sources of knowledge, and methods of working with them	Demonstrates knowledge of the problems and conceptual foundations of the views of representatives of the main scientific schools	
		Be able to conduct typological classification of science and scientific research	Cannot independently conduct typological classification of science and scientific research	Cannot independently conduct typological classification of science and scientific research	Is able to understand, critically analyze, and conduct typological classification of science and scientific research	
		Possess a culture of theoretical thinking, the ability for analytical thinking and generalization, and skills in searching for scientific information on the Internet	Does not fully possess a culture of theoretical thinking, the ability for analytical thinking and generalization, and skills in searching for scientific information on the Internet	Demonstrates a culture of theoretical thinking, the ability for analytical thinking and generalization, and skills in searching for scientific information on the Internet	Demonstrates proficiency in the culture of theoretical thinking, the ability for analytical thinking and generalization, and skills in searching for scientific information on the Internet	
	Advanced	Know the main scientific schools, directions, concepts, sources of knowledge, and methods of working with them				Demonstrates deep knowledge of the main scientific schools, directions, concepts, sources of knowledge, and methods of working with them
		Be able to conduct typological classification of science and scientific research				Is able to creatively use fundamental knowledge of the philosophy of science and technology in substantiating the typological classification of science and scientific research
		Possess a culture of theoretical thinking, the ability for analytical thinking and generalization, and skills in searching for scientific information on the Internet				Fluently possesses a culture of theoretical thinking, the ability for analytical thinking and generalization, and skills in searching for scientific information on the Internet

UC-4	Basic	Knowledge: special terminology in a foreign language used in scientific texts, discourse structuring, basic techniques for translating specialized texts.	Knowledge of special terminology is fragmented and unsystematic.	Knowledge of special terminology is presented in an incomplete volume.	Knowledge of special terminology is presented in full.	
		Skill: to correlate professional vocabulary in a foreign language with the corresponding definition in Russian.	Is partially able to correlate professional vocabulary in a foreign language with the corresponding definition in Russian.	Is able to correlate professional vocabulary in a foreign language with the corresponding definition in Russian, but makes more than 50% errors.	Is able to correlate professional vocabulary in a foreign language with the corresponding definition in Russian in accordance with the basic requirements.	
		Skills: skills in practical solution of social and communicative tasks in various areas of foreign language activity.	Fragmented presence of skills in solving social and communicative tasks.	Possession of basic skills in solving social and communicative tasks, but insufficient degree of their use in practical activity.	Overall successful, but containing individual gaps, application of in-depth knowledge.	
	Advanced	Knowledge: special terminology in a foreign language used in scientific texts, discourse structuring, basic techniques for translating specialized texts				Knowledge of special terminology is presented in full; knows the techniques for translating specialized texts.
		Skill: to correlate professional vocabulary in a foreign language with the corresponding definition in Russian.				Is able to correlate professional vocabulary in a foreign language with the corresponding definition in Russian in accordance with all requirements.
		Skills: skills in practical solution of social and communicative tasks in various areas of foreign language activity.				Successful mastery of skills in solving social and communicative tasks in accordance with all requirements.
UC-5	Basic	Knowledge: the main scientific	Fragmented knowledge of the main scientific	General but unstructured knowledge of	Formed but containing individual	

		directions of the development of science and technology in the field of electric power engineering (mode management, efficient use of equipment)	directions of the development of science and technology in the field of electric power engineering (mode management, efficient use of equipment)	the main scientific directions of the development of science and technology in the field of electric power engineering (mode management, efficient use of equipment)	gaps knowledge of the scientific directions of the development of science and technology in the field of electric power engineering (mode management, efficient use of equipment)	
		Skill: to analyze the state of the scientific and technical problem in the field of electric power engineering and, on this basis, determine the goal of the research, methods, and means of its implementation.	Partially mastered skill of analyzing the state of the scientific and technical problem and determining the goal of the research, methods, and means of its implementation.	Overall successful, but non-systematic skill of analyzing the state of the scientific and technical problem and determining the goal of the research, methods, and means of its implementation.	Overall successful, but containing individual gaps, skill of analyzing the state of the scientific and technical problem and determining the goal of the research, methods, and means of its implementation	
		Skills: to possess methods of forecasting trends in the development of electric power engineering	Fragmented possession of methods of forecasting trends in the development of electric power engineering	Overall successful, but non-systematic possession of methods of forecasting trends in the development of electric power engineering	Overall successful, but containing individual gaps, possession of methods of forecasting trends in the development of electric power engineering	
	Advanced	Knowledge: the main scientific directions of the development of science and technology in the field of electric power engineering (mode management, efficient use of equipment)				Formulated systematic knowledge of the main scientific directions of the development of science and technology in the field of electric power engineering (mode management, efficient use of equipment)
		Skill: to analyze the state of the scientific and technical problem in the field of electric power engineering and, on this basis, determine the goal of the research, methods, and means of its implementation.				Formed skill of analyzing the state of the scientific and technical problem and determining the goal of the research, methods, and means of its implementation.
		Skills: to possess methods of forecasting trends in the development of electric power engineering				Successful and systematic possession of methods of forecasting trends in the development of electric power
	UC-6 Basic	Knowledge: the main scientific directions of the development of science and technology in the field of electric power engineering (mode management, efficient use of equipment)	Fragmented knowledge of the main scientific directions of the development of science and technology in the field of electric power engineering (mode management, efficient use of equipment)	General but unstructured knowledge of the main scientific directions of the development of science and technology in the field of electric power engineering (mode management, efficient use of equipment)	Formed but containing individual gaps knowledge of the scientific directions of the development of science and technology in the field of electric power engineering (mode management, efficient use of equipment)	

GPC-1		Skill: to analyze the state of the scientific and technical problem in the field of electric power engineering and, on this basis, determine the goal of the research, methods, and means of its implementation..	Partially mastered skill of analyzing the state of the scientific and technical problem and determining the goal of the research, methods, and means of its implementation.	Overall successful, but non-systematic skill of analyzing the state of the scientific and technical problem and determining the goal of the research, methods, and means of its implementation.	Overall successful, but containing individual gaps, skill of analyzing the state of the scientific and technical problem and determining the goal of the research, methods, and means of its implementation.	
		Skills: to possess methods of forecasting trends in the development of electric power engineering	Fragmented possession of methods of forecasting trends in the development of electric power engineering	Overall successful, but non-systematic possession of methods of forecasting trends in the development of electric power engineering	Overall successful, but containing individual gaps, possession of methods of forecasting trends in the development of electric power engineering	
	Advanced	Knowledge: the main scientific directions of the development of science and technology in the field of electric power engineering (mode management, efficient use of equipment)				Formulated systematic knowledge of the main scientific directions of the development of science and technology in the field of electric power engineering (mode management, efficient use of equipment)
		Skill: to analyze the state of the scientific and technical problem in the field of electric power engineering and, on this basis, determine the goal of the research, methods, and means of its implementation.				Formed skill of analyzing the state of the scientific and technical problem and determining the goal of the research, methods, and means of its implementation.
		Skills: to possess methods of forecasting trends in the development of electric power engineering				Successful and systematic possession of methods of forecasting trends in the development of electric power engineering
	Basic	Knowledge: Structure of scientific research	Knowledge of the fundamental foundations of scientific research, knowledge is not systematized	Has fragmentary understanding of the fundamental foundations of scientific research	Has an understanding of the structure of scientific research	
		Skill: to formulate the goals and objectives of research	Skills in using fundamental knowledge about the structure of scientific research in practical activity are at a low level	Has difficulty in formulating the goals and objectives of research	Confidently formulates the goals and objectives of research	
		Skills: identifying priorities for solving tasks	No skills in choosing priorities in solving the assigned task	Skills in identifying priorities for solving tasks are at a low level	Correctly identifies priorities in solving the assigned task	
	Advanced	Knowledge:				

		Structure of scientific research and methodologies applied to them				Demonstrates confident knowledge of the structure of scientific research
		Skill: to formulate the goals and objectives of research				Confidently formulates the goals and objectives of research in practical activity
		Skills: identifying priorities for solving tasks, choosing evaluation criteria				Skills in identifying priorities in solving assigned tasks are at the highest level. Has the ability to independently choose criteria for evaluating the work performed.
GPC-2	Basic	Knowledge: research methods and assessment of the results of the work performed	Skills: presentation of the results of the work performed	Knows research methods for the assigned task	Knows the structure of research methods and assessment of results in the work being performed	
		Skill: to conduct an analysis of the obtained results	Is able to perform a primary analysis of the obtained results	s able to assess the obtained results	Is able to analyze the obtained results and make comparisons	
		Skills: presentation of the results of the work performed	Possesses basic skills in presenting and defending the completed work	Possesses skills in constructing a report and defending the results of the completed work	Confidently possesses skills in the reasoned presentation of the results of the completed work	
	Advanced	Knowledge: knowledge of the structure of cognitive activity and the conditions for its organization				Knows research methods and assessment of results for any work performed
		Skill: ability to set goals and objectives for professional and personal self-education				Is able to qualitatively analyze the obtained results and determine the correctness of their determination
		Skills: skills in building an individual trajectory of intellectual, general cultural, and professional development				Uses a creative approach in defending and presenting the results of the completed work. Answers are correct and well-argued.
PC-1	Basic	Knowledge: physical models of processes and phenomena	Fragmented understanding of modern methods of using information and	Knows the main sources of patent information, but does not know how to use them	Knows the main sources of patent information	

			communication technologies in the chosen field of activity			
		Skill: to compare research results of the development object with domestic and foreign analogues	Fragmented use of the ability to select and use experimental and computational-theoretical methods for solving a scientific problem	Is able to conduct a search, but is unable to determine patent clearance	Is able to conduct a search using sources of patent information, determine the patent clearance of developed technical objects	
		Skills: mastery of research methods for experimental work	Fragmented application of skills in planning scientific research, analyzing the obtained results, and formulating conclusions	Possesses minimal experience in preparing primary materials for patenting inventions, registering computer programs and databases	Possesses experience in preparing primary materials for patenting inventions, registering computer programs and databases	
	Advanced	Knowledge: physical models of processes and phenomena				Knows the main sources of patent information, is able to search for additional sources
		Skill: to compare research results of the development object with domestic and foreign analogues				Has performed a search using sources of patent information for his/her patent or computer program
		Skills: mastery of research methods for experimental work				Has real experience working with patented inventions
	PC-2	Knowledge: knowledge of the patterns in conducting experiments	Knowledge: knowledge of the patterns in conducting experiments	Knows part of: methods of planning and formulating the research task	Knows: methods of experimental work	
		Skill: to analyze the reliability of the obtained results	Is unable to: plan and formulate research tasks	Is not fully able to: plan and formulate research tasks	Is able to: choose methods of scientific research	
		Skills: mastery of methods of analysis and processing of experimental data	Does not possess: skills in planning and formulating the research task	Partially possesses: skills in planning and formulating the research task	Possesses: methods of experimental work	
		Knowledge: knowledge of the patterns in conducting experiments				Has excellent and complete knowledge of: methods for assessing the results of scientific research
		Skills:				Is fully and independently able to

		to analyze the reliability of the obtained results				to interpret and evaluate the results of scientific research
		Skills: mastery of methods of analysis and processing of experimental data				Fully possesses: skills in interpreting and evaluating the results of scientific research
PC-3	Basic	Knowledge: special terminology in a foreign language used in scientific texts, discourse structuring, basic techniques for translating specialized texts.	Knowledge of special terminology is fragmented and unsystematic.	Knowledge of special terminology is presented in an incomplete volume.	Knowledge of special terminology is presented in full.	
		Skill: to correlate professional vocabulary in a foreign language with the corresponding definition in Russian..	Is partially able to correlate professional vocabulary in a foreign language with the corresponding definition in Russian.	Is able to correlate professional vocabulary in a foreign language with the corresponding definition in Russian, but makes more than 50% errors.	Is able to correlate professional vocabulary in a foreign language with the corresponding definition in Russian in accordance with the basic requirements.	
		Skills: skills in practical solution of social and communicative tasks in various areas of foreign language activity.	Fragmented presence of skills in solving social and communicative tasks.	Possession of basic skills in solving social and communicative tasks, but insufficient degree of their use in practical activity.	Overall successful, but containing individual gaps, application of in-depth knowledge.	
	Advanced	Knowledge: special terminology in a foreign language used in scientific texts, discourse structuring, basic techniques for translating specialized texts.				Knowledge of special terminology is presented in full; knows the techniques for translating specialized texts..
		Skill: to correlate professional vocabulary in a foreign language with the corresponding definition in Russian.				Is able to correlate professional vocabulary in a foreign language with the corresponding definition in Russian in accordance with all requirements.
		Skills: skills in practical solution of social				Successful mastery of skills in solving

		and communicative tasks in various areas of foreign language activity.				social and communicative tasks in accordance with all requirements.
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2.1 Criteria for Assessing Competencies in the State Examination

The results of the state examination in the field of study 13.04.02 "Electric Power Engineering and Electrical Engineering" are determined by the grades "Excellent," "Good," "Satisfactory," and "Unsatisfactory" in accordance with the requirements. When determining the grade for knowledge, the level of theoretical, scientific, and practical training of the master's students is taken into account. "Excellent" is awarded provided that the master's student has fully answered all questions of the examination ticket, additional questions from committee members, and has demonstrated a high level of theoretical and practical training. "Good" – provided that the master's student has answered the questions of the examination ticket, additional questions from committee members, and demonstrated a good level of training. "Satisfactory" – provided that the master's student has demonstrated a sufficient level of training necessary for practical activity, but made inaccuracies in the answer during the examination. "Unsatisfactory" is given to a master's student who has demonstrated significant gaps in knowledge of the main program material, which do not allow them to begin practical activity without additional training.

Receiving an unsatisfactory grade deprives the master's student of the right to retake the state examination in the field of study 13.04.02 "Electric Power Engineering and Electrical Engineering" and to obtain admission to the completion of the final qualifying work.

2.2 Criteria for Assessing Competencies in the Defense of the Final Qualifying Work / Scientific Report

The grade "Excellent" is awarded to the master's student if the topic of the final qualifying work is relevant and fully disclosed, and corresponds to the field of study 13.04.02 "Electric Power Engineering and Electrical Engineering." The goals and objectives set in the work are fully disclosed and reflected in the conclusions of the final qualifying work. For the execution of the experimental part, the master's student has employed a sufficient scientific apparatus, performed an analysis of the obtained data, and drawn well-founded conclusions. The scientific qualifying work and graphic material are formatted in accordance with GOST and ESKD without comments. The master's oral presentation demonstrated the ability to construct oral and written speech logically, with argumentation and clarity. The master's student fully masters the theoretical component of the scientific qualifying work, competently uses special technical terminology, and provides well-argued answers to all questions from committee members. The master's scientific qualifying work has passed the anti-plagiarism check, and the percentage of originality meets the requirements for master's scientific qualifying works. The supervisor's review is positive, and it is recommended to award the master's student a grade of "Excellent" for the scientific qualifying work and to confer the qualification of Master based on the results of the defense.

The grade "Good" is awarded to the master's student if the topic of the scientific qualifying work is relevant and fully disclosed, and corresponds to the field of study 13.04.02 "Electric Power Engineering and Electrical Engineering." The goals and objectives set in the work are disclosed and reflected in the conclusions of the scientific qualifying work. For the execution of the experimental part, the master's student has employed a sufficient scientific apparatus, performed an analysis of the obtained data, and drawn well-founded conclusions. The scientific qualifying work and graphic material are formatted in accordance with GOST and ESKD with minor comments, reflected in the supervisor's reviews. The master's oral presentation demonstrated the ability to construct oral and written speech logically, with argumentation and clarity. The master's student sufficiently masters the theoretical component of the scientific qualifying work, uses special technical terminology, and provides well-argued answers to questions from committee members. The master's scientific qualifying work has passed the anti-plagiarism check, and the percentage of originality meets the requirements for master's scientific qualifying works. The supervisor's review is positive, and it is recommended to award the master's student a grade of "Good" for the scientific qualifying work and to confer the qualification of Master based on the

results of the defense.

The grade "Satisfactory" is awarded to the master's student if the topic of the scientific qualifying work is relevant and disclosed, and corresponds to the field of study 13.04.02 "Electric Power Engineering and Electrical Engineering." The goals and objectives set in the work are insufficiently disclosed and reflected in the conclusions of the scientific qualifying work. For the execution of the experimental part, the master's student has employed an insufficient scientific apparatus, performed a partial analysis of the obtained data, and drawn not always well-founded conclusions. The scientific qualifying work and graphic material are formatted in accordance with GOST and ESKD with significant comments, reflected in the supervisor's reviews. The master's oral presentation did not demonstrate the ability to construct oral and written speech logically, with argumentation and clarity. The master's student does not fully master the theoretical component of the scientific qualifying work, practically does not use special technical terminology, and does not answer questions from committee members. The master's scientific qualifying work has passed the anti-plagiarism check, and the percentage of originality meets the requirements for master's scientific qualifying works. The supervisor's review is satisfactory, and it is recommended to award the master's student a grade of "Satisfactory" for the scientific qualifying work and to confer the qualification of Master based on the results of the defense.

The grade "Unsatisfactory" is awarded to the master's student if the topic of the scientific qualifying work is not disclosed, but corresponds to the field of study 13.04.02 "Electric Power Engineering and Electrical Engineering." The goals and objectives set in the work are not disclosed and are not reflected in the conclusions of the scientific qualifying work. For the execution of the experimental part, the master's student has employed an insufficient scientific apparatus, performed no analysis of the obtained data, and the conclusions are not substantiated. The scientific qualifying work and graphic material are formatted with gross violations of GOST and ESKD, as reflected in the supervisor's review. The master's oral presentation did not demonstrate the ability to construct oral and written speech logically, with argumentation and clarity. The master's student does not master the theoretical component of the scientific qualifying work, does not know special technical terminology, and does not answer questions from committee members. The master's scientific qualifying work has passed the anti-plagiarism check, and the percentage of originality meets the requirements for master's scientific qualifying works. The supervisor's review is unsatisfactory, with serious comments. It is recommended to award the master's student a grade of "Unsatisfactory" for the scientific qualifying work and not to confer the qualification of Master based on the results of the defense, as the master's student has not confirmed compliance of their training with the requirements of the FSES HPE in the field of study 13.04.02 "Electric Power Engineering and Electrical Engineering."

3. Standard Control Tasks or Other Materials Necessary for Assessing the Results of Mastering the Educational Program

3.1 Questions for the Final (State) Examination

Basic Level

Know	Components of actual electricity losses Electric energy storage systems Methodological stages of energy audit Powers of state authorities of the Russian Federation in the field of energy saving and improving energy efficiency Secondary energy resources in industry Structure of commercial electricity losses Goals and main objectives of energy surveying. Formal and additional tasks of energy surveying Current and voltage instrument transformers. Purpose, technical characteristics, and nameplate data Levels of energy audit, goals of each level, and the main types of work at each level Main measures to reduce electricity losses Priority of implementing measures to reduce electricity losses Structure of technological electricity losses Typical structure of Automated Information and Measurement Systems for Commercial Electricity Metering (AIMS CEM). Composition and levels of AIMS CEM Structure of load electricity losses Mathematical models of stochastic problems Types of electricity tariff systems Components of the electricity balance for an electrical network Mathematical model of an optimization problem Structural analysis of electricity losses Initial information of the optimization problem Classification of energy survey objects Goals and objectives of instrumental energy surveying Functions of energy survey subjects and requirements for them Metrological characteristics of measuring instruments Structure of conditionally fixed electricity losses Main regulatory and legal documents regulating relations in the field of energy saving and improving energy efficiency
Be able to:	Optimization using a generalized objective function Calculation of electricity loss reduction from optimization of disconnection points in 6–35 kV electrical networks with two-way power supply Calculation of electricity loss reduction from phase load balancing in 0.38 kV networks Calculation of electricity loss reduction through the installation of compensating devices in 6–10 kV networks Determination of load electricity losses for the regulated period
Possess	Calculation of electricity losses due to corona in transmission lines Problem of optimal active power distribution in a power system Calculation of electricity loss reduction when replacing underloaded and overloaded transformers Measures to improve technical electricity metering Method of Lagrange multipliers Documentary energy survey and types of information studied during its conduct Modern electricity meters for electricity metering systems and their connection diagrams Methods for calculating load electricity losses in 6–10 kV networks and their accuracy Methods for calculating load losses in 0.38 kV networks and their accuracy

	Method of design days Method of average loads
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Advanced Level

Know	Concept and objectives of energy saving Types and kinds of measurements during instrumental energy surveying, as well as the main measurements carried out at this stage Powers of local self-government bodies in the field of energy saving and improving energy efficiency Main stages of energy surveying Metrological characteristics of measuring instruments, as well as their reliability indicators Mechanical energy storage systems Classification and types of electrical measuring instruments Concept of energy management Types of energy and energy resources Chemical energy storage systems Current causes and measures to improve energy efficiency, definition of energy audit. Key provisions of state policy in the field of energy auditing Main indicators of energy efficiency and energy saving
Be able to	Classification of measures for energy saving and improving energy efficiency. Main stages of their development Determination of weight coefficients of each criterion in solving multi-criteria optimization problems Consideration of line capacity in solving the transportation problem Solving the transportation problem using the potential method
Possess	Communication channels and lines in AIMS CEM systems. Methods of information transmission Energy saving in lighting systems Distribution method for solving the transportation problem Analysis of the optimization problem

4.2 Assessment Tools for Final (State Final) Assessment (Final Qualifying Work / Scientific Report)

4.2.1 List of Topics of Final Qualifying Works / Scientific Reports (topics of scientific reports for postgraduate students must correspond to the topics of scientific qualification works (dissertations)):

Area of Activity	Sample Topics
Research	Best practices in the field of import substitution in the Russian Federation and abroad (by industry and country). Analysis and forecast of the state of the market for main electrical equipment and the capabilities of the domestic industry for import substitution (by equipment groups). Organizational and economic mechanisms for implementing the policy of import substitution of electrical equipment.

	Analysis of approaches to assessing the level of localization of electrical product manufacturing. Assessment of the social impact of grid companies on the development of territorial industrial complexes. Analysis of strategic risks and assessment of their impact on the implementation of import substitution policy in the electric power industry. Management of investment projects in grid companies in the interests of import substitution. Analysis of mechanisms for the participation of grid companies in the development of electrical equipment manufacturing technologies. Organizational and economic mechanisms for facilitating the entry of electrical products of domestic manufacturers into foreign markets. Mechanism for insurance of liability for quality and reliability of power supply as a way to solve the problem of "cross-subsidization." Energy service contracts in addressing issues of placement of static reactive power compensators (SRPC) in networks of multiple owners. Innovative development. Mechanisms for interaction between infrastructure companies and regulatory authorities, business, and educational institutions. Possible schemes for optimizing operating modes using the "Virtual Power Plant" concept. Power supply devices for diagnostic and control equipment at conductor potential. Automated methodology for selecting surge arresters (SA) at substations (CAD). Automated methodology for selecting lightning protection and grounding at substations (CAD). Automated methodology for selecting lightning protection and grounding on high-voltage lines, including surge arresters (CAD). Automated methodology for calculating the aperiodic component of current in the automatic reclosing (AR) cycle (CAD). Automated methodology for calculating electromagnetic compatibility (EMC) of substations (CAD). Calculation methods for evaluating the efficiency and optimizing the placement of surge arresters and lightning arresters on transmission lines. Application of on-load tap-changer (OLTC) reactors for loss reduction and improved regulation quality. Comparison of cost and reliability of design with shunt reactor (SR) and controlled shunt reactor based on thyristor-reactor groups (CSR(T)). Influence of surge arresters and lightning arresters on wave characteristics of overhead lines. Calculated parameters of modern types of cables considering their installation. Identification of failures on polymer insulators. Detection methods and indicators. High-frequency overvoltages in gas-insulated switchgear. Calculation methods and protection against overvoltages in single-phase automatic reclosing cycles of overhead lines. Protection against switching overvoltages using switching device synchronization methods..
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	Calculations of ferroresonance conditions for various schemes and layouts of 330–500 kV switchgear. Assessment of the effectiveness of using modern neutral grounding devices. Assessment of global experience in the operation and installation of cross-linked polyethylene cables. New switching equipment technologies. Reliability indicators of a digital substation. Calculation of digital substation reliability indicators depending on the structure. Technical and economic indicators of the application of wave protections. Methods for detecting short circuits and ensuring automatic reclosing of cable-overhead lines. Technical and economic indicators of wave fault location systems for overhead lines of various configurations (cable-overhead lines, overhead lines with branches, long overhead lines, etc.). Data synchronization algorithms for non-synchronous operation (in the absence of GPS/GLONASS connectivity) of wave fault location devices for overhead lines. Structure of digital data streams in the 61850 protocol. Comparison of relay protection and automation for medium-voltage networks with isolated and resistively grounded transformer neutrals. Comparison of reliability indicators for variants of microprocessor relay protection and automation: traditional, using protocol 61850 8-1, and using 61850 9-2. Methodology for monitoring measurement paths of relay protection and automation for various substation circuit variants. Standard databases required for servicing relay protection and automation devices, creation of a relay protection and automation device passport, and interaction with other services. Standard programs for commissioning, testing, and putting into operation of relay protection and automation devices for various circuit variants and types of reconstruction. Computer-aided design system for the substation relay protection and automation complex (CAD). Automated system for selecting settings and functions of substation relay protection and automation (CAD). "Dead zones" in switchgear of substations. Statistical data and probability of short circuits in the "dead zone." Feasibility of implementing special measures to eliminate them. Modern circuit and technical solutions for ensuring operational interlocking at existing and new substations. Development of measures for managing electrical network operating modes based on information from overhead line condition sensors. Development of approaches to optimizing schedules of scheduled outages of network equipment, taking into account possible reduction in power quality in repair network configurations. Development of approaches for automatic voltage regulation using on-load tap-changers of (auto-) transformers in backbone networks. Development of methods for determining the causes of power quality deterioration in electrical networks based on readings from an automated power quality monitoring system. Development of principles for voltage regulation at a backbone substation with several types of voltage regulation and reactive power compensation means. Development of algorithms for accounting for risks of disruption of reliable power supply to consumers when planning outages of backbone network equipment.
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	Assessment of the potential for loss reduction from various measures for mode optimization and equipment replacement. Multivariable controllers for voltage regulation at a substation. Multi-agent technology for optimization and voltage regulation in electrical networks. Modern methods for assembling and validating topological models and network models based on multi-agent technologies and vector (synchronized) measurements. Use of synchronized measurements for updating network parameters. Modern intelligent algorithms for measurement validation. Use of synchronized measurements for updating generator and load parameters. Methods for accurate determination of corona losses. Use of synchronized measurements for assessing and identifying inconsistencies in metrological characteristics of measuring equipment. Cybersecurity of power system control systems. Ensuring data integrity, attack detection, and response measures. Intelligent algorithms for automatic network restoration after emergencies. Voltage regulation at power plants taking into account corona losses in the adjacent network. Reliability assessment in optimizing substation switchgear configurations. Application of synchronized measurements for detecting emergencies in electrical networks. Criteria for the feasibility of using controlled shunt reactors in EHV networks under various circuit and operational conditions. Assessment of the economic effect of using voltage regulation and power quality improvement means at facilities with traction asymmetrical loads. Automated methodology for calculating a series of operating modes and selecting main equipment during optimization and reliability considerations of substation circuit and technical solutions (CAD). Analysis of the application of standard series towers from the 1970s–1980s in the design of transmission lines according to the 7th edition of the Electrical Installation Regulations. Scope of application of new types of conductors in transmission line design. Regulatory "vacuum," selection problems, and technical effect. "Big transition." Technical and economic comparison of options for using modern types of conductors. Technical feasibility and economic effect. Corrosion effects on overhead line elements, current regulatory framework, and analysis of the effectiveness of protective measures. Domestic and foreign experience. Analysis of the economic and technical efficiency of using modern reinforced concrete towers for transmission line construction. Study of global experience and effectiveness of using polymer insulation on overhead lines. Automated methodology for determining design climatic loads based on zoning maps and observations (CAD). Construction of a regulatory document map and formation of a requirements database for transmission line design (CAD).
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	Study of information models of common CAD systems and assessment of the possibility of applying ISO 15926 for forming a cross-platform information exchange model in design (CAD). Effectiveness of using gas-insulated switchgear. Automated methodology for calculating and selecting the DC auxiliary power system of a substation (CAD). Automated methodology for calculating and selecting circuit and technical solutions for substation auxiliary needs (CAD). Construction of a regulatory document map and formation of a requirements database for transmission line design (CAD). Assessment of the effectiveness of using gas-insulated bus ducts in substation construction. Analysis of failure rates of 220–750 kV power transformers. Analysis of failure rates of gas-insulated switchgear. Use of intelligent search tools for processing data on failure rates of electrical equipment. Assessment of the effectiveness of using unmanned aerial vehicles for servicing transmission lines and substations. Assessment of the effectiveness of using stationary IR and UV spectrum diagnostic sensors. Assessment of the effectiveness of modern methods for diagnosing substation equipment. Application of synchronized measurements for diagnostics of electrical equipment. Application of navigation and radio frequency identification means to increase labor productivity and improve work safety. Methods for increasing the service life of substation auxiliary battery banks. Promising methods for ensuring operational interlocking using new types of sensors. Assessment of the effectiveness of grounding methods in DC auxiliary circuits. Analysis of failure rates and identified defects of high-voltage bushings. Automation of formation and monitoring of consumables inventory for maintenance and repair. Foreign experience in forming emergency reserves (stocking standards, interaction with manufacturers). Analysis of the frequency and composition of standard assemblies used by design institutes in the design of 220–500 kV substations. Analysis of experience and feasibility of reusing substation projects without full revision. Solution methods. Analysis of the negative impact of capacitive voltage transformers on bushings with RIP insulation. Search for alternative solutions. Study of global experience in applying polymer insulation for substation equipment. Analysis of switchgear schemes used in 2006–2014 in the construction of Unified National Electric Grid substations. Current regulatory and technical documentation and recommendations for adjustment. Feasible neutral grounding mode in 10–35 kV networks. Technical features.
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4.2.2. Structure of the Work

Section 1. Literature Review

Level of learning outcomes	Formulation of the assignment	Controlled Competencies or Parts Thereof										
		Universal Competencies						General Professional Competencies		Professional Competencies		
		UC-1	UC-2	UC-3	UC-4	UC-5	UC-6	GPC-1	GPC-2	PC-1	PC-2	PC-3
Know	Assignment 1. Study the requirements of GOST 7.32-2001 "Report on Research Work," GOST 7.1-2003 "Bibliographic Record. Bibliographic Description. General Requirements and Rules for Compilation," ESKD, technical specifications, and other regulatory documents in the field of electric power engineering.		+			+		+	+			
	Assignment 2. Study domestic and foreign literature on the topic of the final qualifying work and related fields of knowledge, reference and patent literature, taking into account information security requirements, including the protection of state secrets.	+			+		+		+	+	+	+
	Assignment 3. Study the main provisions of legislation in the field of copyright, requirements and rules for the execution of lawful citation in qualifying works.			+			+	+		+		
Be able to	Assignment 1. Conduct a generalization and analysis of domestic and foreign literature on the topic of the final qualifying work.							+		+	+	+
	Assignment 2. Together with the supervisor, justify the relevance of the chosen topic of the scientific qualifying work, its scientific novelty, and practical significance based on the analysis of literary sources.		+					+	+	+	+	+

	Assignment 3. Together with the supervisor, define the object and subject of the research, formulate the goal of the scientific qualifying work.					+			+	+	+	+
	Assignment 4. Together with the supervisor, formulate the objectives of the scientific qualifying work and select modeling methodologies for the processes under study and research methods.	+						+	+	+	+	+
	Assignment 5. Together with the supervisor, divide the literature review into subsections covering specific issues of the scientific qualifying work topic and conclusions for the section. The presentation of materials must be logically verified; the generalization of material must be conducted with argumentation and clarity.	+			+			+	+		+	+
Possess	Assignment 1. Compile a literature review on the topic of the final qualifying work, using computer skills, in accordance with the requirements of GOST, ESKD, legislation in the field of copyright, and other regulatory documents.	+	+				+		+			
	Assignment 2. Format figures, diagrams, and drawings (if any) in the literature review in accordance with the requirements of GOST and ESKD, using modern software tools for creating and editing images.							+	+			+

Graphic material (if necessary): diagrams, algorithms, charts, graphs, drawings.

Section 2. Experimental Section

Level of learning outcomes	Formulation of the assignment	Controlled Competencies or Parts Thereof										
		Universal Competencies						General Professional Competencies		Professional Competencies		
		UC-1	UC-2	UC-3	UC-4	UC-5	UC-6	GPC-1	GPC-2	PC-1	PC-2	PC-3

Know	Assignment 1. Present the main provisions of theories, fundamentals of processes, models, algorithms, technological schemes and installations, equipment diagrams used in conducting the experiment (research), both those developed by the master's student and those borrowed (with appropriate references).		+			+		+				
	Assignment 2. Know methods (methodologies) of statistical processing of experimental results, calculation of reproducibility, reliability of experimental results, confidence interval, etc.			+		+		+	+	+	+	+
To able to	Assignment 1. Together with the supervisor, select a methodology for experimental research based on the required (expected) parameters, characteristics of materials and components, and their operating conditions.	+			+			+	+	+	+	+
	Assignment 2. Present clear step-by-step methodologies, algorithms, diagrams, models that were used in conducting the experiment.		+		+	+		+	+	+	+	+
Possess	Assignment 1. Master skills in working with modern equipment (technological, research, control and measuring).			+		+						+

4. Methodological Materials Defining the Procedures for Assessing the Results of Mastering the Educational Program.

The tasks offered to the student allow testing of competencies: UC-1, UC-2, UC-3, UC-4, UC-5, UC-6, GPC-1, GPC-2, PC-1, PC-2, PC-3.

4.1 Methodological Materials Defining the Procedures for Assessing the Results of Mastering the Educational Program in the Final (State) Examination

The procedure for conducting the state examination is carried out in accordance with the Regulations on the Procedure for Conducting State Final Assessment in Higher Education Programs – Bachelor's, Specialist's, and Master's Programs at NCFU and the Regulations on the Procedure for Conducting State Final Assessment in Higher Education Programs – Postgraduate and Residency Programs at NCFU.

The examination ticket includes 3 questions. Each student independently selects an examination ticket once by random selection. The ticket number is recorded by the SEC secretary in the relevant protocol.

The student is given (as a rule, 30 minutes (for technical fields of study (specialties) – up to 1 hour)) to prepare an answer to the examination ticket. During preparation, the student has the right to use the state examination program, as well as reference literature with the permission of the SEC.

5.2 Methodological Materials Defining the Procedures for Assessing the Results of Mastering the Educational Program in the Defense of the Final Qualifying Work / Scientific Report

At each stage, ongoing control of the competency formation process is carried out.

During the defense of the final qualifying work / scientific report, the following are assessed:

1. Presentation:

- Relevance;
- Level of theoretical development of the problem, including knowledge of modern scientific and technical literature;
- Level of experimental research on the dissertation topic;
- Completeness and systematic nature of the proposals made on the issue under consideration;
- Independence in developing the problem;
- Level of engineering (technical, technological, organizational-technical) development of the issues covered in the dissertation;
- Level of development of economic issues;
- Level of compliance with life safety and environmental safety requirements in the dissertation;
- Feasibility of practical implementation.

2. Answers to questions from SEC members and reviewer's comments:

- Level of knowledge of the program material;
- Competence in specific areas of engineering and scientific knowledge on the dissertation topic.

SEC members assess the quality of the completed work during the defense of the final qualifying work, reviewing the explanatory note and illustrative materials, listening to the presentation, and the master's student's answers to questions. Each committee member records their grade in a separate individual assessment sheet for the final qualifying work.

To assess the defense, the assessment system described above is used.