ANNEX 5

Module Reference Book

Electrical Power Engineering (Ma)

Table of Contents

Module 1: Basics of Scientific and Research World View 3
Module 2: Psychological and Pedagogical Education 5
Module 3: Current Problems of Technical Sciences 7
Module 4: Scientific Research 1 9
Module 5: Scientific Research 2 11
Module 6: Scientific Research 3 13
Module 7: Teaching Practice 15
Module 8: Scientific Research 4 17
Module 9: Research Scientific Training 19
Module 10: Final Academic Assessment 21
Module 11: Organizing of Scientific Research 23
Module 12: Support of the Experiment 25
Module 13: Optimization and Control in Electric Power Systems 31

Module Name:	**Module 1: Basics of Scientific and Research World View**
Code	M1EPE(Ma)
Module Elements:	*Compulsory Subjects* Foreign Language (Professional) History and Philosophy of Science
Semester Number:	1
Person responsible for the module	O.M. Vasilyeva
Lecturer:	Foreign Language (Professional) - O.M. Vasilyeva History and Philosophy of Science - A.V. Nikiforov
Language:	Russian, Kazakh
Curriculum relation:	Electrical Power Engineering (Ma)
Type of teaching / number of hours per week and per semester :	1 semester: hours per week – 12 (lectures -1; workshops -3; independent work -8); hours per semester – 180.
Workload:	Teaching Load: 60 hours Extracurricular Classes: 120 hours Total: 180 hours
Credit Points:	6 ECTS
Conditions for Examinations:	For admission to the exam, the student must score at least 50 points out of 100 available for the subject
Recommended Conditions:	This module is based on the knowledge gained by students in previous undergraduate subjects of Philosophy and Foreign Language.
Expected Learning Outcomes:	**Know:** main philosophical trends in the development of technology and technical areas; technical foreign language in the field of electronics. **Be able to:** monitor trends in the influence of technical devices on human activity on the basis of modern philosophical works in the field of technology; work with technical documents and scientific works in a foreign language. **Possess the skills:** work with papers of philosophical technical nature and scientific works in a foreign language for research activities. **Demonstrate the ability to:** conduct research activities, based on the experience of foreign scientific works including those in the field of philosophy of technology
Intendend use/applicability	Module: Final Academic Assessment
Content:	*Foreign Language* Describing professional competence; personal and professional challenges; professional image of contemporary electric engineers; the importance to be skilled; decision-making process; business meetings and correspondence. Grammar review. Listening and speaking. Modal auxiliary verbs. *History and Philosophy of Science* Science in culture and civilization Origin of science. Main stages of the historical development of science. Science in Antiquity and the Middle Ages. Modern science. Classical science and its features. Features of non-classical science period. Post-non-classical science. Structure of scientific knowledge. Laws of development of science. Concepts of K. Popper, T. Kuhn, I. Lakatos and P. Feyerabend. Science as a social institution. Philosophical problems of natural sciences. Philosophical problems of social and humanitarian sciences.
Examination Form, module mark:	*Foreign Language (Professional)* – computer-based testing; *History and Philosophy of Science* – written control examination. Module mark: the result of the exam *History and Philosophy of*

	Science
Technical/Multimedia Facilities:	Multimedia system
Study Materials:	1. Vocabulary: - Social and Domestic Communication: Family in modern society, Housing and accommodation; - Social and Cultural Communication: Kazakhstan, Country studies (English speaking countries: culture, geography, economy), Leisure, Traveling; - Educational and Professional Communication: Education, My University, Jobs and Professions, My future profession, Professional competence, Advantages and disadvantages of different professions; - Social and Cultural Communication: Health and Healthy Life Style, Law, Human Rights, Environment and environmental problems, Mass Media 2. Grammar: - Tenses (Present, Past, Future – Simple, Continuous, Perfect); - Conditional sentences; - Reflexive, Possessive and Relative Pronouns; - The passive Voice; - Modal verbs (might, could, might, can); - Reported Speech; - Connectors (although, however,thus…); - Quantifiers (a few, a little etc.); - Adverbs of frequency; - Degrees of comparison (adjectives and adverbs) 3.D.E. Zemach, L.A.Rumisek. Academic Writing. MacMillan Press, 2006. 2.Key Concepts in Information and Communication Technology (Palgrave) by Roger I. Cartwright.3.Holy Roddick Business Writing Makeovers, AST, Astrel, 2004. 4. P. V. Alekseyev, A.V. Panin. Philosophy: Textbook. M.: Prospect, 2003 5. V. D. Gubin. Philosophy: Textbook. M.: Omega, 2006 6. A. G. Spirkin. Philosophy: Textbook. M.: Gardariki, 2004 7. Philosophy: Textbook/Comp. T. H. Gabitov, Almaty, 2003.
Date of last amendment	20.01.2023

Module Name:	**Module 2: Psychological and Pedagogical Education**
Code	M2EPE(Ma)
Module Elements:	*Compulsory Subjects* Psychology Pedagogics Methods of teaching technical disciplines in higher education
Semester Number:	1, 2
Person responsible for the module	*G.I. Chemodanova*
Lecturer:	Psychology – *L.A. Bogunov* Pedagogics - *G.I. Chemodanova* Methods of teaching technical disciplines in higher education- E.V.Kuharenko
Language:	Russian, Kazakh
Curriculum relation:	Electrical Power Engineering (Ma)
Type of teaching / number of hours per week and per semester :	1 semester: hours per week – 12 (lectures -2; workshops -2; independent work -8); hours per semester – 180. 2 semester: hours per week – 6 (lectures -1; workshops -1; independent work -4); hours per semester – 90.
Workload:	Teaching Load: 90 hours Extracurricular Classes: 180 hours Total: 270 hours
Credit Points:	9 ECTS
Conditions for Examinations:	For admission to the exam, the student must score at least 50 points out of 100 available for each subject of the module
Recommended Conditions:	This module is based on the knowledge obtained from the previous module of the bachelor degree: Social and Humanitarian Knowledge
Expected Learning Outcomes:	**Know:** social and psychological nature of pedagogical activity; properties of mental and cognitive processes included in cognitive activity; content and specifics of psychological and pedagogical influence; psychology of cognitive activity of students in the learning process; main directions and trends of higher education development; general problems of higher school pedagogy, methodological and theoretical bases of higher school pedagogy; **Be able to:** apply psychological methods and means to improve the effectiveness and quality of training; **Possess the skills:** professional communication and intercultural communication; **Demonstrate the ability to:** apply psychological methods and means to improve the effectiveness and quality of training; a holistic view of the factors and laws of the pedagogical process of higher education. build and implement promising lines of intellectual, cultural, moral, physical and professional self-development and self-improvement; follow ethical and legal standards; social adaptation.
Intendend use/applicability	Module: Teaching Practice
Content:	*Psychology* Education as a global object of the psychology of the higher school. Psychological education in high school. Psychological structure of the learning process. Psychology of cognitive activity. Psychological methods and means of improving the efficiency and quality of education in modern conditions. Psychology of

	personality and student group. Problems of education in high school Education and formation of professional consciousness. Psychodiagnostics in high school. Psychological characteristics of pedagogical activity of the teacher of higher school. Management of the learning process. Student as a subject of educational activities. Psychological and pedagogical communication. Psychology of pedagogical influence. The main psychological problems in teaching. *Pedagogics* Main directions and trends of higher education in Kazakhstan. The concept of continuous pedagogical education of the teacher of new formation of the Republic of Kazakhstan. Pedagogical process of higher school. Key competences are the main factor of training competitive specialists. Organization of the learning process in higher education. Forms and methods of teaching in higher school. Educational technology. The concept of pedagogical technology. *Methods of teaching technical disciplines in higher education.* Distance learning technologies. Environments for creating educational materials. Platforms and support tools. Internet multimedia facilities. multimedia projects.
Examination Form, module mark:	Comprehensive examination including: *Psychology* - Written examination *Pedagogics* - Computer-based testing Methods of teaching technical disciplines in higher education - Written examination Module mark: the result of the exam Methods of teaching technical disciplines in higher education
Technical/Multimedia Facilities:	Modern multimedia systems.
Study Materials:	1. L. A. Bogunov Psychology of Training and Education in Higher Education: Textbook. – Petropavlovsk: NKSU named after M. Kozybayev, 2011. – 99 p. 2. V. V. Davydov. Problems of Developmental Education. – M: Publishing center Akademiya, 2004. – 288 p. 3. S. M. Dzhakupov. Psychological Structure of Teaching Process. Almaty: Kazak universitety, 2004. – 311 p. 4. S. M. Dzhakupov. Management of Cognitive Activity of Students in the Teaching Process. Almaty, 2002. – 117 p. 5. I. A. Zimnaya. Pedagogical Psychology. – M.: Logos, 2002. – 384 p. 6. S. D. Smirnov. Pedagogy and Psychology of Higher Education: from Activity to Personality. – M., 2001. – 304 p. 7. Reference Materials in Pedagogical Psychology / ed.-comp. B. R. Mandel. – Rostov-on-Don: Phoenix, 2008. – 384 p. 8. R. L. Hon. Pedagogical Psychology. – M: Academic Project: Culture, 2005. – 376 p. 9. Organization of independent work of students in the conditions of development of distance learning technology / DV Lepeshev. - Omsk: NOU VPO OmGA, 2014. - 112 p. 10. Kleynosova, N.P. Distance learning in the Moodle environment / N.P. Kleynosova, E.A. Kadyrova, I.A. Telkov, O.M. Baskakova, R.V. Khrunichev -, 2011. - 28 p.
Date of last amendment	20.01.2023

Module Name:	**Module 3: Current Problems of Technical Sciences**
Code	M3EPE(Ma)
Module Elements:	*Compulsory subjects* Scientific and Technical Problems of Electrical Power Engineering Current State of Electrical Power Engineering
Semester Number:	1, 2
Person responsible for the module	N.V. Zykova
Lecturer:	Scientific and Technical Problems of Electrical Power Engineering – N.V. Zykova Current State of Electrical Power Engineering – S.I. Latypov
Language:	Russian, Kazakh
Curriculum relation:	Electrical Power Engineering (Ma)
Type of teaching / number of hours per week and per semester :	1 semester: hours per week – 6 (lectures -1; workshops -1; independent work -4); hours per semester – 90. 2 semester: hours per week – 10 (lectures -2; workshops -2; independent work -6); hours per semester – 150.
Workload:	Teaching Load: 90 hours Extracurricular Classes: 150 hours Total: 240 hours
Credit Points:	8 ECTS
Conditions for Examinations:	For admission to the exam, the student must score at least 50 points out of 100 available for each subject of the module
Recommended Conditions:	The module is based on the knowledge gained in the course of undergraduate study modules: Power Systems and Networks, Electric Power Plants and Substations.
Expected Learning Outcomes:	**Know:** main problems of electric power engineering and ways to solve them; a list of issues related to the effectiveness of electrical complexes and systems; trends in the use of world energy resources and existing energy saving programmes. **Be able to:** conduct research and make practical calculations related to the reduction of power losses in power supply systems; assess various indicators of voltage quality and their impact on the operation of electrical devices. **Possess the skills:** identify ways to improve the efficiency of electric power systems. **Demonstrate the ability to:** learning and creative thinking.
Intendend use/applicability	Module: Optimization and Control in Electric Power Systems
Content:	*Scientific and Technical Problems of Electrical Power Engineering* General problems of energetics. Power and environment. Environmental problems of thermal power. Environmental problems of hydropower. Nuclear energy. Some ways to solve the problems of traditional energy. Use of renewable power resources. Power saving - a new power source. Energy-ecological problems of the Central Asian region. Hydrogen energy. The problem of modernization of the power industry in Kazakhstan. Problems of power transmission over long distances. Problems of implementation of microprocessor systems of relay protection. Solar energy. Power quality in power supply systems. Frequency and voltage deviation *Current State of Electrical Power Engineering* Mineral energy resources, production, transportation and storage

	of electrical energy, technogenic threats to nature and humanity and ways to limit them
Examination Form, module mark:	*Scientific and Technical Problems of Electrical Power Engineering* – Computer-based testing *Current State of Electrical Power Engineering* - written examination Module mark: the result of the exam *Current State of Electrical Power Engineering*
Technical/Multimedia Facilities:	Multimedia projector, interactive whiteboard, computers.
Study Materials:	1. Y. P. Volkov, V. A. Barinov, A. S. Manevich. Problems and Prospects of Electric Power Engineering Development. – M: Energoatomizdat, 2010. 2. A. V. Bolotov, G. A. Shepel in Electrotechnological Equipment. – M: VSH, 2010. 3. D. Dukenbayev. Power Engineering of Kazakhstan. Moving to Market. - Almaty.; Gylym, 2009. 4. Power Sources. Facts, Problems, Solutions. – M: Nauka i tekhnika, 2007. 5. K. Dukenbayev. Power Industry of Kazakhstan. Conditions and Mechanisms of its Sustainable Development. Almaty: Gylym, 2002 6. A.V. Lykin. Power Networks and Systems. – M.: Logos, 2007.
Date of last amendment	20.01.2023

Module Name:	**Module 4: Scientific Research 1**
Code	M4EPE(Ma)
Module Elements:	*Compulsory Subjects* Scientific Research
Semester Number:	1
Person responsible for the module	S.I. Latypov
Lecturer:	Scientific Research– S.I. Latypov
Language:	Russian, Kazakh
Curriculum relation:	Electrical Power Engineering (Ma)
Type of teaching / number of hours per week and per semester :	1 semester: hours per week – 14; hours per semester – 210. Scientific Research – 210 hours.
Workload:	Extracurricular Classes: 210 hours. Total:210 hours
Credit Points:	7 ECTS
Conditions for Examinations:	For admission to the report defense, the master's student must score at least 50 points out of 100 available for scientific research
Recommended Conditions:	-
Expected Learning Outcomes:	**Know:** main methods of optimization and management of electric power systems; basics of logic and technology of research; modern systems of control and metering of electric power; the scope of alternative power sources. **Be able to:** plan and conduct experiments in power plants. **Possess the skills:** logical and analytical thinking in solving problems and their proper documentation; use of modern systems of data processing and collection during the technical experiment; mathematical simulation in the study of power systems. **Demonstrate the ability to:** make an experiment in devices and systems of electric power; design controls of electrical technological processes and equipment.
Intendend use/applicability	Modules: Scientific Research 2, Final Academic Assessment
Content:	*Scientific Research 1* Selection of methods and development of the methodology of the study. Literature review and bibliography. Determination of structure and content of the master's thesis.
Examination Form, module mark:	*Scientific Research 1* – scientific research report defense
Technical/Multimedia Facilities:	Control and measuring equipment and devices of specialized laboratories, as well as modern multimedia systems.
Study Materials:	1. Scientific and Technical Text: Rules of Performance and Registration / T. Y. Teplitskaya. - Rostov-on-don : Phoenix, 2007. 2. Rules of Performance of Test Documents in Educational Process: Methodical Instructions on Registration of Abstracts, Standard Calculations, Term Papers for Students of Engineering Specialties – Petropavlovsk, 2002. 3. V. Y. Shishmarev. Units and Elements of Automatic Control Systems. - M: Akademiya, 2005. 4. A. A. Gerasimenko, V. T. Fedin. Transmission and Distribution of Electrical Power. – Rostov-on-Don, 2006 5. Edited by A. A. Okin. Regulations for Technical Operation of Electric Power Plants and Networks, M, 2001 6. V. N. Sazhin Power Systems and Networks. Lecture Notes.

	AIES, 2004, Almaty. 7. K. K. Tokhtibakiyev. Power Systems and Networks. Methods of Calculation of Power Losses and Their Rationing. Textbook, Almaty, 2005. 8. A. F. Monakhov. Protective Measures of Electrical Safety in Electrical Equipment. Textbook. M., ZAO Energoservis, 2008. 9. R. N. Karyakin. Grounding Devices of Electrical Equipment. Reference Book. - M.: Energoservis. 2006. 10. Y. D. Sibikin. Power Safety at Operation of Electrical Equipment of Industrial Enterprises. - M: Akademiya Publishing Center, 2008.
Date of last amendment	20.01.2023

Module Name:	**Module 5: Scientific Research 2**
Code	M5EPE(Ma)
Module Elements:	*Compulsory Subjects* Scientific Research
Semester Number:	2
Person responsible for the module	S.I. Latypov
Lecturer:	Scientific Research– S.I. Latypov
Language:	Russian, Kazakh
Curriculum relation:	Electrical Power Engineering (Ma)
Type of teaching / number of hours per week and per semester :	2 semester: hours per week – 14; hours per semester – 210. Scientific Research – 210 hours.
Workload:	Extracurricular Classes: 210 hours. Total:210 hours
Credit Points:	7 ECTS
Conditions for Examinations:	For admission to the report defense, the master's student must score at least 50 points out of 100 available for scientific research
Recommended Conditions:	Module: Scientific Research 1, Organizing of Scientific Research
Expected Learning Outcomes:	**Know:** main methods of optimization and control of electric power systems; basics of logic and technology of research; modern power control and measurement systems; application of alternative power sources. **Be able to:** plan and conduct experiments in electric power equipment. **Possess the skills:** logical and analytical thinking in solving problems and their proper documentation; use of modern systems of processing and data collection during the technical experiment; mathematical modeling in the study of electrical power systems. **Demonstrate the ability to:** set experiment in devices and systems of electrical power engineering; design of control systems for power engineering processes and equipment.
Intendend use/applicability	Modules: Scientific Research 3, Final Academic Assessment
Content:	*Scientific Research 2* Conducting theoretical research. Presentation of the results of theoretical research. Annual report at the meeting of the Department on the implementation of research works
Examination Form, module mark:	*Scientific Research 2* – scientific research report defense
Technical/Multimedia Facilities:	Control and measuring equipment and devices of specialized laboratories, as well as modern multimedia systems.
Study Materials:	1. Scientific and Technical Text: Rules of Performance and Registration / T. Y. Teplitskaya. - Rostov-on-don : Phoenix, 2007. 2. Rules of Performance of Test Documents in Educational Process: Methodical Instructions on Registration of Abstracts, Standard Calculations, Term Papers for Students of Engineering Specialties – Petropavlovsk, 2002. 3. V. Y. Shishmarev. Units and Elements of Automatic Control Systems. - M: Akademiya, 2005. 4. A. A. Gerasimenko, V. T. Fedin. Transmission and Distribution of Electrical Power. – Rostov-on-Don, 2006 5. Edited by A. A. Okin. Regulations for Technical Operation of Electric Power Plants and Networks, M, 2001 6. V. N. Sazhin Power Systems and Networks. Lecture Notes. AIES, 2004, Almaty.

	7. K. K. Tokhtibakiyev. Power Systems and Networks. Methods of Calculation of Power Losses and Their Rationing. Textbook, Almaty, 2005. 8. A. F. Monakhov. Protective Measures of Electrical Safety in Electrical Equipment. Textbook. M., ZAO Energoservis, 2008. 9. R. N. Karyakin. Grounding Devices of Electrical Equipment. Reference Book. - M.: Energoservis. 2006. 10. Y. D. Sibikin. Power Safety at Operation of Electrical Equipment of Industrial Enterprises. - M: Akademiya Publishing Center, 2008.
Date of last amendment	20.01.2023

Module Name:	**Module 6: Scientific Research 3**
Code	M6EPE(Ma)
Module Elements:	*Compulsory Subjects* Scientific Research
Semester Number:	3
Person responsible for the module	S.I. Latypov
Lecturer:	Scientific Research– S.I. Latypov
Language:	Russian, Kazakh
Curriculum relation:	Electrical Power Engineering (Ma)
Type of teaching / number of hours per week and per semester :	3 semester: hours per week – 14; hours per semester – 210. Scientific Research – 210 hours.
Workload:	Extracurricular Classes: 210 hours. Total:210 hours
Credit Points:	7 ECTS
Conditions for Examinations:	For admission to the report defense, the master's student must score at least 50 points out of 100 available for scientific research
Recommended Conditions:	Module: Scientific Research 2, Organizing of Scientific Research
Expected Learning Outcomes:	**Know:** main methods of optimization and control of electric power systems; basics of logic and technology of research; modern power control and measurement systems; application of alternative power sources. **Be able to:** plan and conduct experiments in electric power equipment. **Possess the skills:** logical and analytical thinking in solving problems and their proper documentation; use of modern systems of processing and data collection during the technical experiment; mathematical modeling in the study of electrical power systems. **Demonstrate the ability to:** set experiment in devices and systems of electrical power engineering; design of control systems for power engineering processes and equipment.
Intendend use/applicability	Modules: Scientific Research 4, Final Academic Assessment
Content:	*Scientific Research 3* Clarification of the topic, structure and content of the master's thesis. Conducting an experimental study. Presentation of the results of the experimental study.
Examination Form, module mark:	*Scientific Research 3* – scientific research report defense
Technical/Multimedia Facilities:	Control and measuring equipment and devices of specialized laboratories, as well as modern multimedia systems.
Study Materials:	1. Scientific and Technical Text: Rules of Performance and Registration / T. Y. Teplitskaya. - Rostov-on-don : Phoenix, 2007. 2. Rules of Performance of Test Documents in Educational Process: Methodical Instructions on Registration of Abstracts, Standard Calculations, Term Papers for Students of Engineering Specialties – Petropavlovsk, 2002. 3. V. Y. Shishmarev. Units and Elements of Automatic Control Systems. - M: Akademiya, 2005. 4. A. A. Gerasimenko, V. T. Fedin. Transmission and Distribution of Electrical Power. – Rostov-on-Don, 2006 5. Edited by A. A. Okin. Regulations for Technical Operation of Electric Power Plants and Networks, M, 2001

	6. V. N. Sazhin Power Systems and Networks. Lecture Notes. AIES, 2004, Almaty. 7. K. K. Tokhtibakiyev. Power Systems and Networks. Methods of Calculation of Power Losses and Their Rationing. Textbook, Almaty, 2005. 8. A. F. Monakhov. Protective Measures of Electrical Safety in Electrical Equipment. Textbook. M., ZAO Energoservis, 2008. 9. R. N. Karyakin. Grounding Devices of Electrical Equipment. Reference Book. - M.: Energoservis. 2006. 10. Y. D. Sibikin. Power Safety at Operation of Electrical Equipment of Industrial Enterprises. - M: Akademiya Publishing Center, 2008.
Date of last amendment	20.01.2023

Module Name:	**Module 7: Teaching Practice**
Code	M7EPE(Ma)
Module Elements:	*Compulsory Subjects* Teaching Practice
Semester Number:	3
Person responsible for the module	S.I. Latypov
Lecturer:	Teaching Practice - S.I. Latypov
Language:	Russian, Kazakh
Curriculum relation:	Electrical Power Engineering (Ma)
Type of teaching / number of hours per week and per semester :	3 semester: hours per week –6; hours per semester – 90. Teaching Practice – 90 hours.
Workload:	Extracurricular Classes: 90 hours. Total:90 hours
Credit Points:	3 ECTS
Conditions for Examinations:	For admission to the report defense, the master's student must score at least 50 points out of 100 available for teaching practice.
Recommended Conditions:	Module: Psychological and Pedagogical Education
Expected Learning Outcomes:	**Know:** methods and techniques of teaching activities, including those of innovative nature. **Be able to:** apply knowledge of pedagogy and psychology of higher education in teaching activities; apply interactive teaching methods; critically analyze existing concepts, theories and approaches to the analysis of processes and phenomena; integrate knowledge gained in different subjects to solve research problems in new unfamiliar conditions. **Possess the skills:** implementation of educational and pedagogical activity on credit technology of training; methods of teaching professional disciplines; use of modern information technologies in the educational process; professional communication and intercultural communication; public speaking, correct and logical design of one's own thoughts in oral and written form. **Demonstrate the ability to:** implementation of educational activities, including those of innovative nature.
Intendend use/applicability	Module: Final Academic Assessment
Content:	*Teaching Practice* Introduction to scientific and pedagogical activity. Implementation of pedagogical activity. Familiarization with the material technical base. Work with regulatory documents.
Examination Form, module mark:	*Teaching Practice* – Practice report defense
Technical/Multimedia Facilities:	Control and measuring equipment and devices of specialized laboratories.
Study Materials:	1. Scientific and Technical Text: Rules of Performance and Registration / T. Y. Teplitskaya. - Rostov-on-don : Phoenix, 2007. 2. Rules of Performance of Test Documents in Educational Process: Methodical Instructions on Registration of Abstracts, Standard Calculations, Term Papers for Students of Engineering Specialties – Petropavlovsk, 2002. 3. Edited by A. A. Okin, Technical Operation of Electric Power Plants and Networks, M, 2001

	4. V. V. Davydov. Problems of Developmental Education. – M: Publishing center Akademiya, 2004. – 288 p. 5. S. M. Dzhakupov. Psychological Structure of Teaching Process. Almaty: Kazak universitety, 2004. – 311 p. 6. S. M. Dzhakupov. Management of Cognitive Activity of Students in the Teaching Process. Almaty, 2002. – 117 p. 7. I.A. Zimnaya. Pedagogical Psychology. – M.: Logos, 2002. – 384 p. 8. S. D. Smirnov. Pedagogy and Psychology of Higher Education: from Activity to Personality. – M., 2001. – 304 p.
Date of last amendment	20.01.2023

Module Name:	**Module 8: Scientific Research 4**
Code	M8EPE(Ma)
Module Elements:	*Compulsory Subjects* Scientific Research
Semester Number:	4
Person responsible for the module	S.I. Latypov
Lecturer:	Scientific Research – S.I. Latypov
Language:	Russian, Kazakh
Curriculum relation:	Electrical Power Engineering (Ma)
Type of teaching / number of hours per week and per semester :	4 semester: hours per week – 14; hours per semester – 210. Scientific Research – 210 hours.
Workload:	Extracurricular Classes: 210 hours. Total: 210 hours
Credit Points:	7 ECTS
Conditions for Examinations:	For admission to the report defense, the master's student must score at least 50 points out of 100 available for scientific research
Recommended Conditions:	Modules: Scientific Research 3, Organizing of Scientific Research
Expected Learning Outcomes:	**Know:** main methods of optimization and control of electric power systems; basics of logic and technology of research; modern power control and measurement systems; application of alternative power sources. **Be able to:** plan and conduct experiments in electric power equipment. **Possess the skills:** logical and analytical thinking in solving problems and their proper documentation; use of modern systems of processing and data collection during the technical experiment; mathematical modeling in the study of electrical power systems. **Demonstrate the ability to:** set experiment in devices and systems of electrical power engineering; design of control systems for power engineering processes and equipment.
Intendend use/applicability	Module: Final Academic Assessment
Content:	*Scientific Research 4* Description and structuring of the final methodology of the scientific experiment on the scientific problem. Generalizations of adjusted models. Publication of the results of the study. Formalization of scientific research in a logical structure.
Examination Form, module mark:	*Scientific Research 4* – Scientific Research Report Defense
Technical/Multimedia Facilities:	Control and measuring equipment and devices of specialized laboratories, as well as modern multimedia systems.
Study Materials:	1. Scientific and Technical Text: Rules of Performance and Registration / T. Y. Teplitskaya. - Rostov-on-don : Phoenix, 2007. 2. Rules of Performance of Test Documents in Educational Process: Methodical Instructions on Registration of Abstracts, Standard Calculations, Term Papers for Students of Engineering Specialties – Petropavlovsk, 2002. 3. V. Y. Shishmarev. Units and Elements of Automatic Control Systems. - M: Akademiya, 2005. 4. A. A. Gerasimenko, V. T. Fedin. Transmission and Distribution of Electrical Power. – Rostov-on-Don, 2006 5. Edited by A. A. Okin. Regulations for Technical Operation

	of Electric Power Plants and Networks, M, 2001 6. V. N. Sazhin Power Systems and Networks. Lecture Notes. AIES, 2004, Almaty. 7. K. K. Tokhtibakiyev. Power Systems and Networks. Methods of Calculation of Power Losses and Their Rationing. Textbook, Almaty, 2005. 8. A. F. Monakhov. Protective Measures of Electrical Safety in Electrical Equipment. Textbook. M., ZAO Energoservis, 2008. 9. R. N. Karyakin. Grounding Devices of Electrical Equipment. Reference Book. - M.: Energoservis. 2006. 10. Y. D. Sibikin. Power Safety at Operation of Electrical Equipment of Industrial Enterprises. - M: Akademiya Publishing Center, 2008.
Date of last amendment	20.01.2023

Module Name:	**Module 9: Research Scientific Training**
Code	M9EPE(Ma)
Module Elements:	*Compulsory Subjects* Research Scientific Training
Semester Number:	4
Person responsible for the module	S.I. Latypov
Lecturer:	Research Scientific Training - S.I. Latypov
Language:	Russian, Kazakh
Curriculum relation:	Electrical Power Engineering (Ma)
Type of teaching / number of hours per week and per semester :	4 semester: hours per week – 16; hours per semester – 240. Research Scientific Training – 240 hours.
Workload:	Extracurricular Classes: 240 hours. Total: 240 hours
Credit Points:	8 ECTS
Conditions for Examinations:	For admission to the report defense, the master's student must score at least 50 points out of 100 available for the training
Recommended Conditions:	Completion of theoretical training on the degree programme
Expected Learning Outcomes:	**Know:** principles of operation and arrangement of different types of electrical machines and transformers; physical phenomena occurring in electrical machines and transformers under different operating conditions and their mathematical description; main properties of machines and transformers. **Be able to** select electrical machines and transformers for specific practice conditions; analyze and describe processes in systems including electrical machines and transformers; conduct tests of electrical machines and transformers. **Possess the skills:** operation and repair of electric machines. **Demonstrate the ability to:** select the type of electrical machines for specific processes.
Intendend use/applicability	Module: Final Academic Assessment
Content:	*Research Scientific Training* Studying the material technical base. Work with regulatory documents. Collection of materials on the research topic. Organization of work on the development and creation of electronic devices and systems. Processing of the collected material on the research topic.
Examination Form, module mark:	*Research Scientific Training* – Training report defense
Technical/Multimedia Facilities:	Control and measuring equipment, electrical tools, instruments and systems of specialized laboratories, as well as modern multimedia systems.
Study Materials:	1. Scientific and Technical Text: Rules of Performance and Registration / T. Y. Teplitskaya. - Rostov-on-don : Phoenix, 2007. 2. V. Y. Shishmarev. Units and Elements of Automatic Control Systems. - M: Akademiya, 2005. 3. A. A. Gerasimenko, V. T. Fedin. Transmission and Distribution of Electrical Power. – Rostov-on-Don, 2006 4. Edited by A. A. Okin. Regulations for Technical Operation of Electric Power Plants and Networks, M, 2001 5. V. N. Sazhin Power Systems and Networks. Lecture Notes. AIES, 2004, Almaty. 6. K. K. Tokhtibakiyev. Power Systems and Networks. Methods of Calculation of Power Losses and Their Rationing. Textbook, Almaty, 2005. 7. A. F. Monakhov. Protective Measures of Electrical Safety in

	Electrical Equipment. Textbook. M., ZAO Energoservis, 2008. 8. Y. D. Sibikin. Power Safety at Operation of Electrical Equipment of Industrial Enterprises. - M: Akademiya Publishing Center, 2008. 9. V. N. Kopyev. Relay Protection. Tomsk, 2001 10. B. A. Alekseyev, Maintenance of Relay Protection and Automation of Power Plants and Power Networks. Part 1. Electromagnetic Relay. / Ed M. Publishing House of the NC ENAS, 2000
Date of last amendment	20.01.2023

Module Name:	**Module 10: Final Academic Assessment**
Code	M10REET(Ma)
Module Elements:	*Compulsory Subjects* Comprehensive examination Development and Defense of Master's Thesis
Semester Number:	4
Person responsible for the module	A.A. Kashevkin
Lecturer:	Comprehensive examination - A.A. Kashevkin Development and Defense of Master's Thesis - A.A. Kashevkin
Language:	Russian, Kazakh
Curriculum relation:	Electrical Power Engineering (Ma)
Type of teaching / number of hours per week and per semester :	8 semester: hours per semester – 450.
Workload:	Extracurricular Classes: 450 hours. Total: 450 hours
Credit Points:	15 ECTS
Conditions for Examinations:	Completion of the degree programme.
Recommended Conditions:	Successful completion of all previous master's degree modules.
Expected Learning Outcomes:	**Know:** the basic requirements for the content and rules of the thesis. **Be able to:** integrate the knowledge gained in different subjects, use them to solve analytical and management problems in new unfamiliar conditions; summarize the results of research and analytical work in the form of a thesis, scientific article, report, analytical note, etc. **Possess the skills** of public speaking, correct and logical design of one's thoughts in oral and written form. **Demonstrate the ability to:** analyze and summarize information, use it to solve problems.
Intendend use/applicability	Professional activity
Content:	*Comprehensive examination* Automatic control and metering systems. High voltage technique. Application of microprocessors in electric power systems. Scientific and Technical Problems of Electrical Power Engineering. Automatic Control and Metering Systems. High-Voltage Engineering. Application of Microprocessors in Electric Power Systems. Scientific and Technical Problems of Electrical Power Engineering. *Development and Defense of Master's Thesis* Critical analysis of the problem, the proposed ways to solve the problem, confirmation of the results of the study indicating their practical application and prospects.
Examination Form, module mark:	*Comprehensive examination* - Oral examination *Development and Defense of Master's Thesis* – Thesis Defense
Technical/Multimedia Facilities:	Control and measuring equipment and devices of specialized laboratories, as well as modern multimedia systems.
Study Materials:	1. Scientific and Technical Text: Rules of Performance and Registration / T. Y. Teplitskaya. - Rostov-on-don : Phoenix, 2007. 2. Rules of Performance of Test Documents in Educational Process: Methodical Instructions on Registration of Abstracts, Standard Calculations, Term Papers for Students of Engineering

	Specialties – Petropavlovsk, 2002. 3. V. Y. Shishmarev. Units and Elements of Automatic Control Systems. - M: Akademiya, 2005. 4. A. A. Gerasimenko, V. T. Fedin. Transmission and Distribution of Electrical Power. – Rostov-on-Don, 2006 5. Edited by A. A. Okin. Regulations for Technical Operation of Electric Power Plants and Networks, M, 2001 6. V. N. Sazhin Power Systems and Networks. Lecture Notes. AIES, 2004, Almaty. 7. K. K. Tokhtibakiyev. Power Systems and Networks. Methods of Calculation of Power Losses and Their Rationing. Textbook, Almaty, 2005. 8. A. F. Monakhov. Protective Measures of Electrical Safety in Electrical Equipment. Textbook. M., ZAO Energoservis, 2008. 9. R. N. Karyakin. Grounding Devices of Electrical Equipment. Reference Book. - M.: Energoservis. 2006. 10. Y. D. Sibikin. Power Safety at Operation of Electrical Equipment of Industrial Enterprises. - M: Akademiya Publishing Center, 2008.
Date of last amendment	20.01.2023

Module Name:	**Module 11: Organizing of Scientific Research**
Code	M11EPE(Ma)
Module Elements:	*Electice Subjects* Research Management Commercialization of Scientific Projects Methods of Organizing of Scientific Research Methods of Organization of Work with Scientific Texts (in Kazakh)
Semester Number:	1
Person responsible for the module	Y.V. Gerasimova
Lecturer:	Research Management - Y.V. Gerasimova Commercialization of Scientific Projects – V.P. Ivel Methods of Organization of Scientific Research – Y.V. Gerasimova Methods of Organization of Work with Scientific Texts (in Kazakh) – S.S. Moldakhmetov
Language:	Russian, Kazakh
Curriculum relation:	Electrical Power Engineering (Ma)
Type of teaching / number of hours per week and per semester :	1 semester: hours per week – 16 (lectures -3; workshops -3; independent work -10); hours per semester – 240.
Workload:	Teaching Load: 90 hours Extracurricular Classes: 150 hours Total: 240 hours
Credit Points:	8 ECTS
Conditions for Examinations:	For admission to the exam, the student must score at least 50 points out of 100 available for each subject of the module
Recommended Conditions:	The module is based on the knowledge gained in the course of undergraduate study modules: Philosophy, Technologies of Technogenic Risk Management.
Expected Learning Outcomes:	**Know:** methodology, and methods of scientific research; types of scientific projects and basic principles of their management; legislative bases of science management and its organizational structure; methods of commercialization of intellectual property; methods of preparation of experimental studies and processing of the results; methods and means of computer simulation of systems; technologies and means of information processing and evaluation of results in relation to solving professional problems. **Be able to:** solve problems related to the management of scientific research, perform the functions of a manager in the management of a scientific project; see the ways of optimization at various stages of design; simulate in simulation environments; integrate the knowledge gained in different disciplines to solve research problems in new unfamiliar conditions. **Possess the skills:** apply modern systems of data processing and collection within the technical experiment; mathematical simulation in the study of power systems. **Demonstrate the ability:** in the design of devices and systems by simulation using specialized software products; in the creation of knowledge bases of expert systems.
Intendend use/applicability	Modules: Support of the Experiment, Scientific Research 2, Scientific Research 3, Scientific Research 4, Research Scientific Training
Content:	*Research Management* Basic concepts related to research in general, main goals and approaches of scientific research. In addition, the following

	functions of research management are considered: planning, organization, motivation and control, as well as the legislative framework of science management. *Commercialization of Scientific Projects* Basic concepts related to research in general, main goals and approaches of scientific research. In addition, the following functions of research management are considered: planning, organization, motivation and control, as well as the legislative framework of science management. *Methods of Organization of Scientific Research* Main stages and deadlines of research. Structural elements of the thesis (theme, relevance, problem, contradiction, object, subject, purpose, tasks, hypothesis). Structural elements of the thesis (methods, scientific novelty, theoretical and practical significance). Methodology and methods of scientific research. Experiment as a research method. Statistical research methods (basics). Statistical research methods (research data analysis). Work with scientific literature. Language and style of scientific speech. Publication of research results. The logic of science. Organization of defense of master's thesis. Modern development of science in Kazakhstan. *Methods of Organization of Work with Scientific Texts (in Kazakh)* This discipline is aimed at the formation of skills of writing scientific texts (annotation, reference paper, abstract, report, essay, comment, etc.) and skills of working with scientific literature in the Kazakh language.
Examination Form, module mark:	*Research Managemen* - computer-based testing *Commercialization of Scientific Projects* - written examination *Modern Methods of Measurement in Radio Engineering and Telecommunication Networks* - computer-based testing *Methods of Organization of Work with Scientific Texts (in Kazakh)* - written examination Module mark: written examination *Elective Subject*
Technical/Multimedia Facilities:	Multimedia projector, interactive whiteboard, computers.
Study Materials:	1. A. M. Novikov. Methodology of Scientific Research: Textbook. -M: LIBROKOM, 2010. 280 p. 2. A.V. Pavlov. Logic and Methodology of Science. Modern Humanitarian Knowledge and its Prospects. - M.:Flinta: Nauka, 2010.- 344 p. 3. Law of the Republic of Kazakhstan on Copyright and Related Rights. 4. Law of the Republic of Kazakhstan on Innovations. 5. Patent Law of the Republic of Kazakhstan. 6. Law of the Republic of Kazakhstan on Science". 7. A. Zakharova, T. Zakharova. How to Write and Defend a Thesis. SPb.: Piter, 2007. -160 p. 8. M. F. Shklyar. Basics of Scientific Research: Textbook .-M: Dashkov i K, 2008.-244 p. 9. A. N. Dzhurinskiy. Development of Education in the Modern World: Textbook.-2nd ed. - M:VLADOS, 2003.-240 p. 10. A. F. Anufriyev, Scientific Study. Course papers, Theses and Dissertations. - 3rd ed.- M. : Os-89, 2007. - 112 p.
Date of last amendment	20.01.2023

Module Name:	**Module 12: Support of the Experiment**
Code	M12EPE(Ma)
Module Elements:	*Elective subjects* Theory of Simulation and Scientific Experiment Wavelet Theory Application of Microprocessors in Electric Power Systems Microprocessor-Based Automatic Control Systems Digital Automation and Control Systems in Electric Power Engineering Information Technologies in Electric Power Engineering Network Technologies Elements of Artificial Intelligence in Technical Systems System Simulation Intelligent Measuring Instruments Systems of Computer Mathematics Visual Simulation Systems Automated Data Collection Systems
Semester Number:	2
Person responsible for the module	A.A. Savostin
Lecturer:	Theory of Simulation and Scientific Experiment – – A.I. Poleschuk Wavelet Theory – A.A. Savostin Application of Microprocessors in Electric Power Systems – D.V. Ritter Microprocessor-Based Automatic Control Systems – D.V. Ritter Digital Automation and Control Systems in Electric Power Engineering – D.V. Ritter Information Technologies in Electric Power Engineering – A.I. Poleschuk Network Technologies – D.V. Ritter Elements of Artificial Intelligence in Technical Systems – A.A. Savostin System Simulation – A.A. Savostin Intelligent Measuring Instruments – A.I. Poleschuk Systems of Computer Mathematics – A.A. Savostin Visual Simulation Systems – A.A. Savostin Automated Data Collection Systems – A.A. Savostin
Language:	Russian, Kazakh
Curriculum relation:	Electrical Power Engineering (Ma)
Type of teaching / number of hours per week and per semester :	2 semester: hours per week – 30 (lectures -6; workshops -6; independent work -18); hours per semester – 300.
Workload:	Teaching Load: 180 hours Extracurricular Classes: 270 hours Total: 450 hours
Credit Points:	15 ECTS
Conditions for Examinations:	For admission to the exam, the master's student must score at least 50 points out of 100 available for the subject of the module
Recommended Conditions:	Module: Organizing of Scientific Research
Expected Learning Outcomes:	**Know:** methods of experimental and computational and theoretical research; principles of modeling, methods of representation of models of control systems for industrial use; principles of the solution of technical problems of measurements with the use of modern hardware and software,

	architecture and algorithms of functioning of universal measuring interfaces, universal languages; special languages; simulation environments; theoretical and practical aspects of obtaining, formalization and structuring of problem knowledge; technologies and means of information processing and evaluation of results in relation to the solution of professional problems; general issues of construction of measuring systems using modern computer technology; principles of solving technical problems of measurement with application of modern hardware and software architecture and algorithms of universal measuring interfaces; methods of preparation of experimental studies and processing of the obtained results; tools such as MathCAD, MATLAB, LabVEIW for processing of experimental data; universal languages; specialized languages; simulation environment; methods and facility of computer simulation of systems; classification of artificial intelligence systems (AIS), models of knowledge representation, output solutions and communication models in AIS; theoretical and practical aspects of obtaining, formalization and structuring of problem knowledge; technology and means of information processing and evaluation of results in relation to the solution of professional problems; basic theoretical information on the problems of artificial intelligence, applied models and methods of their analysis and building skills and abilities. **Be able to:** use the methods of digital signal processing; organize research and production work; determine the optimal level of power loss in electrical networks by the criterion of minimum cost of power transmission, as well as to apply the methodology of step-by-step optimization of electrical networks by topological and regime properties; use the knowledge gained for the original development and application of ideas in the context of scientific research; choose numerical methods for modeling electrical power systems or develop a new algorithm for solving the problem; to calculate and analyze schemes in various systems of computer mathematics; to see ways of optimization at various stages of design; to simulate in simulation environments; build mathematical models for analysis and optimization of objects, to select numerical methods for their simulation or to develop a new algorithm for solving the problem; conduct calculation and analysis of schemes in various systems of computer mathematics; to model in simulation environments, to formalize and to structure the problem of knowledge. **Possess the skills:** extension and deepening of knowledge required for everyday professional activity and further education in doctoral studies; use of modern systems of data processing and collection during the technical experiment; design of controls for electrotechnological processes and equipment; use of microprocessor-based automatic control systems; apply modern systems of data processing and collection within the technical experiment; mathematical simulation in the study of power systems. **Demonstrate the ability:** in the analysis of the state of the power system and methods of regulation of its modes; in the design of electric drive control systems; in the application of the mathematical apparatus of wavelet transform; in the field

	of synthesis of digital control systems using modern engineering design software, digital automation and control systems in the electric power engineering; in the design of devices and systems by simulation using specialized software products; in the creation of knowledge bases of expert systems.
Intendend use/applicability	Modules: Research Scientific Training, Final Academic Assessment
Content:	*Theory of Simulation and Scientific Experiment* Classification, types and objectives of the experiment, single-factor and multifactorial experiment, experimental technique. Measurement methods, absolute and relative errors, single and multiple measurements. Mathematical statistics, tasks and main sections of mathematical statistics, general and sample population, sampling, sample representativeness, sample parameterization, application of built-in Excel tools for statistical data processing. Investigation of experimental data on the reliability and reproducibility of the experimental results. *Wavelet Theory* Optimization problems, linear programming, objective function, constraints in the form of equations and inequalities, least squares method. A trend line, approximating functions, accuracy of approximation, the coefficients of determination. Application of the wavelet theory. *Application of Microprocessors in Electric Power Systems* Philosophy of microprocessor technology. Bus microprocessor systems and cycles of exchange. Backbone device features. Addressing operands. Command system of the processor. Processor core and microcontroller memory. Organization of communication of the microcontroller with the environment and time. Auxiliary hardware of the microcontroller. *Microprocessor-Based Automatic Control Systems* AVR microcontrollers. Introduction to Arduino. Download and run the sample sketch in IDE Arduino. Arduino. Creating one's own sketch. Use of mathematical operators. Serial interface. Arduino. Digital and analog input. Receiving input data from sensors. Arduino. Physical and visual data output. Arduino. The use of PWM signals generated by Arduino. Arduino. Remote control of external devices. Arduino. Real-time clock usage. Arduino. Using the display. Arduino. I2C and SPI data interfaces. Arduino. Communication via wireless interfaces. Automated ZigBee technology. The system of commands used in ZigBee technology. *Digital Automation and Control Systems in Electric Power Engineering* PIC series of microcontroller hardware. Special functions and command system of PIC series microcontrollers. Features of development of digital devices based on microcontrollers. Software development for PIC microcontrollers. Architecture and processors of personal computers. Development of simple digital devices. Devices that are part of a personal computer. *Information Technologies in Electric Power Engineering* Structure and content of the course. Signal Coordination Systems. Asynchronous input/output of digital signals: line, port. Synchronous input/output of digital arrays. Organization

	of communication of data analysis systems with the external environment and time. Measurement errors. Regulation of errors and correction of measurement results. Modeling of intelligent systems. Equal and unequal measurements. Single measurements. Indirect measurements. Logical-linguistic description of systems. Normalization of metrological properties of measuring tools. Additive and multiplicative component of the measuring tool error. Connection layout of measuring devices. The calculation of the error of the measuring system. *Network Technologies* Local networks and their topology. Place and role of local networks. Media of information communication. Wireless communication channels. Optic cable. The levels of network architecture. OSI reference model. The apparatus of local networks. Protection of information in local networks. Standard local networks. Ethernet and Fast Ethernet Ethernet/fast ethernet network algorithms. Standard Ethernet and fast Ethernet segments. Logical network structuring using bridges and switches. Principles of network interconnection based on network layer protocols. The main characteristics of routers and hubs. Domains. Global network. Monitoring and analysis of local networks. Main stages of professional development of personality and their characteristics. *Elements of Artificial Intelligence in Technical Systems* Philosophical aspects of AIS problem. History of the development of AIS. Analog I / o. Issues of AIS Simulation. Expert system as a kind of AIS. Coordination of the signals. The methodology for developing expert systems. Models of knowledge representation. Models of decisions output and communication in AIS. Fuzzy sets. Fuzzy relations. Fuzzy and linguistic variables. Fuzzy statements and fuzzy system models. Logical-linguistic description of systems. Artificial neural network. *System Simulation* Classification of system models. Methods of simulation of electric power systems. Methods of description of electric power equipment as a control object. Structural and mathematical models. Simulation modeling. *Intelligent Measuring Instruments* Structure and content of the course of Intelligent Measuring Instruments. Initial provisions and review of the state of research on the intellectualization of measurements and measuring instruments. Application of nanostructures in the measuring instruments. Artificial neural network. Modern directions of development of neural network technologies. Application of neural networks to solve practical problems. Methods of knowledge formalization. Model of measuring knowledge representation. Features of the hardware of intelligent measuring instruments. Features of the software of intelligent systems. *Systems of Computer Mathematics* Introduction. Evolution of computer mathematics systems. System of computer mathematics MathCAD. Organization of calculations. Data types. System of computer mathematics MATLAB.

	Visual Simulation Systems Programming in MATLAB. Functions of applied and numerical mathematics. Classes of computational objects. Digital signal processing. Signal Processing Toolbox. Procedures of spectral (frequency) and statistical analysis of processes. *Automated Data Collection Systems* Filters design. Investigation of linear stationary systems. Modeling of nonlinear systems (Simulink package). Matlab expansion packs. Interface design. LabVIEW modeling and data acquisition system.
Examination Form, module mark:	*Theory of Simulation and Scientific Experiment* - written examination *Wavelet Theory* – Computer-based testing *Application of Microprocessors in Electric Power Systems*– Computer-based testing *Microprocessor-Based Automatic Control Systems*– Computer-based testing *Digital Automation and Control Systems in Electric Power Engineering* – written control examination *Information Technologies in Electric Power Engineering* – Computer-based testing *Network Technologies* – written control examination *Elements of Artificial Intelligence in Technical Systems*– Computer-based testing *System Simulation*– Computer-based testing *Intelligent Measuring Instruments* - written examination *Systems of Computer Mathematics*- Computer-based testing *Visual Simulation Systems*- Computer-based testing *Automated Data Collection Systems* - Computer-based testing Module mark: written examination *Elective Subject*
Technical/Multimedia Facilities:	Multimedia system Laboratories of Computer Mathematics and Electronic Simulation, Simulation of Power Devices and Systems, Digital Devices and Microprocessors and Electrical Power Engineering
Study Materials:	1. A. Y.Grishentsev. Theory and Practice of Technical and Technological Experiment. - SPb.: SPbSU ITMO, 2010. 102 p. 2. V. N. Vapnik. Restoration of Dependencies according to Empirical Data, 2001. 6. T-FLEX CAD. 3D-Modeling. User manual (electronic document), M.: AO Top Systemy, 2007. 7. A. S. Uvarov, P-CAD. Design and Construction of Electronic Devices., M.: Goryachaya liniya-Telekom, 2004. 8. O. I. Shelukhin, Modeling of Information Systems, M.: Radiotekhnika, 2005. 9. Y. B. Kolesov, Y. B. Senichenkov, System Simulation. Object-Oriented Approach, SPb.: BHV-Petersburg, 2006. 3. Sid Katcen. The Quitessential PIC Microcontroller: translated from English by A. V. Yevstifeyeva. - Moscow : Dodeka-XXI, 2010 .- 656 p. 4. B. Brey Applying PIC 18 Microcontrollers. Architecture, Programming, and Interfacing Using C and Assembly: translated from English - K.: MK-Press, SPb Korona-Vek, 2008.-576 p. 5. S. V. Yakubovskiy, Analog and Digital Integrated Circuits.

	Reference book, M.: Radio i svyaz, 2009 6. V. I. Boyko. Microprocessors and Microcontrollers. S.-P.: BHV-Petersburg, 2005. 7. V. B. Brodin, A.V. Kalinin. Systems on microcontrollers and LSI of programmable logic. M.: EKOM Publishing house, 2007. 8. Hunte. Artificial Intelligence, Moscow, 2000.. – No. 3 – P. 69-71. 9. P. V. Novitskiy Basics of Information Theory of Measuring Devices. - L.: Energiya. 2012. - 248 p. 10. Guide to the Expression of Uncertainty in Measurement, ed. by Prof V. A. Slayev; Translation and publishing enterprise VNIIM named after. D. I. Mendeleyev. -SPb.: OOSG Tipografiya LITAS+, 2010,- 126 p. 11. J.-L. Lorier, Artificial Intelligence Systems, M. Mir, 2014. 12. P. V. Novitskiy Basics of Information Theory of Measuring Devices. - L.: Energiya. 2012. - 248 p. 13. Guide to the Expression of Uncertainty in Measurement, ed. by Prof V. A. Slayev; Translation and publishing enterprise VNIIM named after. D. I. Mendeleyev. -SPb.: OOSG Tipografiya LITAS+, 2010,- 126 p. 14. D. Kiryanov MathCAD 11. SPb.: BHV - St. Petersburg, 2013. 15. Y. L. Ketkov, A.Y. Ketkov, M.M. Schulz. MATLAB 7: Programming ,Numerical Methods. SPb.: BHV-Petersburg, 2014. — 752 p.: with pictures. 16. V. P. Dyakonov MATLAB 6.5 SP1/7 + Simulink 5/6* in Mathematics and Modeling. Series: Library of Professionals. - M.: SOLON-Press, 2014. 576 p.: with pictures. 17. D. Trevis. LabVIEW for Everyone. M.: Goryachaya liniya-Telekom, 2015. 18. A. M. Polovko, P.N. Butusov. MATLAB for a Student. SPb.; BHV-Petersburg. – 2005. – 320 p. 19. E. R. Alekseyev, O. V. Chesnokova. Solution of Problems in Computational Mathematics Packages such as MathCad 12, MATLAB 7 and Maple 9. M.: NT Press, 2006. – 469 p. 20. V.Ochkov. MathCAD 12. SPb.: BHV - St. Petersburg, 2005.
Date of last amendment	20.01.2023

Module Name:	**Module 13: Optimization and Control in Electric Power Systems**
Code	M13EPE(Ma)
Module Elements:	*Elective subjects* Modes of Operation of Electric Power Systems Reliability of Electric Power Systems Automatic Control and Metering Systems Self-Contained Power Supply Systems Operation of Power Systems High-Voltage Engineering Long-Distance EHV Power Transmission Power Transmission and DC Links Engineering in Electric Power Industry Power Losses in Electrical Power Networks Energy Saving in Power Supply Systems Cable Lines of Power Supply Systems Air Power Supply Lines Power Supply Systems of Cities and Industrial Enterprises Automation and Relay Protection Systems Emergency Automation Short Circuits in Electric Power Systems Theory of Automated Electric Drive
Semester Number:	3
Person responsible for the module	S.I. Latypov
Lecturer:	Modes of Operation of Electric Power Systems– S.I. Latypov Automatic Control and Metering Systems – S.I. Latypov Self-Contained Power Supply Systems – S.I. Latypov Operation of Power Systems – S.I. Latypov High-Voltage Engineering – A.A. Kashevkin Long-Distance EHV Power Transmission – A.A. Kashevkin Power Transmission and DC Links – A.A. Kashevkin Engineering in Electric Power Industry – A.I. Poleschuk Power Losses in Electrical Power Networks – A.I. Poleschuk Energy Saving in Power Supply Systems – A.I. Poleschuk Cable Lines of Power Supply Systems – A.A. Kashevkin Air Power Supply Lines – A.A. Kashevkin Power Supply Systems of Cities and Industrial Enterprises – A.A. Kashevkin Automation and Relay Protection Systems – S.I. Latypov Emergency Automation – S.I. Latypov Short Circuits in Electric Power Systems – S.I. Latypov Theory of Automated Electric Drive – A.A. Kashevkin Reliability of Electric Power Systems – S.I. Latypov
Language:	Russian, Kazakh
Curriculum relation:	Electrical Power Engineering (Ma)
Type of teaching / number of hours per week and per semester :	3 semester: hours per week – 40 (lectures -7; workshops -7; independent work -26); hours per semester – 600.
Workload:	Teaching Load: 210 hours Extracurricular Classes: 390 hours Total: 600 hours
Credit Points:	20 ECTS
Conditions for Examinations:	For admission to the exam, the master's student must score at least 50 points out of 100 available for each subject of the module
Recommended Conditions:	Module: Current Problems of Technical Sciences

Expected Learning Outcomes:	**Know:** technical means of metering and control of power consumption; ways to optimize the electric power system operation; main features of the modes of operation of automated electric drives, as well as features of their operation; ways to optimize the operation of electric power systems; basic regulatory and technical documents, as well as technologies for the design, start-up and operation of power systems; methods of experimental, computational and theoretical research; principles of simulation, methods of presentation of control systems models for industrial use; basics of DC power lines functioning; structures and materials of power cables and structure of cable lines, distribution of electric and thermal fields in power cables of various types and methods of their calculation; methodology for calculations and analysis of the processes occurring in normal and emergency modes of power cable systems; principles of construction and operation of basic types of devices of relay protection and automation of electric power systems; methods of calculation of currents during short circuits and switching in the network transformers and electric motors; criteria and features of reliability, methods of reliability analysis, methods of reliability improvement, methods of testing facilities for reliability. **Be able to:** apply the obtained theoretical knowledge to predict the ways of operation of electric power equipment and electric power systems; develop automated control systems and power metering for a given object; organize work on the design, start-up and operation of electric power systems; determine the optimal levels of electricity losses in electric networks according to the criterion of the minimum cost of electricity transmission, as well as apply the methodology of stage-by-stage optimization of electric networks on topological and regime characteristics; organize the work on designing, launching and operation of electric power systems; calculation of parameters of EHV lines; calculation of parameters for direct current power lines; evaluate quality results of electric power projects; determine the optimal levels of power losses in electric power networks by the criterion of minimum power transmission cost and know the methodology of phased optimization of electrical power networks according to topological and performance characteristics; make a choice of elements of relay protection and automation; calculate the short-circuit currents, starting and self-starting processes of electric motors, the level of static and dynamic stability of the power system; apply the obtained theoretical knowledge to predict the ways of operation of electric power equipment and electric power systems. **Possess the skills:** of extension and deepening of knowledge required for the everyday professional activity and continuation of education in doctoral studies; calculation and design of overhead lines; calculation and design of power supply systems; service and tests, diagnostics and monitoring of power supply systems; analysis of operating modes of electric power and electrical equipment of EPS and calculation of parameters of relay protection and automation devices. **Demonstrate the ability:** in the field of determining the

	probability of failure-free operation of various electrical equipment; in the design and operation of autonomous power systems; in the analysis of the state of the electrical system and methods of regulation of its modes; in the application of long-distance power lines of extra-high and ultra-high AC voltages; in the application of long-distance power lines of extra-high and ultra-high DC voltages; in the field of engineering activities; in the field of power saving in power supply systems; optimization and control of electric power systems; assembling and lining, maintenance and testing, diagnostics and monitoring of electric power objects; the analysis of electromagnetic and electromechanical transient processes in electric power systems.
Intendend use/applicability	Modules: Scientific Research 4, Research Scientific Training, Final Academic Assessment
Content:	*Modes of Operation of Electric Power Systems* Features of transmission and distribution of electrical power. Principles of transmission lines design. Features and calculation of equivalent circuit parameters of overhead and cable power lines. Parameters and equivalent circuits of transformers and autotransformers. Modeling and metering of electrical loads. Performance indicators of the power network section. Calculation and analysis of the steady-state modes of open power networks. Calculation of the steady-state modes of closed power networks. Methods of calculation and analysis of electric power losses. Basics of mode regulation of electric power transmission and distribution. General requirements to schemes and reliability of power supply. Typical schemes of switchgears. Selection of key design decisions. Basics of parameter optimization and system modes of electric power transmission and distribution. Optimization of design solutions. *Automatic Control and Metering Systems* Basic principles and rules of electric power metering. Requirements for the organization of power metering. Devices of control and metering of electric power. Automated systems of electric power metering. Signal conversion devices (modems). Regulation and metering of heating energy. Instrument type. Formation of electricity tariffs. Parameters of quality of electric power. Parameters of quality of electric power. Key performance indicators of power use and saving. Power saving. Main provisions and principles of power saving. Guidelines and prospects of power saving. Priority areas of power saving in the main sectors of the economy. Environmental problems of electric power. *Self-Contained Power Supply Systems* Comparative analysis of autonomous power plants schemes using renewable energy plants. Hydrogen installations of autonomous power supply on solar and wind power. Development of a mathematical model of autonomous power plants working on RES. *Operation of Power Systems* Organization of operation and repair of electrical equipment. Scheduled preventive maintenance and non-destructive methods of control of electrical equipment. Operation of transformers and autotransformers. Cooling systems and their maintenance. Operation of voltage regulation devices.

	Activation and control of the operation. Circuits and connection group and phasing of transformers. Operation of transformer oils. Repair of transformers and autotransformers. Pre-drying, drying and testing standards for transformers. Repair of the active part of the transformer. Repair of the active part of the transformer. Repair of safety components. Repair of inputs. Repair of means of oil protection from environment. *High-Voltage Engineering* Main provisions of the course. Main types of ionization processes. Phenomenon of electronegativity. Discharge in resonant fields. Patterns of occurrence and development of main types of electrical discharges in gases: corona, spark, arc, and surface. General properties and theories of liquid dielectric breakdown. Breakdown mechanisms of solid dielectrics: electrical, thermal, electrical aging. Classification of insulation. Types of internal insulation. Linear and equipment-station isolation. Inputs. Insulation of high-power transformers, capacitors, cables and electrical machines. Methods and devices for obtaining high variable, constant and pulse voltages. Classification of overvoltage. Isolation levels and coordination. Lightning overvoltage. Lightning parameters. Resonant overvoltages at the fundamental frequency of a one-way power line. Overvoltage when disconnecting unloaded lines. Overvoltage at arc ground faults. *Long-Distance EHV Power Transmission* The role of EHV power transmission in modern power industry. Specific linear parameters of EHV lines. Main properties of the uncompensated AC line. Equivalent circuits of long-distance ac power transmission. Calculations of standard and post-accident modes of EHV power transmission. Mode of one-direction powering of a long-distance EHV line. Capacity of EHV power transmission. Controlled AC power lines. *Power Transmission and DC Links* DC power transmission in modern power engineering. Circuits of power transmission and DC links. Analysis of operating modes of converters. Power properties of converters. Main equipment of converting substations. Technical and economic indicators of DC power transmission. *Engineering in Electric Power Industry* General information on the electrical system. Heat power plants. Water power plants. Nuclear power plants. Renewable power sources. Synchronous generators. Power transformers. Electric motors. Switching and protective devices of high voltage. Grounding devices. DC equipment with rechargeable batteries. Power circuits of heat power plants. Management and control system. Power circuits of water power plants. BOP needs of power plants. Management and control system. *Power Losses in Electrical Power Networks* Main sources of power losses in power networks. Reactive power as a source of losses in power networks. Worn high-voltage lines as a source of power losses. Reconstruction of high-voltage substations. Automatic reclosure. Automatic

	switchover. Automatic frequency load shedding. Application of renewable energy sources. Accumulation of electrical power. Inverters. Measures to reduce the thievery of power from low-voltage power networks. Improvement of methods and means of control and metering of electric power. Automated system of commercial power metering. Consumption of electric power for own needs of power plants and substations and ways to reduce it. Optimization of losses in power networks. *Energy Saving in Power Supply Systems* Power resources of the world. Power conversion stations. Load graphs and power storage. Methods of direct power conversion. Alternative renewable power sources. Power transportation and distribution. Prices and tariffs for power resources. Price and tariff regulation. Rationing of power consumption. Power saving capacity. Basic legal and regulatory documents in the field of power saving. Fuel and energy company management. Power saving programs. Some of the technical ways of power saving. Secondary power resources. Basics of power management and audit. Issues of efficient use of power in various spheres of urban economy. Power saving and ecology. Power saving in foreign countries. *Cable Lines of Power Supply Systems* Cable products as means of transmission of energy and information. Characteristics of technological processes of production of cable products. Theory and technology of insulation of thermoplastic materials. Electric field in cable insulation. Magnetic field in cable products. Heat and mass transfer processes in the operation and manufacture of cable insulation. Communication cable. Testing of cable products and their automation. *Air Power Supply Lines* Classification of overhead power supply lines. Elements of overhead power lines. Equivalent circuit overhead power lines and their parameters. Modes of operation of overhead power lines. Operation of overhead power lines. High voltage tests. Design technology of overhead power lines. Calculation of overhead power lines for mechanical integrity. *Power Supply Systems of Cities and Industrial Enterprises* Basic definitions and starting provisions. Properties of electric devices and the estimated load. Power supply reliability. Technical and economic features of cable lines. Technical and economic indicators of transformers and urban substations. Power supply systems for cities and consumers. Voltage power supply systems. Automation and relay protection. *Automation and Relay Protection Systems* Basic provisions of relay protection and automation. Passive linear measuring transducers of sinusoidal voltages and currents. Electromechanical elements. Semiconductor and microprocessor element base. Earth fault protection in networks with isolated and compensated neutrals. *Emergency Automation* Remote protection. Differential current protection. Devices of automation of electric networks. Protection and automation of electrical networks up to 1 kV.

	Microprocessor complete relay protection, control and automation devices. *Short Circuits in Electric Power Systems* Electrothermal elements. Current protection. Protection and automation of synchronous generators. Protection and automation of transformers. Protection and automation of electric motors. *Theory of Automated Electric Drive* Automated electric drive. Typical closed-loop control systems for electric drives. Servo drive. Program control. Design elements of the electric drive. *Reliability of Electric Power Systems* Introduction to the theory of reliability. Basic concepts and quantitative indicators of reliability of objects. Stochastic patterns in the theory of reliability. The flows of failures and restorations in the theory of reliability. Calculation of systems for reliability. Methods for calculating the reliability of non-simplex systems. Methods for calculating the reliability of redundant systems. Methods of calculation and analysis of reliability of objects as complex systems. Reliability models of Parameter – Tolerance Limit. Reliability models of Load – Bearing Capacity. Methods of evaluation and prediction of durability of objects. Reliability tests. Theoretical bases of estimation of object reliability by results of operation. Methods to improve the reliability of objects. Reliability of the operating personnel of complex systems.
Examination Form, module mark:	Comprehensive examination of the module including *Modes of Operation of Electric Power Systems*– written control examination *Automatic Control and Metering Systems* – computer-based testing *Self-Contained Power Supply Systems* – computer-based testing *Operation of Power Systems* – computer-based testing *High-Voltage Engineering* – computer-based testing *Long-Distance EHV Power Transmission* – computer-based testing *Power Transmission and DC Links* – computer-based testing *Energy Saving in Power Supply Systems* – written control examination *Power Losses in Electrical Power Networks* – free-form examination *Engineering in Electric Power Industry* – written control examination *Cable Lines of Power Supply Systems* – free-form examination *Power Supply Systems of Cities and Industrial Enterprises* – free-form examination *Air Power Supply Lines* – free-form examination *Short Circuits in Electric Power Systems* – written control examination *Automation and Relay Protection Systems* – free-form examination *Emergency Automation* – written control examination *Theory of Automated Electric Drive* - written examination *Reliability of Electric Power Systems* - Written examination Module mark: free-form examination *Elective Subject*
Technical/Multimedia Facilities:	Multimedia system.

	Laboratories of Electrical Power Engineering, and Power Supply and Electrical Equipment Installation
Study Materials:	1. N. F. Ilyinskiy. Basics of Electric Drive, Publishing House of MPEI, 2003. 2. Under the editorship of Y.N. Petrenko. Computer-Aided Control of Electric Drives, M: ACADEMA, 2005. 3. M. P. Belov et al. Automated Electric Drive of Typical Production Mechanisms and Technological Complexes, M.: ACADEMA, 2005. 4. V. Y. Shishmarev. Units and Elements of Automatic Control Systems. - M: Akademiya, 2005. 5. A. A. Gerasimenko, V. T. Fedin. Transmission and Distribution of Electrical Power. – Rostov-on-Don, 2006 6. S. N. Kostin, V. N. Rusanov, P. A. Sinyutin. Organization of Facilitation of Electric Power Metering Automated Systems for Industrial Consumers. – M.: Energiya, 2007 – 128 p. 7. A. L. Gurtovtsev. Complex Automation of Power Metering at Industrial Enterprises and Economic Entities. – Moscow: Vysshaya Shkola, 2013 – 163 p. 8. S. G. Bytsenko. Concept of Creation of Automated Power Consumption Control and Management System. – SPb.: BHV-Petersburg, 2006 – 206 p. 9. A. N. Anokhin. Operator Activity Analysis: Models and Methods. – Obninsk: IATE, 2009 – 88 p. 10. A. A. Gerasimenko, V. T. Fedin. Transmission and Distribution of Electrical Power. – Rostov-on-Don, 2008 11. A. D. Trukhniy, A. A. Makarov, V. V. Klimenko, Basics of Modern Electric Power Engineering in 2 books, M., 2010. 12. Y. P. Ryzhov. Long Distance EHV Transmission: textbook for high schools / Y. P. Ryzhov. - M.: Publishing house of MPEI, 2007 13. V. N. Ivakin. Power Transmission and DC Links and Static VAR Compensators / V. N. Ivakin, N. G. Sysoyev, V. V. Khudyakov; Under the editorship of V. V. Khudyakov. - M : Energoatomizdat, 2013 14. V. V. Khudyakov, DC Power Transmission and Experience of their Operation. Textbook. – M.: Publishing house of MPEI, 2012 15. V. A. Venikov, Y. P. Ryzhov. Long-Distance AC and DC PowerTransmission: Textbook for high schools. - M: Energoatomizdat, 2010 16. A. V. Posse. Circuits and Modes of DC Power Transmission - L.: Energiya, 2006 17. Environmental Problems and Power Saving: textbook / ed. V. D. Karminskiy. - M: Marshrut, 2004. 18. E. M. Kravchenya. Occupational Safety and Basics of Power Saving: textbook. - Minsk: TETRA SYSTEMS, 2005. 19. Power Saving in Heat Supply, Ventilation and Air Conditioning Systems: Reference Book/ under the editorship of L. D. Buguslavskiy and V. I. Livchak. - M: Stroyizdat, 2010. 20. Y. T. Larina Power Cables and Cable Lines. – M: Energoatomizdat, 2006. 21. V. M. Leonov, I. B. Peshkov et al. Basics of Cable Technology. – M: Akademiya, 2006. 22. S. Y. Sokolov, V. N. Sazhin. Operation and Repair of Overhead and Cable Lines. Textbook. – Almaty: AIES, 2006.

	23. A. A. Gerasimenko, V. T. Fedin Transmission and Distribution of Electric Power. M.: Knorus, 2014 24. G. A. Fadeyeva, Design of Power Distribution Networks. - Minsk : Vysheyshaya Shkola, 2009. 25. V. N. Andriyevskiy. Operation of Overhead Power Lines. - M., Energiya, 2006. 26. B. I. Kudrin. Power Supply of Industrial Enterprises. – M.: Intermet Engineering, 2009 27. Y. A. Konyukhova. Power Supply of Different Facilities. M.: Akademiya, 2010 28. Y. D. Sibikin. Power Supply of Industrial and civil Buildings M.: Akademiya, 2012 29. V. A. Andreyev. Relay Protection and Automation of Power Supply Systems. - M: Vysshaya shkola, 2006. 30. E. Bass, A. Doroguntsev, Relay Protection of Electric Power Systems. Textbook. – M.: MPEI, 2002. 31. Y. A. Kireyeva, S. A. Tsyruk. Relay Protection and Automation of Electric Power Systems. – M: Akademiya , 2013. 32. N. Y. Savoskin Reliability of Electrical Power Systems. Textbook/Penza State University. – Penza, 2004. 33. N. G. Volkov. Reliability of Power Supply Systems. Textbook/ Tomsk Polytechnic University– Tomsk, 2003. 34. Y. A. Konyukhova. Reliability of Power Supply of Industrial Enterprises./Y. A. Konyukhova, Y. A. Kireyeva. – Moscow: NTF Energoprogress, 2001.
Date of last amendment	20.01.2023