

**NON-PROFIT JOINT STOCK COMPANY**  
**ALMATY UNIVERSITY OF POWER ENGINEERING AND**  
**TELECOMMUNICATIONS NAMED AFTER GUMARBEK DAUKEYEV**

**Institute of Energy and Green Technologies**

Vice-Rector for Academic Affairs  
A. Zhupankhan

« 12 » 2025 year.



**PROGRAM**

Entrance examination to the doctoral program in the direction

«8D07101 – Electric power engineering»

Almaty 2025

The program for the educational program «8D07101 – Electric power engineering» was compiled on the basis of standard, working curricula and programs of disciplines.

The program was reviewed and approved at a meeting of the PSEDEE department protocol No. 8 dated 07.04, 2025.

Head of the Department of PSEDEE  Zh.S. Shynybay

The program was reviewed and approved at a meeting of the EPE department protocol No. 8 dated 10.04, 2025.

Head of the Department of EPE  Uteshkalieva L.S.

The program was reviewed and approved at a meeting of the PSRES department protocol No. 7 dated 08.04, 2025.

Head of the Department of PSRES  Tergemes K.T.

The program of the entrance examination in the specialty was approved by the Educational and Methodological Commission of the Institute of energy and green technologies «08»05 2025. protocol No 7.

Director of IEGT  Amitov E.T.

The program of the entrance exam for doctoral studies in the educational program 8D07101- «Electric Power Industry» has been coordinated with the Department of Science of the AUPET named after G.Daukeev.

Director of the Department of Science  Kalyeva N.B.

Vice Rector for Science  Alipbayev K.A.

The program of the entrance exam for doctoral studies in the educational program 8D07101- «Electric Power Industry» has been coordinated with the Department of Academic Affairs of the AUPET named after G.Daukeev.

Director of the Department of Academic Affairs  Baizakova S.M.

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# **1 ELECTRIC DRIVE AND AUTOMATION OF TECHNOLOGICAL COMPLEXES**

## **Topic 1. Composition and structure of modern automated electric drive.**

Mechanics of the electric drive. Characteristics of mechanisms and engines. Equation of motion of the electric drive. Conclusion and analysis.

## **Topic 2. Energy saving in technological processes by means of an electric drive.**

Possible ways of energy saving, basic concepts and definitions. Adjustable electric drive, as a means of energy saving. Evaluation of the energy efficiency of electric drives.

## **Topic 3. Frequency converters for controlling AC motors.**

The principle of operation. Schematic solutions. Energy indicators. Frequency-controlled electric drive. The laws of frequency regulation as an energy saving factor.

## **Topic 4. Automated DC electric drive.**

Classification, principle of operation, design, characteristics. Modern schemes. Development prospects.

## **Topic 5. Analysis of methods of speed control.**

Regulation of the rotation speed of electric motors by changing their sliding. Frequency-controlled electric drive of centrifugal pumps. Cascade control schemes.

## **THE LIST OF RECOMMENDED LITERATURE**

### **Major**

1. Epifanov A.P. Electric drive: Textbook for universities. SPb.: «Lan», 2012 400s.
2. Vasiliev, B.Y. Electric drive. Electric drive power engineering.- M.: Solon-Press, 2015.- 272s.
3. Moskalenko, V.V. Automated control systems of electric drive [Text]: textbook / V.V. Moskalenko.- M.: INFRA-M, 2011.- 208s.
4. Leznov B.S. Frequency-controlled electric drive of pumping units. M.: «Mechanical engineering», 2013.-176s.

### **Additional**

5. Mustafin M.A., Almuratova N.K. Elektr zhetegi: Darister zhinagi.- - Almaty: - Adebu, 2011.-59b.
6. Energy-saving electric drive of centrifugal pumps [Text]: textbook.manual / M.A. Mustafin, N.K. Almuratova, S.S. Tabultaev; MOiN RK, NAO AUES.- Almaty: AUES, 2016.- 90c: 6 academic-ed.L.12 Moskalenko, V.V. Automated



control systems of electric drive [Text]: textbook / V.V. Moskalenko.- M.: INFRA-M, 2011.- 208s.

7. Krasovsky, A.B. Fundamentals of electric drive [Text] : textbook.manual / A.B. Krasovsky. - M. : Bauman Moscow State Technical University, 2015

8. Anuchin, A.S. Control systems of electric drives [Text] : textbook for universities / A.S. Anuchin. - M. : MEI, 2015

9. Tergemes K.T. Fundamentals of electric drive: textbook; KSUTI named after Sh.Yesenov, 2014 – 158s.

10. Yu.A Tsyba, Yu.V. Kuzmin, Darkenbayeva E.B. Elements of an automated electric drive. Study guide. AUES.-Almaty., 2018.

## **2 ELECTRICAL NETWORKS AND SYSTEMS**

### **Topic 1. Voltage regulation in electrical networks.**

Regulation of voltage and reactive power in distribution electrical networks of 6-10/0.4 kV. Methods and means of voltage regulation in electrical networks. Modern approaches. The status of the issue. Means and methods of regulation.

### **Topic 2. Electricity losses.**

The structure of electricity losses. Measurement and calculation methods. Methods of reducing losses. The effectiveness of measures to reduce electricity losses. Calculation, analysis and rationing of electricity losses. Means and methods of calculation and analysis of modes of electric power systems. The capacity of power transmission lines. Means and methods of increasing the capacity of power transmission lines. Modern approaches to the problem of reactive power compensation. Selection of locations and capacities of condenser installations in distribution networks.

### **Topic 3. Criteria for optimizing the modes of electrical networks.**

The state and prospects of development of nuclear generation in the Republic of Kazakhstan. Features of the modes of feeding extended power transmission lines with a voltage of 110-220 kV. The main methods of optimizing the modes of electrical networks.

### **Topic 4. Long-range ultra-high voltage power transmission**

Promising methods of electricity transmission. The main measures to improve the stability of energy systems. Problems of stability of parallel operation of power connections. Advantages and disadvantages of alternating and direct current transmissions. New means and methods of long-distance transmission of electricity.



## **Topic 5. Operation of electrical networks and systems.**

Features of operation of electrical equipment at the present stage. Modern diagnostic tools and methods and their comparative analysis. Voltage deviations in networks of different voltage classes and ways and methods of providing the required values. Causes of higher harmonics in electrical networks and ways to eliminate them. Causes and consequences of voltage deviations and fluctuations in electrical networks and ways to eliminate them.

### **THE LIST OF RECOMMENDED LITERATURE**

#### *Major literature*

1. Transmission and distribution of electricity: Study guide. – A.A.Gerasimenko, V.T.Fedin. -4th edition, ster. -M. KNORUS, 2014. -648p.
2. Lykin A.V. Electrical systems and networks: Study guide. - Moscow: University Book; Logos, 2008. — 254 p.
3. Electric power systems and networks: a textbook / S.S. Ananicheva, S.N. Shelyug.- Yekaterinburg: Ural Publishing House. un-ta, 2019. -296 p.
4. Kostin V.N.: Power supply systems and electrical networks: educational and methodical complex (textbook) St. Petersburg: Publishing House of NWTU, 2007-154p
5. Design of electrical networks : studies. manual / S.S. Ananicheva, E.N.Kotova.- Yekaterinburg : Ural Publishing House. un-ta, 2017.
6. Ryzhev Yu.P. Long-range power transmission of ultra-high voltage: textbook for universities - Moscow: Publishing House of the MEI, 2007. -488p.
7. Alexandrov G.N. Modes of operation of overhead power transmission lines: textbook- St. Petersburg: Second edition of the Center for Training Energy Personnel, 2006. -139p.
8. Transmission of electricity for long distances: A textbook / S. S. Ananicheva, P. I. Bartolomey, A. L. Myzin; 3rd edition, corrected. Yekaterinburg: UrFU, 2012. 85 p.
9. Electric power quality management: textbook / U 677 I.I. Kartashev, V.N. Tulskey, R.G. Shamonov, etc.; edited by Yu.V. Sharov. 3rd ed., reprint. and additional M.: Publishing House of MEI, 2017, — 347 p
10. Diagnostics of electrical equipment of power stations and substations: textbook / A. I. Khalyasmaa [et al.]. — Yekaterinburg: Ural Publishing House. un-ta, 2015. — 64 s
11. Kozlov A.N., Naumov I.V. Methods of diagnostics of electrical equipment of electrical installations: a collection of educational and methodological materials for the direction of training 13.06.01. - Blagoveshchensk: Amur State University, 2017. – 48 p.
12. Operation of electrical equipment / G. P. Eroshenko, A. P. Kolomiets, Yu. A.; Medvedko, M. A. Taranov. – M.: KoloS, 2008. — 344 p.: ill. —



(Textbooks and studies. manuals for higher education students. studies. establishments)

*Additional literature*

13. Lenkov Yu. A., Barykin A. S. Design of electric power stations: a textbook for students of electric power specialists 2016

14. Electrical equipment of power stations and substations: textbook for students. institutions sred. Prof. education / L. D. Rozhkova, L. K. Karneeva, T.V. Chirkova. - 10th ed., ster. — M.: Publishing Center "Academy", 2013. - 448 p.

15. Calculations of permissible power overflows in power systems: textbook / S.A. Eroshenko, A.O. Egorov, V.O. Samoylenko, A. I. Khalyasmaa. - Yekaterinburg: Ural Publishing House. un-ta, 2017.- 86 p.

16. Calculation and selection of equipment of district transformer substations: textbook / I.V.Naumov, T.B.Leshchinskaya, D.A.Ivanov – Irkutsk: Irkutsk. state agricultural enterprise. akad., 2012. – 96 p.

### **3 ELECTRICITY SUPPLY AND RENEWABLE ENERGY SOURCES**

**Topic 1. The system of state support within the framework of the Law of the Republic of Kazakhstan «On support for the use of renewable energy sources».**

To reveal the essence of the Law of the Republic of Kazakhstan «On support for the use of renewable energy sources».

1. Strategy «Kazakhstan-2050».

2. National Development Plan of the Republic of Kazakhstan until 2025.

3. To reveal the essence of the Law of the Republic of Kazakhstan «On support for the use of renewable energy sources».

**Topic 2. Introduction of the auction mechanism for renewable energy placement projects in Kazakhstan.**

1. The concept of the transition of the Republic of Kazakhstan to a green economy.

2. Ways of economic stimulation of renewable energy development in the Republic of Kazakhstan.

3. Introduction of an auction mechanism for RES placement projects.

**Topic 3. Problems with financial support of renewable energy power plants and possible solutions.**

1. Code of the Republic of Kazakhstan dated January 2, 2021 No. 400-VI «Environmental Code of the Republic of Kazakhstan»;

2. Law of the Republic of Kazakhstan «On Electric Power industry» dated July 9, 2004 No. 588;

3. Problems of financial support of renewable energy power plants and possible solutions.



## **THE LIST OF RECOMMENDED LITERATURE**

### **Major**

1. The Law of the Republic of Kazakhstan «On Amendments and Additions to some Legislative Acts of the Republic of Kazakhstan on support of the use of renewable energy sources and electric power industry» dated December 7, 2020.
2. The Law of the Republic of Kazakhstan dated July 4, 2009 No. 165-IV «On support for the use of renewable energy sources» (with amendments and additions as of 07.03.2022) (auction price - the purchase price by the settlement and financial center for the support of renewable energy sources).
3. The Law of the Republic of Kazakhstan dated July 9, 2004 No. 588-II «On Electric Power industry» (with amendments and additions as of 07.03.2022).

### **Additional literature**

4. National Development Plan of the Republic of Kazakhstan until 2025.
5. The concept of the transition of the Republic of Kazakhstan to a «green economy».
6. Land Code of the Republic of Kazakhstan dated June 20, 2003 No. 442.
7. Code of the Republic of Kazakhstan dated January 2, 2021 No. 400-VI «Environmental Code of the Republic of Kazakhstan».
8. The Civil Code of the Republic of Kazakhstan (General Part), adopted by the Supreme Council of the Republic of Kazakhstan on December 27, 1994.
9. Law of the Republic of Kazakhstan dated April 16, 1997 No. 94-I «On housing relations».
10. Law of the Republic of Kazakhstan No. 204-VI «On Natural Monopolies» dated December 27, 2018.
11. Law of the Republic of Kazakhstan dated July 16, 2001 No. 242 «On architectural, urban planning and construction activities in the Republic of Kazakhstan».

## **4 Relay protection and power supply**

Topic 1. Single-phase ground faults in networks with an isolated, compensated or resistively grounded neutral

1. The problem of limiting overvoltages during single-phase ground faults (SFG) in networks with an isolated, compensated or resistively grounded neutral.
2. Principles of protection against single-phase ground faults in 10 kV cable networks
3. Principles of implementation of centralized selective protection against single-phase ground faults.

Topic 2 Digital substations.

1. Give the basic terminological characteristics of the Digital substation.
2. Advantages of design, installation and commissioning of a Digital substation



3. What problems arise during the design, construction and operation of a Digital substation.
4. Provide basic information about the 61850 protocol, its purpose and its sections.
5. Prospects for the use of digital twins (DT) in technologies for remote control of power equipment and relay protection devices and automation of substations of electric power systems.

## LIST OF RECOMMENDED READINGS

1. Shuin V.A., Shadrikova T.Yu., Dobryagina O.A., Shagurina E.S. Protection device against single-phase ground faults in networks with an isolated neutral and with capacitive current compensation, Pat. 2688210 RU, application. 07/16/18; publ. 05.21.19. - Bull. No. 15
2. Titenkov S.S., Pugachev A.A. Neutral grounding modes in 6-35 kV networks and organization of relay protection against single-phase ground faults // *Energoexpert*. 2010 No. 2 P. 18-25. RD 34.20.179
3. Standard instructions for compensating capacitive fault current to ground in electrical networks 6-35 kV. SPO Soyuztekhnenergo No. 1988, 2009 – 26 p.
- 4/ STO 34.01-21-004-2019. Digital feeding center. Requirements for the technological design of digital substations with voltages of 110-220 kV and node digital substations with voltages of 35 kV [Electronic resource]. – M.: Department of Operational and Technological Management of PJSC ROSSETI. – 114 p. – Access mode: [https://www.rosseti.ru/investment/standart/corp\\_standart/doc/CTO\\_34.01-21-004-2019.pdf](https://www.rosseti.ru/investment/standart/corp_standart/doc/CTO_34.01-21-004-2019.pdf).
5. Digital substations - a step into the future of energy / V.A. Vinogradov [etc.] // *Fundamental and applied scientific research: current issues, achievements and innovations: materials of the conference*. – Penza, 2019. – pp. 91-94.
6. Golovshchikov, V.O. Digital substation - the main element of the digital electric power system / V.O. Golovshchikov // *Modern technologies and scientific and technological progress: materials of the conference*. - Angarsk. – 2019. – pp. 224-225.
- additional literature
7. Concept for the development of relay protection, automation and automated control systems for technological processes of the electrical grid complex of the Rosseti group of companies [Electronic resource] <https://www.rosseti.ru/suppliers/technical-policy/organization-standards>
8. Anoshin A.O. Standard IEC61850/ A.O. Anoshin, A.V. Golovin // *Electrical engineering*. – 2013 – No. 2 – P. 80-86.

9. Anoshin A.O. Standard IEC 61850 Information model of the device / A.O. Anoshin, A.V. Golovin // Electrical Engineering News. –2021.– No. 2 – pp. 51–55.

10. Misina, E. A. Network monitoring at a digital substation / E. A. Misina, V. V. Prokopyev, D. A. Krylov // Information technologies in electrical engineering and power engineering: materials of the XIII All-Russian scientific and technical conference, Cheboksary, June 03, 2022. – Cheboksary: Chuvash State University named after I. N. Ulyanov, 2022 – P. 386–387.