Syllabus
Course Program

Fundamentals of electric power industry

Specialty
141 – Electric Power Engineering, Electrical Engineering and Electromechanics

Institute
Institute of Education and Science in Power Engineering, Electronics and Electromechanics

Educational program
Electrical Power Engineering. Electric Power Stations,

Department
Electric Power Stations (130)

Level of education
Bachelor's level.

Course type
Special (professional), Optional

Semester
4

Language of instruction
English, Ukrainian

Lecturers and course developers

Stanislav Fedorchuk
Stanislav.Fedorchuk@khpi.edu.ua
Ph.D., senior lecturer of the Department of Power Stations of NTU "KhPI"

Author and co-author of more than 20 scientific and methodological works. Courses: "Energy Management", "Energy Management and Audit", "Fundamentals of Energy Management", "Fundamentals of Electric Power Engineering", "Microprocessor Systems with Open Code", "Virtual Power Stations".
More about the lecturer on the department's website

Olexii Bulhakov
Olexii.Bulhakov@khpi.edu.ua
Assistant

Author of more than 20 scientific publications and educational and methodological works. Leading lecturer in the disciplines: "Fundamentals of thermography", "Energy management and audit", "Renewable energy sources and secondary energy resources"
More about the lecturer on the department's website

General information

Summary

The course on the basics of electrical engineering is designed for future specialists in the specialty 141 Electrical engineering, electrical engineering and electromechanics. Its study will make it possible to understand the principles of the operation of energy systems, how the balance of active and reactive power in the energy system is formed and maintained, what it affects, what is the current and prospective state of the energy system in Ukraine and the world, as well as the principles by which electric networks are built and the basic methods of their analysis . The course is designed for the formation of mainly basic knowledge and skills, which will be deepened in the following more specialized disciplines

Course objectives and goals

The purpose of the educational discipline "Fundamentals of Electric Power Engineering" is the formation of knowledge about the main processes that take place in electric power systems, the main indicators of the quality of electric energy and the factors that affect them, the balance of active and reactive power in the power system, means and methods of controlling voltage and frequency in electric networks, as well as about schemes for replacing the main elements of the electric power system.
goals
Know:
- basic principles of operation of electric power systems,
- indicators of the quality of electrical energy;
- factors affecting frequency and voltage in electric power systems;
- methods of maintaining voltage and frequency in electric power systems;
- basic schemes for replacing elements of electric power systems.
Be able:
- to determine the main indicators of the quality of electric energy;
- perform calculations using the method of symmetrical components;
- find higher harmonic components for graphs;
- set the operating mode of transformers with on-load tap-changer, which will meet the specified requirements;
- calculate substitution schemes.

Format of classes

Lectures, practical work, laboratory work, independent work, consultations. The final control is an exam.

Competencies

Program competencies according to the educational program:
K01 Ability to abstract thinking, analysis and synthesis.
K02 Ability to apply knowledge in practical situations
K05 Ability to search, process and analyze information from various sources.
K06 Ability to identify, pose and solve problems
K12 Ability to solve practical problems involving the methods of mathematics, physics and electrical engineering
K13 The ability to solve complex specialized tasks and practical problems related to the operation of electrical systems and networks, the electrical part of stations and substations, and high-voltage equipment.
K16 Ability to solve complex specialized problems and
practical problems related to problems of production, transmission and distribution of electrical energy.
K17 The ability to develop projects of electric power, electrotechnical and electromechanical equipment in compliance with the requirements of legislation, standards and specifications
K19 Awareness of the need to increase the efficiency of electric power, electrotechnical and electromechanical equipment.
K24. Obtaining and using professional knowledge and understanding related to the organization and support of electricity production processes based on traditional and renewable energy sources in compliance with the given technological parameters of energy facilities and the quality of electricity
K25 Obtaining and using professional knowledge and understanding related to the processes of transmission, distribution of electricity and electricity supply in compliance with the specified parameters of technological processes and electricity quality.
K27 Acquisition and use of professional knowledge and understanding related to the processes of creation and use of safe and effective electrical insulation, cable and optical fiber
Systems

Learning outcomes

Program learning outcomes according to the educational program:
PR01 Know and understand the principles of operation of electrical systems and networks, power equipment of electrical stations and substations, protective grounding and lightning protection devices and be able to use them to solve practical problems in professional activities
PR04 Know the principles of operation of bioenergy, wind energy, hydropower and solar energy installations.
PR07 Carry out process analysis in electric power, electrotechnical and electromechanical equipment, relevant complexes and systems
PR09 To be able to evaluate the energy efficiency and reliability of power, electrotechnical and electromechanical systems
PR10 Find the necessary information in scientific and technical literature, databases and other sources of information, evaluate its relevance and reliability.
PR13 Understand the importance of traditional and renewable energy for the successful economic development of the country.
PR17 Solve complex specialized problems in the design and maintenance of electromechanical systems, electrical equipment of power stations, substations, systems and networks.
PR18 To be able to learn independently, acquire new knowledge and improve skills in working with modern equipment, measuring equipment and application software.
PR19 Apply suitable empirical and theoretical methods to reduce losses of electrical energy during its production, transportation, distribution and use.
PR20. To solve professional problems in the design, installation and operation of electric power, electrotechnical, electromechanical complexes and systems
PR23 To know and understand the principles of organization of electricity production processes based on traditional and renewable energy sources in compliance with the specified technological parameters of energy facilities and the quality of electricity

Student workload

The total scope of the discipline is 180 hours. (6 ECTS credits): lectures – 32 hours, practical work – 32 hours, laboratory work 16 hours, independent work – 100 hours.

Course prerequisites

Disciplines of bachelor's level training in specialty 141 "Electroenergetics, electrical engineering and electromechanics".

Features of the course, teaching and learning methods, and technologies

Lectures are conducted interactively using multimedia technologies, virtual tours of power stations are used. In practical classes, a project approach to learning is used, attention is focused on the application of information technologies, students also have optional tasks that require the use of new, deeper than in the course profile skills, for the performance of which they can receive additional points.. Educational materials are formed together with students via a shared whiteboard

Program of the course

Topics of the lectures

Topic 1. Introduction
Objectives of the educational discipline. Volume of educational material, types of classes and organization of work.
Topic 2. Basic elements of the energy system
Electric power system. Energy system of Ukraine
Topic 3. Quality indicators of electrical energy
Calculation methods and methods of determining quality indicators. Norms and assessment of the quality of electric energy.
Topic 4. Characteristics of current and voltage

Symmetric components of current and voltage, systems of symmetrical components. Determination of harmonic voltage components.

Topic 5. Active power balance.

Connection of power balances with parameters of electrical energy. Static load characteristics.

Topic 6. Frequency maintenance in the power system.

Characteristics of primary engines. The essence of primary and secondary frequency regulation in the power system. Selection of capacities and frequencies of leading stations.

Topic 7. Voltage regulation in electrical networks.

Voltage regulation at power stations, substations, distribution networks.

Topic 8. Basics of optimal distribution of active power in the electric power system.

The physical essence of the process. Devices and means.

Topic 9. Reactive power balance.

Physical basis of the presence of reactive power. Means of reactive power compensation. Placement of compensating devices.

Topic 10. Generation of electric and thermal energy.

Thermal power plant, nuclear power plant, hydroelectric power plant, hydroelectric power plant, hydropower plant, boiler houses. Synchronous machines in substitution schemes

Topic 11. Transmission of electrical energy.

Parameters of elements of electric power systems. Substitution schemes and parameters of power lines, transformers, autotransformers.

Topic 12. Consumers of electric and thermal energy.

Types of consumers. Peculiarities of consumer modes of operation. Representation of loads in calculation schemes.

Topics of the workshops

Topic 1. Method of symmetrical components.

The main areas of application of the method, work with vector diagrams.

Topic 2. Analysis of higher harmonic components of the voltage graph.

Development of the voltage graph. Work with the expansion in the Fourier series

Topic 3. Determination of the mode of operation of a transformer with tap-changer, which will meet the given conditions.

Transformer replacement schemes. Calculation of the on-load tap-changer operating mode.

Topic 4. Calculation of the necessary parameters for the selection of means of reactive power compensation.

Selection of power and installation location of reactive power compensation devices.

Topic 5. Calculation of schemes for replacing the main elements of electric power systems.

Calculation of replacement schemes for power transmission lines, transformers, generators, etc.

Topic 6. Familiarization with basic software tools for modeling and analysis of stable and transient modes of electric power systems.

Study of Matlab, Powerfactory and independent mathematical modeling tools

Topics of the laboratory classes

Topic 1. Obtaining and analyzing voltage graphs in the 0.4 kV network.

Using the Fourier series expansion to find higher harmonic components. Determination of indicators of the quality of electrical energy based on the received data.

Topic 2. Obtaining and analyzing voltage graphs in the 0.4 kV network.

Study of the influence of GEN of consumers at a voltage of 0.4 kV on the modes and characteristics of the power system.

Topic 3. Using MS Excel to determine the operating mode of a transformer with tap-changer.

Using the "solution search" module. Automatic determination of the optimal mode.

Topic 4. Matlab and Powerfactory.

Familiarization with basic software tools for modeling and analysis of stable and transient modes of electric power systems

Topic 5. Study of the influence of consumers on the stability of the electric power system.

Use of software tools to obtain impact characteristics.

Topic 6. Analysis of power station projects.

Study of projects of stations of various types.

Self-study

Report on the topic "Functioning of energy systems of different countries"
Deadline: 16 weeks.
The report is given publicly using prepared presentation materials.
Coursework "Development of the power supply system of an industrial enterprise". Group project work.
Deadline: 16 weeks.
Additional tasks. Control paper number 2 has two additional tasks devoted to a more in-depth study of the material and the acquisition of new skills, which includes the selection and verification of high-voltage equipment and optimization tools.
Deadline: 16 weeks

Course materials and recommended reading

Basic literature:
1. V. V. Shevchenko. Fundamentals of electric power engineering: a study guide for students of specialty 141 "Electric power engineering, electrical engineering and electromechanics". 3rd edition, revised and supplemented. Kharkiv: KhPI National Technical University, 2024. – 438 p.
2. A. A. Malinovskyi. Basics of electric power and electricity supply / A. A. Malinovskyi, B. K. Khokhulin. – Lviv: Publishing House of Lviv Polytechnic, 2009. – 436 p.
3. Power supply of industrial enterprises: Textbook for students of electromechanical specialties / V.I. Milikh, T.P. Pavlenko. - Kharkiv: FOP Panov A.M., 2016. - 272 p.

Additional materials:
1. Mathworks [Electronic resource]. – 2024. – Resource access mode: https://www.mathworks.com/.
2. Quality of electrical energy [Electronic resource]. – 2024. – Mode of access to the resource: https://www.nerc.gov.ua/sferi-diyalnosti/elektroenergiya/yakist-elektropostachanya/yakist-elektrichnoyi-energiyi
Virtual tours of power plants [Electronic resource]. – 2024. – Resource access mode: http://virtualniprohlidky.cez.cz/cez-virtual-tour/

Assessment and grading

Criteria for assessment of student performance, and the final score structure

100% of the final grade consists of assessment results in the form of an exam (40 points) and current assessment (60 points). Exam: written assignment (3 questions from theories + problem solving) and an oral report. Current assessment: 2 tests (each 15 points) and defense of the course project (30 points).

Grading scale

Total points	National	ECTS
90–100	Excellent	A
82–89	Good	B
75–81	Good	C
64–74	Satisfactory	D
60–63	Satisfactory	E
35–59	Unsatisfactory (requires additional learning)	FX
1–34	Unsatisfactory (requires repetition of the course)	F

Norms of academic integrity and course policy

The student must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": to demonstrate discipline, good manners, kindness, honesty, and responsibility. Conflict situations should be openly discussed in academic groups with a lecturer, and if it is impossible to resolve the conflict, they should be brought to the attention of the Institute's management.
Regulatory and legal documents related to the implementation of the principles of academic integrity at NTU "KhPI" are available on the website: http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Approval

Approved by	Date, signature	Head of the department Oleksandr LAZURENKO
	Date, signature	Guarantor of the educational program Halyna OMELYANENKO