Syllabus of the educational component
Program of educational discipline

EXPLOITATION AND MODES OF OPERATION OF ELECTRICAL EQUIPMENT OF POWER PLANTS

Code and name of the specialty
141 – Electrical power, electrical engineering and electromechanics

Institute
Educational and scientific institute of Energy, Electronics and Electromechanics

Name of the program
Electric power industry

Department
Electrical stations

level of higher education
first (bachelor's)

Program type
Vocational training, selective

Semester
8

Language of instruction
English

Teachers, developers

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Doct. Tech. Sciences, Associate Professor, Professor of the Department Electrical Machines

She has more than 300 publications in scientific journals, 10 patents, 8 monographs and manuals. May of the title "ING-PAED IGIP" (International teacher in the gallery of engineering pedagogy IGIP). Basic courses - Electrical machines, Electrical machines and devices, Reliability and diagnostics, Electric generators for HPPs and mini-HPPs, Power supply of industrial enterprises, Operation and modes of operation of power plants electrical equipment, Prospects for the use of superconductivity in electromechanics.
Learn more about the teacher on the department's website

General information

Abstract

The discipline studies issues of operation and modes of operation of power plants electrical equipment (EE), reliability and diagnostics of the technical condition of EE of electric stations, issues related to drawing up an inspection program to ensure reliable operation, installation and maintenance; diagnostics and tests of EE, establishing the possibility of further operation.

Purpose and objectives of the disciplines

The goal of the educational discipline is the preparation of bachelors in the specialty 141 " Electrical power electrical engineering and electromechanics", which provides future specialists with the acquisition of theoretical and practical knowledge in the field of operation, installation, diagnosis, of the technical condition of the electrical stations and substations equipment; drawing up a program for its inspection; to form students' knowledge about the modes of operation of electric stations and substations, about individual types of EE and their construction, about modern methods of EE diagnostics and tests on the

territory of electric stations and substations; formation of students' knowledge about establishing the possibility of further operation within the established period of operation and after its expiration.

Format of classes

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

Competences

Ability to solve specialized and practical problems during professional activity in the field electrical engineering, electrical engineering and electromechanics, which involves the application of theories and methods of physics and engineering sciences and are characterized complexity and uncertainty of conditions.
Ability to abstract thinking, analysis and synthesis.
Ability to apply knowledge in practical situations.
Ability to communicate in the national and foreign (English) languages both orally and in writing.
Ability to search, process and analyze information from various sources.
Ability to identify, pose and solve problems.
Ability to work autonomously and in a team.
The ability to realize one's rights and responsibilities as a member of society, to be aware of the values of a civil (free democratic) society and the need its sustainable development, rule of law, rights and freedoms person and citizen in Ukraine.
The ability to solve complex specialized and practical problems related to the operation of power stations electrical equipment.
Ability to use information and communication technologies.
The ability to perform professional duties in compliance with the requirements of the rules of safety, labor protection, industrial sanitation and environmental protection.
Awareness of the need to increase the efficiency of electric power, electrotechnical and electromechanical equipment.
Awareness of the need to constantly expand one's own knowledge of new technologies in electric power, electrical engineering and electromechanics.
Ability to produce new ideas, make informed decisions, show creativity and system thinking, identify and assess risks.
Knowledge and understanding of modern technological processes and systems of technological preparation of production, technical characteristics, design features, purpose and rules of operation of electric power, electrotechnical and electromechanical equipment.
Ability to use laws and engineering principles, high-level mathematical apparatus for design, modeling, construction, production, installation, operation, maintenance and disposal of facilities at power plants.

Learning outcomes

The student must be able:
- to assess the state of electrical equipment (EE) of power stations based on modern methods of its diagnosis, choose new types of EE, evaluate their characteristics, determine the principles of construction and normal functioning of elements of electric power, electrotechnical electromechanical complexes and systems;
- to evaluate the energy efficiency and reliability of electric power, electrotechnical and electromechanical systems, calculate indicators of reliability, durability and maintainability of EO; use distribution laws when calculating reliability; evaluate reliability based on experimental data; determine the reliability of EO;
- to build models of operational reliability of EE; use accelerated test methods and perform EE maintenance tasks with the help of relevant instructions and practical skills;
- know the rules for the manufacture and operation of EE, the technology and organization of work on calculations, design, installation, maintenance and adjustment of EE, follow the strategies and tactics of solving professional tasks by experienced workers in the field of electric power, electrical engineering and electromechanics;
- know and be able to draw up programs of general and special tests and conduct experimental studies of EE on the territory of power stations, to be able to use them to solve practical problems in professional activity;

- to develop a program of EE research and analyze the obtained experimental data, present them in graphic, tabular and other forms, draw conclusions about the obtained parameters and characteristics.

Find the necessary information in scientific and technical literature, databases and other sources of information, evaluate its relevance and reliability.

To understand the basic principles and tasks of technical and environmental safety of power stations and substations, take them into account when making decisions.

To understand the importance of traditional and renewable energy for the successful economic development of the country.

Understand the principles of European democracy and respect for the rights of citizens, take them into account when making decisions.

The scope of discipline

The total scope of the discipline is 150 hours. (5 ECTS credits): lectures – 30 hours, laboratory work – 15 hours, practical work – 15 hours; independent work - 90 hours; consultations, examination.

Prerequisites for studying the discipline (prerequisites)

Introduction to the specialty; Electric stations (general course); Electric machines; Higher mathematics; General Physics; Informatics, computing and programming; Theoretical mechanics; Theoretical foundations of electrical engineering; Electrical materials; Basics of metrology and electrical measurements; Fundamentals of electronics; Computer graphics and programming

Features of the discipline, methods and technologies of education

Various teaching methods are used in lecture, laboratory and practical classes in accordance with the content of the work program and with the aim of activating the educational and cognitive activity of students when studying the discipline (active forms of conducting classes, methods of interaction between the teacher and students): lecture, lecture-dialogue, lecture survey, laboratory and practical classes, engineering seminar, interview, consultation. Current control is implemented in the form of a survey at lectures and consultations, when conducting input control and control of the execution of an individual task (calculation-graphic task), when conducting control (modular) works. Control of the study of sections of the work program, sections mastered during the student's independent work, is carried out by checking notes and writing a test paper. Semester control – examination (according to examination tickets), in accordance with the curriculum, taking into account the results of current success, in the amount of educational material determined by the curriculum, in the terms established by the curriculum.

Program of educational discipline

Lecture topics

Topic 1. The structure of organizations providing electricity distribution systems

Topic 1.1. Institutions and organizations related to the development of energy and its functioning. Modes of operation of electricity consumers and receivers. Power plants of Ukraine.

Topic 1.2. Marginal - allowable operational indicators of electrical equipment (EE). Technical documentation, which is necessary for the installation of EM and transformers. Features of operation of electrical equipment at elevated temperature, overvoltage, in aggressive environments, etc. Directions for ensuring the reliability of electrical equipment operating in special conditions (on NPP units).

Topic 1.3. Reliability of the "Electric Power" system. The concept of reliability in the theory of electric machines: reliability, operability, failure, malfunctions, run-in, fail-safe. Failure intensity as a measure of electrical equipment reliability. Failures of electrical equipment in the theory of reliability. Redundancy and increased safety margins as a way to improve reliability.

Topic 1.4. Error prevention when ordering, designing and manufacturing equipment for power facilities (stations and substations). Prevention of the risk of design errors. Elimination of risks of defects during transportation of the equipment to the installation site. Exclusion of risks during installation and adjustment of EO. Typical errors during operation.

Topic 1.5. Parameters that set the warranty period of operation of the EO. System of planned and preventive repairs (PPR).

Topic 2. Features of operation of various types of electrical equipment. Operation, repair and maintenance of electric motors of power plants

Topic 2.1. Typical equipment defects and the reduction of the probability of their development. Establishing typical equipment defects and reducing the likelihood of their development. Problems and limitations of self-starting electric motors of own needs of power plants.

Topic 2.2. Factors limiting the maximum power of turbogenerators (TG). Features of the operation of TG, taking into account their thermal state. Excitation systems of powerful TG (contact and non-contact).

Topic 2.3. Evaluation of the reliability of EE work. Criteria for evaluating equipment reliability and the influence of the number of TG failures on electricity generation. Modes of operation of electric machines and transformers. Carrying out post-repair tests on station blocks and substations.

Topic 2.4. Modes of operation of electric motors (ED) of electrical equipment of TPPs and NPPs. Organization of ED repair at power plant units. Dismantling of ED at the station block. Maintenance and testing of ED.

Topic 2.5. Prospects for the development of EO of electricity distribution networks. Peculiarities of operation of modern energy systems. Prospective choice of electrical equipment in conditions of changes in energy consumption by electrical receivers.

Topic 3. Testing and operation of electrical stations and substations electrical equipment

Topic 3.1. Testing of electrical machines and transformers before the first switch-on. Acceptance and acceptance tests of electric machines and transformers. Checking the marking of the terminals of electric machines and transformers.

Topic 3.2. Measurement of insulation resistance and coating quality. Measurement of active resistance of EM windings and transformers. Winding insulation test with increased industrial frequency voltage.

Topic 3.3. Diagnostics of electrical equipment when stopped for repair and in "on-line" mode. Monitoring of the condition of machines and equipment during operation and operation.

Topic 3.4. Types of electrical equipment failures: operational failures; failures caused by wear and tear of individual parts of the electric machine; sudden failures during normal operation. Directions of modernization of EE. Solving issues of energy saving during the modernization of EE.

Topic 3.5. Start and stop of powerful TG. Modernization of EE for the purpose of solving energy saving issues using the example of modernization of powerful TG. Establishing operating modes of TG at power plant units in order to regulate the power factor of the power grid.

Topics for practical exercises

Topic 1. The technological process of obtaining electricity at the TPP. Types of fuel. Ball mills for coal preparation.

Topic 2. The technological process of obtaining electricity at the NPP. Electrical equipment for the NPP's own needs.

Topic 3. Complete transformer substations (CTS): assembly, installation location, ensuring magnetic compatibility of CTS elements.

Topic 4. Alternative diagnostic tools for the PPR system at power plants. Human factor.

Topic 5. New AD efficiency classes (IE code). AD energy efficiency classification system (EFF3, EFF2, EFF1).

Topic 6. Analysis of *U*-shaped and angular characteristics of a synchronous generator on power plant units. Maintaining the balance of active and reactive energy in the network due to the change in the mode of operation of the TG.

Topic 7. Conducting an analysis of starting and stopping the synchronous generator on the power plant block (hydro-lift, shaft-turning device). Bearing currents.

Topic 8. Protection of the calculation task.

Topics of laboratory work

Topic 1. Study of single- and three-phase two-winding transformers.

Topic 2. Research on the inclusion of three-phase transformers for parallel operation.

Topic 3. Start-up and frequency control of the rotation frequency of a three-phase asynchronous motor (AD) with a short-circuited rotor.
Topic 4. Rheostat start and study of operating characteristics of a three-phase AD with a phase rotor.
Topic 5. Study of the characteristics of a synchronous generator under autonomous load.
Topic 6. Study of the parallel operation of a synchronous generator with the network. The Synchroscopes.
Topic 7. Study of the operating characteristics of a direct current generator with parallel excitation. Checking the fulfillment of self-excitation conditions.
Topic 8. Protection of laboratory works.

Independent work

Individual tasks. "Determining the main parameters of electrical equipment after repair and during operation."
The calculation task should be performed according to methodological instructions [7].

Literature and primary materials

1. G. Mottershead, S. Bomben, I. Kerszenbaum, G. Klempner. “Handbook of Large Hydro Generators: Operation and Maintenance, First Edition”. – Hoboken, New Jersey: John Wiley & Sons, Inc., 2021. – 672 p.
2. Bonchuk I. A., Shaposhnikov A. P., Erokhin P. M. & Sozinov M. A. Optimization of the Operating Modes of Power Plants in Isolated Electrical Power Systems. // Power Technology and Engineering volume. – 2021. – No 55. – Pp. 445-453.
3. Janusz Turowski, Marek Turowski. Engineering Electrodynamics: Electric Machine, Trans-former, and Power Equipment Design 1st Edition. [Electronic resource]. Available at: https://www.amazon.com/Engineering-Electrodynamics-Electric-Transformer-Equipment/dp/1466589310
4. H. Lee Willis, Muhammad H. Rashid. Power Engineering Equipment. Maintenance and Testing. Second Edition. – University of West Florida. Library of Congress Cataloging-in-Publication Data. 2009. – 1002 p.
5. Sahdev S. K. Electrical Machines. - Cambridge University Press, 2018. – 980 p. [Electronic resource]. Available at: https://is.gd/V7AARC
6. Shevchenko V.V. Basics of electric power engineering. Beginning. Training manual. Kharkiv, 2022. 256 p. [Electronic resource]. Available at: https://zenodo.org/record/6465750
7. James Cale. Control of Wind Turbine Generators. – Colorado State University? 2014/ - 57 p. [Electronic resource]. Available at: https://www.engr.colostate.edu/ECE566/Slides/ECE566_Week5_LectureSlides_Cale.pdf
8. Chaplin R.A. Fundamentals of Electric Power Generation // Thermal power plants – Vol. III. Available at: https://www.eolss.net/sample-chapters/c08/E3-10-03-09.pdf
9. Ceraolo M., Poli D. Fundamentals of Electric Power Engineering: From Electromagnetics to Power Systems. – Power Technology & Power Engineering, 2014. – 552 p. Available at: https://www.wiley.com/en-gb/Fundamentals+of+Electric+Power+Engineering:+From+Electromagnetics+to+Power+Systems-p-9781118679692
10. Elements of Electrical Machines. Lecture Notes. Subject Code: BEE 1301. For 3rd Semester Mechanical Engineering and Production Engineering students. VEER Surendra SAI university of technology burla, Odisha, India. – Department of Electrical Engineering. [Electronic resource]. Available at: https://www.vssut.ac.in/lecture_notes/lecture1423454727.pdf
11. Electricity quality and its provision – Balance of active and reactive power. [Electronic resource]. Available at: https://forca.ru/knigi/arhivy/kachestvo-elektroenergii-i-ego-obespechenie-7.html
12. Calculation of power equipment parameters of power plants after repairs. Methodical instructions for performing calculation tasks in the discipline " Exploitation and Modes of Operation of Electrical Equipment of Power Plants" for foreign full-time students of specialty 141 – Power industry, electrical engineering and electromechanics / Compilers Shevchenko V.V., Lazurenko O.P. – Kharkiv: NTU "KhPI", 2023. – 24 p.

Evaluation system

Criteria for evaluating student performance and distribution of points

Current control is implemented in the form of surveys at lectures and consultations, during the input control and control of the individual task (WG), during the control (modular) work. The control of studying the sections of the work program, the sections that are mastered during the independent work of the student, is carried out by checking the abstracts and writing a test. Semester control - examination (according to examination tickets), in accordance with the curriculum, taking into account the results of current performance, in the amount of educational material defined by the curriculum, within the time limits set by the curriculum.
The resulting assessment consists of grades for work in the semester: in lectures (15 points), in practical work (10 points), in laboratory work (10 points); during the interview on the topics of the student's independent work - 5; for the performance of an individual task - 30; on the exam - 40 points.
A student can score a total of 100 points.

Rating scale

Total points	National assessment	ECTS
90–100	Perfectly	A
82–89	Fine	B
75–81	Fine	C
64–74	Satisfactorily	D
60–63	Satisfactorily	E
35–59	Unsatisfactorily (Further study required)	FX
1–34	Unsatisfactorily (re-study required)	F

Norms of academic ethics and policy of the course

The student must adhere to the "Code of Ethics of Academic Relations and Integrity of NTU "KhPI": show discipline, education, benevolence, honesty, responsibility. Conflict situations should be openly discussed in study groups with the teacher, and if it is impossible to resolve the conflict, it should be brought to the attention of the employees of the institute's directorate.
Regulatory and legal support for the implementation of the principles of academic integrity of NTU "KhPI" is posted on the website: http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Approval

The syllabus has been agreed

_____
Date of approval, signature

Head of Department
Oleksandr LAZURENKO

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Date of approval, signature

Guarantor of the educational program