Syllabus
Course Program

Electrical Part Of Power Stations And Substations

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,
Electrical Power Engineering. Energy Management and Energy-Efficient Technologies

Department
Electric Power Stations (130)

Level of education
Bachelor's level

Course type
Special (professional), Optional

Semester
6

Language of instruction
English, Ukrainian

Lecturers and course developers

Shokarov Dmytro

Dmytro.Shokarov@khpi.edu.ua
PhD, Associate Professor, Associate Professor of the Department Electric Power Stations

Author of more than 90 scientific, educational, and methodological publications. Leading lecturer of the disciplines: " Power Plant Dispatching and SCADA", " Electrical Part Of Stations And Substations ", " Power Supply Systems".
More about the lecturer on the department's website

General information

Summary

Power stations and substations are the main elements of the energy system and ensure the production and distribution of electricity. The discipline is dedicated to the study of technological and electrical schemes of various types of power stations, the main electrical equipment and the principles of its operation.
In the theoretical part of the discipline, the issue of electricity generation technology at various types of stations, the role and place of power stations and substations in the energy system is considered. The peculiarities of electrical schemes of various types of stations, their requirements, the process and stages of designing the electrical part of stations and substations are studied. Modes and principles of operation, designs of the main electrical equipment of stations and substations are studied.
The practical part of the discipline is devoted to the development of the electrical part of the station/substation and the design of its complete schematic diagram.

Course objectives and goals

Goal.

Study of the structure and principle of operation of electrical equipment, study of electrical connection schemes of power plants and substations, and formation of abilities and skills in choosing the conditions of their operation as part of the electric power system.
Electrical part of stations and substations
Objectives.
Know:
– Technological schemes of electric stations;
– Schemes and main electrical and communication equipment of electrical stations and substations;
– Normative documents on electrical equipment and schemes of distribution devices;
– Basic modes of operation of the equipment of electrical stations and substations;
– Physical phenomena and processes in electric power plants.
Be able:
– Analyze the operation of electrical connection schemes of power plants and substations in normal and emergency modes;
- Prepare output data for calculating short-circuit modes using specialized computer programs;
- Apply and operate electrical equipment of electrical stations and substations;
– Analyze technical information on electrical equipment, electrical connection diagrams of electrical stations and substations;
- Work on projects of electrical stations and substations;
– Graphically display schemes of distribution devices;
- Choose the main electrical and switching equipment of electrical stations and substations..

Format of classes

Lectures, practical studies, laboratory studies, consultations, self-study. Final control – exam.

Competencies

GC 7. Skills of using information and communication technologies.
GC 9. Ability to search, process and analyze information from various sources
PC 1. Ability to use computer-aided design (CAD), manufacturing (CAM) and engineering calculations (CAE) and related application software packages.
PC 21. Receipt and use of professional knowledge and understanding related to the information protection of power systems with the use of modern information and computer technologies.

Learning outcomes

PRT 1. To find the necessary information in the information space.
PRT 30. To improve the skills of working with modern equipment and software when performing calculations of operating modes of electrical, electrical and electromechanical equipment, corresponding complexes and systems

Student workload

The total volume of the course is 150 hours (6 ECTS credits): lectures - 48 hours, laboratory classes – 12 hours, practical classes (workshops) – 12 hours, self-study - 78 hours.

Course prerequisites

Theoretical Foundations of Electrical Engineering , Electrical Systems and Networks

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

Lectures are conducted interactively using multimedia technologies. At workshops and laboratory classes, the skills of student work formatting, the ability to use the university educational platform and resources are practiced. Practical tasks are performed using open-source software or on the Microsoft 365 platform. Learning materials are available to students through the OneNote Class Notebook.

Program of the course

Topics of the lectures

Objectives of the discipline

The value of this discipline for other professional disciplines. The amount of educational material, types of classes and organization of training.

Content module 1. Technological schemes of power plants and substations

Topic 1. Introduction

The main indicators of energy development of the countries of the world. The concept of the energy system. The process of production, transmission, distribution and consumption of electricity. Elements of the electrical system. Classification of electrical network objects.

Topic 2. Modern types of power plants and substations, features of their technological process Electrical part of stations and substations

Technological schemes of power plants. Prospective sources of electricity. Load distribution between power plants of different types. The concept of load schedules of power plants and substations. Reliability of electricity supply to consumers.

Topic 3. Synchronous generators and power transformers

Designs, main parameters and operational characteristics. Cooling systems. Modern excitation systems and requirements for them.

Content module 2. Structural diagrams of power plants and substations

Topic 4. Schemes of electrical connections of stations and substations

Types of electrical circuits. Peculiarities of structural and principle schemes of condensing power plants (KES), thermal power plants (CHP), nuclear power plants (NPP), hydroelectric power plants (HEP), and substations (PS). Technical and economic calculation of variants of structural schemes.

Topic 5. Own needs of power plants and substations

Purpose, role and impact on the reliability of power plants. Electricity supply schemes for own needs. Consumption of electricity for own needs.

Topic 6. Schemes of distribution devices of power plants and substations

Typical groups of schemes, their characteristics, operating conditions and scope of application.

Content module 3. Power plant and substation equipment

Topic 7. Working conditions of conductors and devices

Grounding in electrical installations and neutral operating modes. Heating of conductors and devices with continuous current. Heat balance equation. The thermal impulse of the short-circuit current. Thermal stability of devices. Electrodynamic effect of electric current. Losses in conductors with alternating current. Short circuits in electrical installations. Three-phase short circuit. Methods of calculating three-phase short-circuit currents. Schemes of substitution. Ways of limiting the short-circuit current.

Topic 8. Switching electrical devices

Electric arc phenomenon. The process of extinguishing an electric arc in switching devices. Arc extinguishing device of electric devices of alternating and direct current. Types of switches and their design features. Basic parameters and operational characteristics of modern switches, disconnectors and other electrical devices.

Topics of the workshops

Topic 1. Development of electrical connection schemes of power plants and substations in a software environment for CAD
Topic 2. Selection of transformers and autotransformers, checking of load capacity
Topic 3. Structure diagrams of CHP, CHP, NPP, HPP, GAPP, SPP, WPP, BioPP
Topic 4. Schemes of own needs of power plants and substations
Topic 5. Selection of variants of switchgear schemes
Topic 6. Calculation of short-circuit currents. Selection of equipment

Topics of the laboratory classes

Topic 1. Operation of synchronous generators in the power system
Topic 2. Research of the insulation control device of high-voltage alternating current installations
Topic 3. Electrodynamic forces of current-limiting reactors
Topic 4. Study of the operation of electrical equipment of a complete cell

Self-study

Individual calculation work on the electrical part of the station" in the amount of 20-30 p.
Submission deadline: 16th week.
The work should contain sections on the selection of the structural diagram of the electrical station in accordance with the task, the selection of switchgear schemes and the power supply scheme of the station's own needs, as well as the calculation of short-circuit currents and the selection of main equipment.
A complete schematic diagram of the station and a section of the switchgear cell are attached to the explanatory note of the calculation work. Work design, protection and graphic materials are evaluated.

Coursework
The educational component of " Electrical Part Of Power Stations And Substations " involves the performance of calculation work (C). The results of calculations are drawn up in a written report.
The term of defense of the coursework is the 16th week.

Course materials and recommended reading

Compulsory.
1. EPRI-RP3098-01, An Assessment of Distribution System Power Quality.
2. A. McEachern, “Roles of Intelligent Systems in Power Quality Monitoring: Past, Present, and Future,” Conference Record, Power Engineering Society Summer Meeting, 2001, Vol. 2, pp. 1103–1105.
3. R. P. Bingham, “Recent Advancements in Monitoring the Quality of the Supply,” Power Engineering Society Summer Meeting, 2001, Vol. 2, pp. 1106–1109.
4. Dranetz Engineering Laboratories, “Series 606 Power-Line Disturbance Analyzer,” December 1975.
5. E. W. Gunther, J. Rossman, “Application of Advanced Characterization Algorithms, UCA and Internet Communications Technology at the Point of Power Quantity and Quality Measurement,” Conference Proceedings of EPRI PQA 1999.
6. IEEE Standard 141-1993: Recommended Practice for Power Distribution in Industrial Plants.
7. IEEE Standard 519-1992: Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
520 Chapter Eleven
Power Quality Monitoring

8. IEC 61000-4-15, Electromagnetic Compatibility (EMC). Part 4: Testing and Measuring Techniques. Section 15: Flickermeter—Functional and Design Specifications.
9. D. A. Douglass, Potential Transformer Accuracy at 60-Hz Voltages above and below Rating and at Frequencies above 60 Hz. Presented at the IEEE Power Engineering Society Summer Meeting, Minneapolis, Minn., July 13–18, 1980.
10. D. A. Douglass, "Current Transformer Accuracy with Asymmetric and High Frequency Fault Currents," IEEE Transactions on Power Apparatus on Systems, Vol. PAS-100, No. 3, March 1981.
for the Exchange of Power Quality
Measurement and Simulation Data, SCC 22.

Additional.
1. S. Santoso, J. D. Lamoree, "Answer Module: A Custom-Built Module to Meet Specific Power Monitoring Tasks," Conference Proceedings of EPRI PQA 2001, Pittsburgh, Pa.
2. U. Fayyad, G. Piatetsky-Shapiro, P. Smyth, "From Data Mining to Knowledge Discovery: An Overview," in U. Fayyad, G. Piatetsky-Shapiro, P. Smyth, R. Uthurusamy, eds., Advances in Knowledge Discovery and Data Mining, MIT Press, 1996, pp. 471–494.
3. S. Santoso, R. C. Dugan, J. D. Lamoree, A. Sundaram, "Distance Estimation Technique for Single Line-to-Ground Faults in a Radial Distribution System," Conference Record, Power Engineering Society Winter Meeting, 2000 IEEE, Vol. 4, pp. 2551–2555.
4. S. Santoso, J. D. Lamoree, M. F. McGranaghan, "Signature Analysis to Track Capacitor Switching Performance," Conference Record, Transmission and Distribution Conference and Exposition, 2001 IEEE/PES, Vol. 1, pp. 259–263.
5. IEEE Standard 1159-1995, Recommended Practice on Monitoring Electric Power.
6. Draft Standard IEC 61000-4-30 77A/356/CDV, Power Quality Measurement Methods.
7. IEEE Draft Standard P1159.3, Recommended Practice for a Power Quality Data Interchange Format—An Extensible File Format

Assessment and grading

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

Final score consists of up to:
30 points for two module tests,
30 points for laboratory classes and workshops tasks,
20 points for coursework, and
20 points for final tests.

Coursework defense is mandatory.

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 Oleksandr LAZURENKO