Syllabus
Course Program

Electrical Part Of Power Stations And Substations p.2

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
7

Language of instruction
English, Ukrainian

Lecturers and course developers

Shokarov Dmytro

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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 120 hours (4 ECTS credits): lectures - 32 hours, laboratory classes – 16 hours, practical classes (workshops) – 16 hours, self-study - 56 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.

Topic 1. Introduction

Classification of power plants according to the principle of electricity production. Thermal and nuclear power plants. Hydro and pumped storage power plants. Non-traditional sources of electrical energy. The main technological equipment of thermal and nuclear power plants: turbines, synchronous generators, transformers. Characteristics of the processes of electricity production.

Topic 2. Synchronous generators:

Technical characteristics and design of modern generators, generator cooling system. Schematic diagrams of excitation of generators: brushless, high-frequency. Field extinguishing machines: purpose, principle of operation, schematic diagrams of switching. Main transformers: types and parameters, structural elements, transformer cooling systems; voltage regulation principle.

Topic 3. Basic provisions of high voltage technology

Information on electrophysical processes in dialectics (solid, gaseous and liquid). Electrical insulation: condition diagnostics, preventive tests, control methods. General requirements for substation schemes: classification of substations by purpose, technical and economic requirements for schemes. Optimal execution of circuits on the high voltage side (HV) in terms of reliability and economy. Optimal execution of circuits on the low voltage (LV) side under the conditions of power supply to consumers with different load patterns. Compensating and filtering compensating devices at substations of industrial enterprises. Modes of neutrality of distribution networks of industrial enterprises.

Content module 2.

Topic 4. High-voltage and low-voltage switching devices

Conditions for the occurrence and extinguishing of an electric arc. Circuit breakers with a voltage greater than 1000V: classification, principles of electric arc extinguishing; turning off side and low-oil; air and gas; vacuum and electromagnetic. Separators, short-circuits and disconnectors.
Fuses: design, principle of operation, types. Switching devices with voltage up to 1000V: automatic machines, contactors, magnetic starters; classification, principle of operation, types.

Topic 5. Selection of electrical equipment, live parts and cables

Conditions for the selection of electrical equipment: electrodynamic and thermalresistance to short-circuit currents (short-circuit).
The main provisions of the method for calculating short-circuit currents: substitution schemes, parameters of the short-circuit mode. Design conditions for checking electrical equipment for short-circuit mode: switches, disconnectors and fuses. Purpose, classification and selection of current and voltage transformers.
Methods of limiting short-circuit currents: application of circuit solutions and electrical equipment. Current-limiting reactors: principle of operation, classification and design, installation site.
Typical groups of schemes, their characteristics, operating conditions and scope of application.

Content module 3.

Topic 7. Electrical diagrams of power plants and substations

General requirements for power plant schemes; Main schemes of power plants: single bus system; operating and backup bus systems; dual tire system; power supply circuits for consumers on generator voltage. Selection of transformers for communication with the power system.
Power supply schemes for auxiliary needs of power plants: power of auxiliary transformers, power supply schemes with a voltage of 3 kV or 6 kV, redundancy of power supply to consumers with a voltage of up to 1000 V.

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Topic 8. Switchgears for power plants and substations

Classification of switchgears based on their requirements. Open switchgears: layout of the electrical installation area; location of electrical equipment and lightning protection devices.
Enclosed switchgears of ultra-high voltage (110–150 kV) and high voltage (6–10 kV): design of switchgear elements, complete switchgears.
AC and DC auxiliaries: scope of application, specifics of service.
Protective grounding: classification, design, normalization of the value of grounding resistance. Method for calculating the grounding of an industrial substation.

Topics of the workshops

Topic 1. Calculation of single-phase ground fault currents.
Topic 2. Construction of a substitution scheme for the calculation of short-circuit currents and selection of of the main electrical equipment of the step-down substation.
Topic 3. Calculation of short-circuit currents on the secondary side of the auxiliary transformer, selection of cables and low-voltage switching equipment.
Topic 4. Study of the design and diagram of electrical connections substation switchgear.
Topic 5. Calculation of protective earth resistance and lightning protection step-down substation of an industrial enterprise.
Topic 6. Study of the design and selection of current-limiting reactors

Topics of the laboratory classes

Topic 1. Study of the schematic diagram of the block and elements of the turbine-generator structure: parameters, control and regulation of the mode
Topic 2. Study of the design of the main step-down transformer
and the study of its characteristics
Topic 3. Study of the design and diagram of electrical
Switchgear connections
Topic 4. Study of the design and measurement of the resistance of the protective Grounding of the electrical installation
Topic 5 Study of the design, principle of operation and control scheme
Low-volume oil switch
Topic 6Study of the design and principle of operation of a vacuum circuit breaker

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.

Downloaded from Digital Engineering Library @ McGraw-Hill (www.digitalengineeringlibrary.com)
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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