Vinnytsia National Technical University
Department of Power Plants and Systems
Faculty of Power Engineering and Electromechanics

Systems of computer-aided design of electrical installations

(Normative)
Master's level of higher education
Educational program: Electrical Power Engineering
Specialty: 141 – CAD system of electrical installation
Lecturer: Teptya Vera and Rubanenko Olena
ECTS credits – 5 (150 hours)
Lectures – 27 hours
Practical lessons – 18 hours
Self-support work – 27 hours
Laboratory lessons – 18 hours
Project – 60 hours
The course is given in English

Course content

The purpose of studying the discipline is to study the methods and means of computer-aided design of electrical installations (power plants and substations), to study the tools for making effective decisions when designing the electrical part of electrical installations.
The main tasks of studying the discipline are
- to study with the basic methods and means of designing the main schemes of power plants and substations;
- to study acquainted with the methods and normative documents used during the design of the main schemes of electrical installations and the choice of electrical equipment.

Recommended previous knowledge

Processes of designing the electrical part of power plants and substations, Making decisions on the choice of electrical connections, Electrical equipment and its location, and optimization of fragments and the object as a whole.
This discipline is directly related and complements such basic disciplines as "Computing and CAD in energy", "Electrical part of stations and substations", "Electrical systems and networks", "Electrical machines", "Electrical apparatus", "Transients"," Mathematical problems of energy".

Learning outcome

After completing this course the candidate should:

- Ability to abstract thinking, analysis, and synthesis.
- Ability to search, process, and analyze information from various sources.
- Ability to use information and communication technologies.
- Ability to apply knowledge in practical situations.
- Ability to use a foreign language to carry out scientific and technical activities.
- Ability to make informed decisions.
- Ability to learn and master modern knowledge.
- Ability to identify and assess risks.
- Ability to work independently and in a team.
- Ability to identify feedback and adjust your actions to take them into account.
- Ability to apply the acquired theoretical knowledge, scientific and technical methods to solve scientific and technical problems and problems of power engineering and electrical engineering.

- Ability to apply existing and develop new methods, techniques, technologies, and procedures to solve engineering problems of electricity and electrical engineering.
- Ability to plan, organize and conduct research in the field of power engineering and electrical engineering.
- Ability to develop and implement measures to improve reliability, efficiency, and safety - during the design and operation of electrical equipment of power plants.
- Ability to analyze technical and economic indicators and expertise in design solutions in the field of power engineering and electrical engineering.
- Ability to demonstrate knowledge and understanding of mathematical principles and methods required for use in power engineering, electrical engineering and
- electromechanics and during the production of electricity.
- Ability to understand and take into account social, environmental, ethical, economic, and commercial considerations that affect the implementation of technical solutions in electricity, electrical engineering, and electromechanics and power plants.
- Ability to manage projects and evaluate their results.
- Ability to assess the reliability and efficiency of power plants.
- Ability to develop plans and projects to ensure the achievement of a specific goal, taking into account all aspects of the problem to be solved, including the production, operation, maintenance, and disposal of power plant equipment.
- Ability to demonstrate awareness and ability to use regulations, norms, rules, and standards in the power industry.
- Ability to use software for computer modeling, computer-aided design, automated production, and automated development or design of elements of the electrical part of power plants.
- Ability to publish the results of their research in scientific journals.

Skills:

- The finding options to increase energy efficiency and reliability of electrical, electrical, and electromechanical equipment and related complexes and systems.
- To reproduce processes in electric power, electrotechnical, and electromechanical systems at their computer modeling.
- Master new versions or new software designed for computer modeling of objects and processes in power systems.
- Analyze the processes in the equipment of power plants.
- Reconstruct the existing electrical part of power plants and substations in order to increase their reliability, operational efficiency, and life extension.
- Have methods of mathematical and physical modeling of objects and processes in the electrical part of power plants.
- Present research materials at international scientific conferences and seminars on current issues in the field of electricity, electrical engineering, and electricity generation.
- To substantiate the choice of direction and methods of scientific research taking into account modern problems in the field of electricity production.
- Plan and implement research and innovation projects in the field of electricity and electrical engineering and in the field of electricity generation.
- Participate in joint research and development with foreign scientists and specialists in the field of power engineering, electrical engineering, and electromechanics and in the field of electricity production.
- Combine different forms of research and practical activities in order to bridge the gap between theory and practice, scientific achievements, and their practical implementation.
- Demonstrate an understanding of regulations, norms, rules, and standards in the field of electricity, electrical engineering, and electromechanics and in the field of electricity generation.

Topical Outline:

The program of the discipline

Content module 1. Basic provisions and basic concepts of computer-aided design (CAD) of electrical installations.

Topic 1. Introduction.

List of references. The purpose and objectives of the discipline. General information about the design of power plants. The main stages of design. The composition of works on the design of the electrical part of power plants.

Topic 2. Automation of power plant design.

General Information. CAD structure of electrical installations. Methods for optimizing the projected object. Mathematical model of the design process. Graph of the electrical circuit design of block power plants. Design algorithms.

Topic 3. Structures and engineering communications of power plants and their location.

Site selection for construction. Buildings, structures, communications, and their general principles of layout. Performing internal electrical connections.

Topic 4. Design of the technological part of power plants.

Choice of the structural technological scheme. Selection of auxiliary equipment. Design of the thermal scheme.

Topic 5. Feasibility study in the design of electrical installations.

Terms. Determining the cost of electricity losses. Determination of reliability indicators of electrical installations. Determination of damage from the unreliability of the designed electrical installations.

Content module 2. Design of the electrical part of power plants

Topic 6. Design of the main electrical circuit of power plants.

Selection of the scheme of connection of power plants to the power system. Selection of an appropriate method of limiting short-circuit currents. Selection of the electrical circuit of switchgear. Calculation of short-circuit currents and selection of conductors and switching devices.

Topic 7. Constructions of switchgear.

The procedure for designing switchgear. General requirements. Choice of design type of switchgear. Design of open and complete switchgear. Foreign constructions of open switchgear. Calculation of lightning protection and grounding of open switchgear.

Topic 8. Design of control systems.

General Information. Choice of the organizational structure of operational control. Design of control panels. Selection of sources and schemes of operational current.

Learning methods and activities

Lectures. Compulsory exercises and computer simulations. Compulsory project work.

Topics of the course project

The course project is the design of the electrical part of the EC (CES, CHP, NPP, HPP, PSP, PGES, GTES, WPP or SES) for the formation of students' design skills.

Settlement and explanatory note (40-60 pp.) Consists of the following sections:

Introduction.

1. Feasibility study of the project (connection of the power plant with the system and its role in the system).

2. Electrical part.

2.1. Calculation of graphs of electrical loads.

2.2. Choice of type and power of generators, turbines and boiler units.

2.3. Selection of the structural scheme of the station (based on a comparison of at least two options). Choice of block transformers, autotransformers of communication, transformers of own needs, quantity of power lines and other equipment.

2.4. Selection of high voltage open high voltage switchgear schemes on the basis of comparison of at least two options according to technical and economic indicators.

2.5. Choice of the scheme of own station needs.

2.6. Calculation of short-circuit currents for selection of equipment and current-carrying parts.

2.7. Choice of switching equipment.

2.8. Selection of live parts.

2.9. Selection of current limiting reactors (for CHP stations).

2.10. Selection of measuring transformers.

2.11. Selection of equipment for overvoltage limitation and high-frequency barriers (shunt reactors for 500 and 750 kV transmission lines).

2.12. Choosing a rechargeable battery.

2.13. Calculation of lightning protection of open high voltage switchgear of high voltage.

2.14. Calculation of the grounding device of the open high voltage switchgear.

Conclusion

List of references

Graphic material

1. The main scheme of electrical connections of power plants (1 sheet of A4 format).

2. Plan and cross section of the high voltage (1 sheet of A4 format).

Further on evaluation

Current control, which is carried out in the form of frontal, individual, or combined control of students' knowledge during lectures, practical and laboratory classes, testing, exams, defense of the course project.

Course materials

Neil Sclater. Handbook of Electrical Design Details, Second Edition (McGraw-Hill, 2003, 1997). https://www.accessengineeringlibrary.com/content/book/9780071377515

Additional materials

2. Dieter Roller, Pere Brunet. “Power system analysis and design,” 1997.

3. Control and automation of electrical power distribution systems. James Northcote-Green, Robert G. Wilson, James Northcote-Green, (2007)

4. Power systems engineering and mathematics. International Series of Monographs in Electrical Engineering U. G. Knight, D. J. Silverleaf (2017) https://www.perlego.com/book/1884148/power-systems-engineering-and-mathematics-international-series-of-monographs-in-electrical-engineering-pdf

5. Analysis and design of low-voltage power systems: an engineer's field guide 1st edition