Syllabus
Course Program

Automatization of Electric Power Stations

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), Mandatory

Semester
8

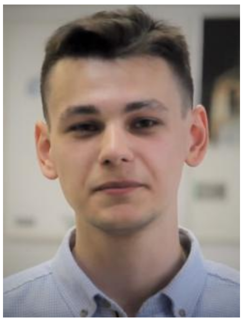
Language of instruction
English

Lecturers and course developers

Ihor Bohatyrov

ihor.bohatyrov@khpi.edu.ua
Associate Professor

Author of 46 scientific publications and educational and methodological works, 20 patents for inventions, 8 devices and systems that were produced or are being produced in series.
Leading lecturer in the disciplines: "Microprocessor technology", "Accounting and measurement of parameters of energy carriers", "Automation of power plants", "Designing of electric power facilities and systems", "Intelligent energy consumption management systems".
More about the lecturer on the department's website



Vladyslav Hrytsenko

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Assistant

Field of interests:
Modelling and operation of electric system processes in case of production-consumption balance disturbance. Investigation of processes in grids with renewable energy sources in the energy mix to develop a control algorithm for a virtual synchronization generator unit coupled with energy storage in grids with low inertia. Author of 12 scientific publications..
More about the lecturer on the department's website

General information

Summary

Technical means of the Process Control Systems include all devices that are part of the control system and are designed to receive information, transmit it, store and convert it, as well as to perform control and regulatory actions on the technological control object.
The main attention in this lecture course is paid to the means of regulation, to which the course is devoted.

Course objectives and goals

Purpose: To form in students knowledge of the general principles of constructing automatic control systems, types of control systems and their mathematical description, as well as methods of studying automatic control systems for stability and quality of control.

Objectives: to know: methods of mathematical description of control objects at power stations; means of improving the quality of control of power equipment; methods of computer modeling of automatic control systems. to be able to: use experimental methods of determining the dynamic characteristics of control objects; to compose and transform functional and structural diagrams of control objects; to choose the control law and the type of regulator; to determine the dynamic characteristics of the control object; to choose structural diagrams and the necessary equipment for the implementation of automatic control systems at power stations.

Format of classes

Lectures, laboratory classes, consultations, self-study. Final control in the form of an exam.

Competencies

C01. The ability for abstract thinking, analysis and synthesis.
C05. Ability to search, process and analyze information from various sources.
C11. The ability to solve practical problems using computer-aided design and calculation (CAD) systems.
C12. Ability to solve practical problems using methods from mathematics, physics, and electrical engineering.
C15. Ability to use knowledge of metrology and electrical measurements, automatic control theory and electronics to solve measurement, design, control and management problems in electric power, electrical engineering and electromechanics.
C19. Awareness of the need to increase the efficiency of electrical power, electrical engineering and electromechanical equipment.

Learning outcomes

LO06. Apply application software, microcontrollers, and microprocessor technology to solve practical problems in professional activities.
LO08 Select and apply appropriate methods for the analysis and synthesis of electromechanical and electropower systems with given parameters.
LO10. Find the necessary information in scientific and technical literature, databases and other sources of information, evaluate its relevance and reliability.
LO17. Solve complex specialized tasks in the design and maintenance of electromechanical systems, electrical equipment of power plants, substations, systems and networks
LO18. Be able to learn independently, master new knowledge, and improve skills in working with modern equipment, measuring equipment, and applied software.

Student workload

The total volume of the course is 120 hours (4 ECTS credits): lectures - 30 hours, workshops - 20 hours, self-study - 68 hours, consultations - 2 hours.

Course prerequisites

Electrical Part Of Power Stations And Substations Pt1-3

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

Topic 1. Introduction
Course Objectives. Relevance to Other Professional Disciplines: How this course supports and integrates with related technical subjects. Scope and Structure: Overview of course content, types of instructional activities, and learning organization

Topic 2. Structure of Automated Process Control Systems (APCS)
Classification of automatic control systems. Classification of control instrumentation and devices. Classification of controlled processes and systems. Industrial requirements for automatic control systems

Topic 3. Methods of Input Signal Integration into Controllers
Instrumentation-based input methods. Hardware-based input methods. Aggregate-level input methods

Topic 4. Architecture of Automatic Control Systems
National standards and instrumentation systems used in automation technologies

Topic 5. Primary Transducers
Sensor types and applications. Physical principles of sensor operation. Actuating mechanisms. Control elements (valves, dampers, etc.)

Topic 6. Industrial Temperature Sensors
Operating principles. Application features and considerations

Topic 7. Industrial Pressure Sensors
Operating principles. Application features and considerations

Topic 8. Industrial Flow Sensors
Flow measurement devices. Operating principles. Application features and considerations

Topic 9. Methods for Characterizing Control System Behavior
Static and dynamic system characteristics. Standard control system components. System block interconnections. Transfer functions. Laplace transformation of differential equations

Topic 10. Experimental Techniques for Identifying Dynamic Characteristics of Control Objects
Determining parameters of transient response characteristics

Topic 11. Control Laws
Standard nonlinear control laws. Standard linear control laws. Proportional (P) control. Integral (I) control. Proportional-Integral (PI), Proportional-Derivative (PD), and Proportional-Integral-Derivative (PID) control laws

Topic 12. Actuator Characteristics and Their Influence on Control Law Design
Pneumatic actuators. Hydraulic actuators. Electric actuators

Topic 13. Types of Controllers – Two-Position
Purpose and operating principles. Two-position control algorithms. Hysteresis zone. Control processes using two-position logic. Types and logic of two-position controllers and alarm systems. Advantages and limitations

Topic 14. Types of Controllers – Three-Position
Purpose and operating principles. Three-position control algorithms. Hysteresis zone. Control processes using three-position logic

Topic 15. Design of Multi-Position Microprocessor-Based Control Systems
P, PI, PD, PID controllers. Standard controller types and control characteristics. Structural diagrams of continuous controllers. Output device compatibility. Control algorithms. Step response behavior

Topic 16. Selection of Control Laws and Controller Types
Identification of dynamic characteristics of the controlled system. Performance indicators for continuous control systems. Guidelines for selecting appropriate control laws and controller types

Topics of the workshops

Topic 1. Analysis of Structural Schemes of Automatic Control Systems in Power Plants
Topic 2. Selection of Temperature Sensors and Measurement Schemes. Error Calculation
Topic 3. Selection and Calculation of Flow Measurement Devices
Topic 4. Study of Dynamic Characteristics of Typical Control System Elements and Their Physical Analogs

Topic 5. Determination of the Transfer Function of a Controlled Object Based on Tabular or Graphical Step Response Characteristics
Topic 6. Modeling Control Systems with I, PI, and PID Controllers
Topic 7. Modeling Control Systems with Relay Controllers
Topic 8. Modeling Control Systems and Evaluating Quality Indicators of the Control Process

Topics of the laboratory classes

This field is filled in the same way if the curriculum includes laboratory classes.

Self-study

Information on self-study and individual assignments (reports, course projects, etc.), if it is necessary according to the plan. Also, methods of control and assessment of self-study.

Course materials and recommended reading

Mandatory:
1. G. T. Heydt, Electric Power Quality. West Lafayette, IN: Stars in a Circle Publications, 1991.
2. O. I. Elgerd, Electric Energy Systems Theory: An Introduction. New York, NY: McGraw-Hill, 1982.
3. A. J. Wood and B. F. Wollenberg, Power Generation, Operation, and Control. New York, NY: Wiley-Interscience, 1984
4.M. P. Kazmierkowski, "Renewable Energy Devices and Systems with Simulations in MATLAB and ANSYS,"(IEEE Industrial Electronics Magazine, vol. 12, no. 2, pp. 80-83, June 2018) doi: 10.1109/MIE.2018.2827859
5.Zhang XP., Rehtanz C., Pal B. Flexible AC Transmission Systems: Modelling and Control. Power Systems. Springer, Berlin, Heidelberg, 2012, 552 pages) https://doi.org/10.1007/978-3-642-28241-6_5

Optional:
1. Kundur, P.: Power system stability and control. McGraw Hill, New York (1994)
2. Power System Dynamics and Stability by Peter W. Sauer and M. A.Pai. (Prentice Hall, 1998, ISBN 0-13-678830-0, 357 pages
3. IEEE Power Engineering Society, IEEE Recommended Practice for Electric Power Distribution for Industrial Plants, IEEE Std 141-1993, New York, NY: IEEE, 1993
4. Pandey, Utkarsh, Anshumaan Pathak, Adesh Kumar, and Surajit Mondal. “Applications of Artificial Intelligence in Power System Operation, Control and Planning: A Review.” Clean Energy 7, no. 6 (2023): 1199–1218. https://academic.oup.com/ce/article/7/6/1199/7425141 .

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 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