Syllabus
Course Program

Power Plant Dispatching and SCADA

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
Masters's level

Course type
Special (professional), Optional

Semester
1

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

The " Power Plant Dispatching and SCADA " course is designed to provide students with knowledge and skills related to solving common and engineering tasks of energy-intensive industries a clear idea of the means of automation of energy-intensive industries, the structure and connections of the elements of its control system, the functions and software tools of automated control systems and SCADA system.

Course objectives and goals

Goal.
Training of students in the field of dispatch control and SCADA systems of power plants.
Objectives.
To know:
- tasks and functions of the dispatcher of the electric station;
- goals, tasks and functions of automated power plant control systems;
- principles of construction of SCADA of electrical stations;
- the basics of choosing the equipment of the lower level of SCADA;
- basics of equipment selection for the level of collection and preparation of information of SCADA;

- principles of action, device, work, main technical industrial means of SCADA.
-To be able to:
- apply the acquired knowledge when solving practical problems related to the performance of the functions of the dispatcher of the electric station;
- choose equipment of the lower level of SCADA;
- to choose the structure and equipment of the level of information collection and preparation of SCADA
- evaluate the efficiency of the automated power plant control systems.

Format of classes

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

Competencies

GC 1. Ability to think, analyze and synthesize.
GC 2. Ability to search, process and analyze information from different sources.
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, , practical classes (workshops) – 16 hours, self-study - 100 hours.

Course prerequisites

No special knowledge is required for this course.

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. SCADA system
Topic 1 Background to SCADA
Introduction. Evolution of automation systems. History of automation systems.Supervisory control and data acquisition (SCADA)systems. Components of SCADA systems. SCAD Aapplications. SCADA in power systems. SCADA basic functions. SCADA application functions. Advantages of SCADA in power systems.
Topic 2 SCADA fundamentals

Open system: Need and advantages. Building blocks of SCADA systems. Remote terminal unit (RTU24). Evolution of RTUs. Components of RTU. Communication subsystem. Communication protocols.

Topic 3 Power system automation

Evolution of automation systems. History of automation systems. Supervisory control and data acquisition (SCADA) systems. Components of SCADA systems. SCADA applications. SCADA in power systems. SCADA basic functions. SCADA application functions. Generation SCADA application functions. Transmission SCADA application functions. Distribution automation application functions. Advantages of SCADA in power systems.

Topic 4 SCADA Operator interface

Access-Control Mechanisms. Standard System Displays. Site/Industry–Specific Displays. Historical Trending . Logs and Reports .

Topic 5 SCADA communication

SCADA communication requirements. Smart grid communication infrastructure. SCADA communication topologies. SCADA data communication techniques. SCADA communication protocol architecture. Security for SCADA and smart grid communication. Challenges for SCADA and smart grid communication.

Content module 2. Energy management systems

Topic 6 Substation automation (SA).

Deregulation and competition. Development of intelligent electronic devices (IEDs). Enterprise-wide interest in information from IEDs. Implementation and acceptance of standards. Construction cost savings and reduction in physical complexity. Conventional substations: Islands of automation. New smart devices for substation automation. IEDs. New instrument transformers with digital interface. Data warehouse. System responsibilities. System architecture. Substation host processor. Substation LAN. Protection and control level. Station bus and station level. Substation automation architectures.

Topic 7 Energy management systems (EMS) for control Centers

Operating states of the power system and sources of grid Vulnerability. Energy control centers. Energy management systems (EMS): Energy management systems evolution. Energy scheduling and accounting. Event analysis. Energy service providers. Dispatcher training simulator. Smart transmission.

Topic 8 Distribution automation and distribution

management (DA/DMS) systems. Overview of distribution systems. Introduction to distribution automation. Customer automation. Feeder automation. Substation automation. Subsystems in a distribution control center. Distribution management systems (DMSs). Outage management systems (OMS). Topology processing (TP)

Topic 9 SCADA systems, hardware and firmware

Comparison of the terms SCADA, DCS, PLC and smart instrument. System SCADA software.

Topic 10 SCADA systems software and protocols

The components of a SCADA system. The SCADA software package. Specialized SCADA protocols. Introduction to protocols.

Topics of the practical studies

Topic 1. Distributed SCADA system architecture
Topic 2. SCADA configuration utilities
Topic 3. Typical corporate IP network architecture
Topic 4. Example tabular operator display
Topic 5. SCADA as a service.
Topic 6. Example host definition of downloaded calculation functions
Topic 7. Network-based serial protocol architecture
Topic 8. Connection-oriented telephone circuits

Topics of the workshops

Topics of the laboratory classes

Self-study

Topics
Topic 1. Background to SCADA
Topic 2. SCADA fundamentals
Topic 3. Power system automation
Topic 4. Operator interface
Topic 5. SCADA communication
Topic 6. Substation automation (SA).
Topic 7. Energy management systems (EMS) for control Centers
Topic 8. Distribution automation and distribution
Topic 9. Algorithms for calculating the number, sum, mean, root mean square, product, maximum, minimum
Topic 10. SCADA systems, hardware and firmware

Course materials and recommended reading

Compulsory.
. George W. Arnold, "Challenges and opportunities in smart grid: a position article," Proceedings of the IEEE, vol. 99, no. 6, June 2011, pp. 922–927.
2. Roger N. Anderson, Albert Boulanger, Warren B. Powell, and Warren Scott "Adaptive stochastic control for the smart grid," Proceedings of the IEEE,vol. 99, no. 6, June 2011. 296 Power system SCADA and smart grids
3. James Momoh, "Smart grid: Fundamentals of design and analysis," Wiley- IEEE press, 2012.
4. Power and utilities changing workforce: Keeping the lights on.PWC, December 2012.
5. Peter Palensky, and Dietmar Dietrich, "Demand side management: demand response, intelligent energy systems, and smart loads," IEEE Transactions on Industrial Informatics, vol. 7, no. 3, pp. 381–388, August 2011.
6. Benjamin Kroposki, Pankaj K. Sen, Keith Malmedal, "Selection of Distribution Feeders for Implementing Distributed Generation and Renewable Energy Applications," IEEE Transactions on Industrial Applications, val. 49, no. 6,
pp. 2825–2834, November/December 2013.
7. J.J. Iannucci, L. Cibulka, J.M. Eyer, and R.L. Pupp, Distributed Utility Associates Livermore, California, "DER Benefits Analysis Studies: Final Report," NREL/SR-620-34636, September 2003.
8. Mauro Bosetti, Operation of Distributed networks with distributed Generation, Ph D Thesis, University of Bologna, 2009.
9. A. Mohd, E. Ortjohann, A. Schmelter, N.Hamsic, and D. Morton, "Challenges in integrating distributed energy storage systems into future smart grid,'' in Proc. IEEE Int. Symp. Industrial Electronics, June 30-July 2, 2008, pp. 1627–1632.
10. Grid 2030- A National Vision for Electricity's Second 100 Years, Based on the Results of the National Electric System Vision Meeting Washington DC,vApril2–3 2003.

Additional.
1. Mohammad Ashiqur Rahman, and Ehab Al-Shaer, University of North Carolina at Charlotte, “AMI Analyzer: Security Analysis of AMI Configurations”.
2. NETL Grid strategy, Powering our 21st Century Economy, Advanced metering infrastructure, US Department of Energy, Feb 2008
3. John D McDonald “Integrating DA With AMI May Be Rude Awakening for Some Utilities,” Renew Grid (Feb. 20, 2013).
4. Hyunjeong Lee, Wan-Ki Park and Il Woo lee “A Home Energy Management System for Energy-Efficient Smart Homes,” 2014 International Conference on Computational Science and Computational Intelligence, vol. 2, March 2014, pp. 142–145.

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