Syllabus
Course Program

Technique and design of experiments

Specialty
141 – Electric Power, Electrical Engineering and Electromechanics

Institute
Institute of Education and Science in Power Engineering, Electronics and Electromechanics

Educational program
Electric Power Industry

Department
Engineering Electrophysics (135)

Level of education
Master's level

Course type
Special (Professional) / Optional

Semester
2

Language of instruction
English

Lecturers and course developers

Mykyta Petrenko

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Ph. D., Associate Professor at the Engineering Electrophysics Department of NTU "KhPI".
Authored 6 publications in the domain of strong magnetic field calculations, computation of strong magnetic fields, electromagnetic forming and related areas. Lecturer on “Modelling of Electro-Physical and Electric Power Equipment and Processes”, “High Voltage Measurements”, “High Voltage Equipment”, “High Voltage Pulse Equipment”, etc.
More about the lecturer on the department's website

General information

Summary

The "Technique and Design of Experiments" course is an essential exploration into experimental methods in electrical engineering, blending digital and analog technologies. It introduces digital signal processors, analog-digital converters, and electrical filters, moving to practical skills such as soldering and electromagnetic field protection. The course also covers the operational principles of electron-beam and digital oscilloscopes. Focused on modern experimental methods and measuring devices, it equips students with theoretical knowledge and practical skills essential for electrical engineering challenges.

Course objectives and goals

This course aims to familiarize students with modern scientific experimentation techniques in electrical engineering, focusing on digital oscilloscope usage and computer integration in experiments. Objectives include understanding the calculation of voltage dividers and current shunts in high-voltage pulse technology and mastering digital filters and ionization transducers. The course combines lectures and practical work to develop students' skills in experimental research and application, preparing them for professional challenges in electrical engineering.

Format of classes

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

Competencies

GC 3. The ability to apply knowledge in practical situations
GC 7. Skills of using information and communication technologies.
GC 8. The ability to learn and master modern knowledge.
GC 9. Ability to search, process and analyze information from various sources
PC 3. Ability to use basic knowledge of general physics, higher mathematics, theoretical foundations of electrical engineering and electrical materials for solving practical problems in the field of electric power engineering, electrical engineering and electromechanics.
PC 4. Ability to use professional knowledge in the basics of electric power: electrical part of stations and substations, electrical systems and networks, relay protection and automatics of power systems and high voltage equipment for solving practical problems in the field of electric power engineering, electrical engineering and electromechanics.
PC 12. Ability to study and analyze scientific and technical information in the field of electric power engineering, electrical engineering and electromechanics.
PC 20. Receiving and using professional knowledge and understanding related to the processes of electrophysical highvoltage installations for scientific research and industrial technologies, as well as renewable energy installations.

Learning outcomes

PRT 2. Discuss professional topics
PRT 18. To evaluate the parameters of the electrical, electrical and electromechanical equipment and related complexes and systems work and to develop measures to increase their energy efficiency and reliability.
PRT 19. Solving professional tasks in the design, installation and operation of electric power, electrical engineering, electromechanical complexes and systems.
PRT 40. Know and understand the processes of operation of electrophysical high-voltage installations for scientific research and industrial technologies, as well as renewable energy installations.

Student workload

The total volume of the course is 120 hours (4 ECTS credits): lectures - 16 hours, workshops - 16 hours, laboratory classes - 16 hours, self-study - 72 hours.

Course prerequisites

Physics, Higher Mathematics, Theoretical Foundations of Electrical Engineering

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

Lectures employ modern multimedia tools to enhance the learning experience. Workshops and laboratory classes are structured around a mix of student preparatory self-study and collaborative team activities. Experiential learning is also an integral part of the coursework, allowing students to learn from real-world scenarios. Knowledge and skills cultivated during practical sessions are further reinforced as students tackle individual computational tasks.

Program of the course

Topics of the lectures

Topic 1. Digital Signal Processing Fundamentals
An introduction to the core concepts of digital signal processing. This lecture will cover the basics of signal conversion and processing techniques used in modern electronics.
Topic 2. Analog and Digital Signals: Conversion Techniques
Exploring the methods of converting analog signals to digital forms and vice versa. Focus will be on understanding the functionality and application of analog-to-digital converters.
Topic 3. Electrical Filters and Measurement Transducers
A comprehensive overview of electrical filters and their role in measuring transducers. The session will discuss different types of filters and their applications in signal processing.

Topic 4. Principles of Ionization Transducers
Delving into the operational principles of ionization transducers. This lecture will cover the function and use of gas discharge counters in measuring and experimental setups.
Topic 5. Techniques in Soldering and Welding
An introduction to basic soldering and welding techniques. The focus will be on practical applications and methods in electronic and engineering experiments.
Topic 6. Electromagnetic Field Shielding Methods
Exploring methods and principles of electromagnetic field shielding. This lecture will discuss techniques for effective shielding in experimental setups.
Topic 7. Electron-Beam Oscilloscopes: Operational Principles
An exploration of the workings of electron-beam oscilloscopes. Emphasis will be on understanding their operation, uses, and applications in experimental measurements.
Topic 8. Digital Oscilloscopes: Signal Digitization and Display
Focusing on the principles of digital oscilloscopes. This lecture will cover signal digitization, display methods, and understanding concepts like bandwidth and sampling rate.

Topics of the workshops

Topic 1. Applications of Digital Signal Processors
Hands-on exploration of digital signal processors, emphasizing their applications in signal processing and measurement experiments.
Topic 2. Implementing Analog-to-Digital Converters
Practical workshop on using analog-to-digital converters. Focus on understanding their implementation in various electronic systems.
Topic 3. Designing and Using Electrical Filters
Interactive session on the design and application of electrical filters in measurement and signal processing.
Topic 4. Working with Ionization Transducers
Hands-on experience with ionization transducers, exploring their use in gas discharge measurements and experimentation.
Topic 5. Practical Soldering and Welding Skills
A practical workshop focused on developing essential soldering and welding skills, crucial for electronic and engineering experiments.
Topic 6. Building Electromagnetic Shields
Workshop on constructing and testing electromagnetic shields, understanding their importance in protecting electronic experiments.
Topic 7. Using Electron-Beam Oscilloscopes in Practice
Practical insights into using electron-beam oscilloscopes, focusing on their application in measuring and testing environments.
Topic 8. Hands-On with Digital Oscilloscopes
Interactive session on operating digital oscilloscopes, covering aspects like signal analysis, display options, and troubleshooting.

Topics of the laboratory classes

Topic 1. Experiments with Digital Signal Processors
Laboratory exercises focused on using digital signal processors, allowing students to apply theory in practical signal processing scenarios.
Topic 2. Analog and Digital Signal Conversion Experiments
Hands-on lab activities exploring the conversion between analog and digital signals, using various analog-to-digital conversion techniques.
Topic 3. Electrical Filter and Transducer Applications
Practical lab sessions on implementing electrical filters and transducers, understanding their roles in signal processing and measurements.
Topic 4. Experiments with Gas Discharge Counters
Laboratory experiments involving ionization transducers, specifically focusing on the operation and applications of gas discharge counters.
Topic 5. Soldering and Welding Techniques

A lab focused on developing practical soldering and welding skills, essential for assembling and repairing electronic components and circuits.

Topic 6. Testing Electromagnetic Shielding Efficacy

Experiments designed to test and evaluate the effectiveness of various electromagnetic shielding methods in lab settings.

Topic 7. Operational Analysis of Electron-Beam Oscilloscopes

Practical lab work centered on using electron-beam oscilloscopes, exploring their functionality in measuring and analysis applications.

Topic 8. Signal Processing with Digital Oscilloscopes

Laboratory sessions dedicated to hands-on experience with digital oscilloscopes, focusing on signal processing, analysis, and display techniques.

Self-study

In the "Technique and Design of Experiments" course's self-study segment, students are tasked with applying theoretical knowledge to practical signal processing scenarios. They will delve into analog-to-digital conversion processes and solve calculation-based problems, deepening their understanding of these techniques. This independent work culminates in a comprehensive report, demonstrating their grasp of the course content through clear and detailed analysis. Additional resources, including readings and software tutorials, are provided to enhance their learning and cover areas not extensively explored in class.

Course materials and recommended reading

1. Oppenheim, Alan V. "Applications of digital signal processing." Englewood Cliffs (1978).
2. Kester, Walt. Analog-digital conversion. Norwood, MA: Analog Devices, 2004.
3. Horowitz, Paul, Winfield Hill, and Ian Robinson. The art of electronics. Vol. 2. Cambridge: Cambridge university press, 1989.
4. Dimopoulos, Hercules G. Analog electronic filters: theory, design and synthesis. Springer Science & Business Media, 2011.

Assessment and grading

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

The final score for this course is calculated based on a combination of evaluations from final exam, workshop task achievements, and the execution of individual assignments.

1. Exam.

Students can earn up to 40 points from the final exam. The exam evaluate the student's comprehension and knowledge retention from the lecture material.

2. Workshops Assignments.

Engaging and participating in workshop sessions, including quizzes and tasks, can earn students up to 30 points.

3. Individual Assignments.

For the completion of individual assignments students can receive up to 30 points.

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 2023	Head of the department Serhii MOSTOVYI
	Date, signature 2023	Guarantor of the educational program Halyna OMELIANENKO