Syllabus
Course Program

Physics of electrostatic processes and technologies

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
Optional

Semester
1

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 "Physics of Electrostatic Processes and Technologies" course provides an in-depth understanding of electrostatics in technology. Focusing on the generation of strong electric fields, the course covers static electricity charge formation and factors affecting charge magnitudes in technological processes. Students learn about electrification processes, electrostatic field calculations, and devices for measuring electrostatic fields. The course emphasizes safety measures and risk mitigation associated with electrostatic charges, preparing students for practical applications in industrial settings.

Course objectives and goals

This course aims to impart a solid understanding of electrostatics, focusing on its application in industrial and technological processes. Students will learn about static electricity charge generation, measurement, and the influence of these charges on various processes. The course covers the selection and use of measurement devices and neutralizers for static electricity. Students will also develop skills to reduce the impact of static electricity in technology, blending theoretical knowledge with practical skills for real-world problem-solving in electrostatic technologies.

Format of classes

Lectures, workshops, 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 90 hours (3 ECTS credits): lectures - 32 hours, workshops - 16 hours, self-study - 42 hours.

Course prerequisites

Physics, Theoretical Foundations of Electrical Engineering p.1, Theoretical Foundations of Electrical Engineering p.2

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

Lectures employ modern multimedia tools to enhance the learning experience. Workshops 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. Introduction to Electrostatics in Technological Processes
Exploring the historical development of electrostatic field studies and their significance in modern industry. This lecture sets the stage for understanding the role of electrostatics in various technological processes.
Topic 2. Fundamentals of Static Electricity Charge Formation
Delving into the physical basis of static electricity charge formation, including the effects of different factors on the magnitude of these charges in industrial processes.
Topic 3. Elementary Processes of Electrification and Field Calculation

Examining the basic processes of electrification and the methods for calculating the potential and intensity of electrostatic fields.

Topic 4. Tribal Electricity and its Industrial Implications

Discussing tribal electricity phenomena, focusing on the industrial implications and the fundamental physics behind this type of electrification.

Topic 5. Induction Charging and its Applications

Understanding the process of induction charging and its practical applications in the industry, including the principles and mechanics behind it.

Topic 6. Mechanical Processes and Electrification of Solids

Analyzing the mechanical processes that lead to the electrification of solid materials and how these processes impact various industrial operations.

Topic 7. Electrification in Pneumatic Transport Pipelines

Investigating the electrification patterns in pneumatic transport pipelines, with a focus on the laws governing these phenomena.

Topic 8. Theories of Electrification in Dielectric Fluids

Delving into the theories behind the electrification of dielectric fluids, covering the fundamental principles and industrial relevance.

Topic 9. Ignition of Combustible Mixtures by Spark Discharges

Studying the process of ignition in combustible mixtures caused by spark discharges, including the conditions and risks associated with these events.

Topic 10. Detection Techniques for Electrostatic Fields

Exploring various methods and techniques for detecting electrostatic fields, including the principles and technologies used in these detection processes.

Topic 11. Measuring Static Electrification in Dielectrics

Discussing methods for measuring static electrification in dielectrics, focusing on the parameters that characterize static electrification and the devices used for these measurements.

Topic 12. Utilizing Electrostatic Induction in Measurement Devices

Examining the use of electrostatic induction in measurement devices, including the principles behind these devices and their applications in measuring static electricity.

Topic 13. Continuous Process Charge Measurement Strategies

Exploring strategies for measuring static electricity charges in continuous processes, focusing on the practical approaches and methodologies.

Topic 14. Voltage-Based Static Charge Measurement

Delving into methods for measuring static electricity charges based on voltage in known capacities, including the principles and techniques involved.

Topic 15. Electrophysical Effects in Electric Field Measurement

Studying various electrophysical effects that are utilized in measuring the intensity of electric fields, focusing on the principles and applications of these effects.

Topic 16. Overview of Electrostatic Charge Measurement Methods

Providing a comprehensive overview of different methods for measuring electrostatic charges, discussing their effectiveness and areas of application.

Topics of the workshops

Topic 1: Practical Exploration of Electrostatics in Industrial Settings

This workshop focuses on the practical aspects of electrostatic phenomena in various industries. Participants will engage in hands-on activities to understand the real-world applications of electrostatic principles covered in the introductory lectures.

Topic 2: Static Charge Analysis and Control Techniques

A session dedicated to the techniques used for assessing and controlling static electricity charges. This workshop aligns with the lectures on static charge formation and elementary electrification processes, providing practical exercises and case studies.

Topic 3: Case Studies in Electrification and Field Calculations

An interactive workshop where students analyze case studies related to electrification and field calculations, applying the theoretical knowledge gained from lectures on tribal electricity and induction charging.

Topic 4: Industrial Applications of Electrification in Solids and Fluids

This workshop delves into the industrial implications of electrification in solids and fluids. Participants will explore the electrification in pneumatic transport pipelines and dielectric fluids through practical demonstrations and discussions.

Topic 5: Techniques for Detecting and Measuring Electrostatic Fields

A hands-on session on the various methods of detecting and measuring electrostatic fields, complementing the lectures on detection techniques and static electrification measurement in dielectrics.

Topic 6: Advanced Measurement of Static Electricity in Continuous Processes

This workshop is designed to provide advanced knowledge and practical skills in measuring static electricity in ongoing industrial processes, building on the topics of continuous process charge measurement and voltage-based static charge measurement.

Topic 7: Practical Applications of Electric Field Intensity Measurement

Participants will engage in exercises and experiments to measure the intensity of electric fields, using the principles discussed in lectures on electrophysical effects in electric field measurement.

Topic 8: Comprehensive Analysis of Electrostatic Charge Measurement Methods

This final workshop offers a thorough analysis of various electrostatic charge measurement methods. It aligns with the lecture on the overview of charge measurement methods, allowing participants to compare and contrast different techniques through practical exercises.

Topics of the laboratory classes

Self-study

In the "Physics of Electrostatic Processes and Technologies" course, self-study is crucial for reinforcing and applying theoretical knowledge. Students will analyze a real-world electrostatic scenario, deepening their understanding of its impact on technological processes and the importance of control measures. This includes a calculation task to practically apply and analyze electrostatic principles.

Students are expected to synthesize their findings into a concise report, demonstrating their ability to translate theory into practical analysis. Additionally, they are encouraged to consult supplementary resources for a broader understanding of the subject. This self-guided approach ensures a comprehensive grasp of electrostatic processes in real-world applications.

Course materials and recommended reading

1. Griffiths, David J. "Introduction to electrodynamics." (2005): 574-574.
2. Chang, Jen-Shih, Arnold J. Kelly, and Joseph M. Crowley. Handbook of electrostatic processes. CRC Press, 1995.
3. Jonassen, Niels. Electrostatics. Springer Science & Business Media, 2013.
4. Welker, Roger W., Ramamurthy Nagarajan, and Carl E. Newberg. Contamination and ESD control in high-technology manufacturing. John Wiley & Sons, 2006.

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