Syllabus
Course Program

Fundamentals of electrophysical technologies

Specialty
141 Electric Power Engineering, Electrical Engineering and Electromechanics

Institute
Institute of Power Engineering, Electrical Engineering and Electromechanics

Educational program
Electrical engineering

Department
Engineering Electrophysics (135)

Level of education
Bachelor's level.

Course type
Profile, Selective

Semester
4

Language of instruction
English, Ukrainian

Lecturers and course developers

Liutenko Larisa Anatoliivna

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Candidate of Technical Sciences, Associate Professor of the Department of Engineering Electrophysics of KhPI National Technical University

Author and co-author of more than 20 scientific and methodical publications. Courses: "Introduction to the specialty", "Wind energy", "Fundamentals of electrophysical technologies", "Experimental studies of electrophysical processes", "Calculation and design of magnetic pulse installations", «History of the development of scientific schools of the department».
More about the lecturer on the department's website

General information

Summary

The course "Fundamentals of Electrophysical Technologies" examines modern electrophysical technologies and their areas of application. In the course of training, students will learn about the composition and principle of operation of modern technological equipment for electrophysical processing of materials, will understand the physical processes that occur during processing and will learn to choose the main parameters of technological equipment.

Course objectives and goals

Acquisition of theoretical knowledge and practical skills in the field of modern electrophysical technologies of material processing. Formation of ideas about electrophysical processes that occur during electrophysical processing of substances, the scope of application and the principle of operation of modern technological equipment.

Format of classes

Lectures, practical classes, laboratory works, consultations. Coursework. Final control - exam.

Competencies

ZK1. Ability to apply knowledge and understanding in practice in a manner that indicates a professional approach to electrical engineering problem solving.
ZK 7. Ability to make informed decisions.
FC 3. Ability to use basic knowledge of general physics, higher mathematics, theoretical foundations of electrical engineering and electrical engineering materials to solve practical problems in the field of electric power engineering, electrical engineering and electromechanics.
FC 11. The ability to comply with the requirements of the rules of safety and occupational health and industrial sanitation when working at enterprises of electric power and electromechanical complexes.
FCs 20. Acquisition and use of professional knowledge and understanding related to the processes of operation of electrophysical high-voltage installations for scientific research and industrial technologies, as well as installations of renewable energy.

Learning outcomes

PRN 23. Assess hazards when performing work in electrical installations.
PRNs 40. To know and understand the work processes of electrophysical high-voltage installations for scientific research and industrial technologies, as well as installations of renewable energy.

Student workload

The total volume of the course is 180 hours (6 ECTS credits): lectures - 48 hours, practical classes – 32 hours, laboratory classes - 16 hours, self-study - 84 hours.

Course prerequisites

To successfully pass the course, you must have knowledge and practical skills in the following disciplines: "General physics", "Introduction to the specialty", "Theoretical foundations of electrical engineering".

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

Lectures are conducted interactively using multimedia technologies. In practical classes, a project approach to learning is used, attention is focused on the application of information technologies. Study materials are available to students through Class Notebook and as a distance course in the Moodle system.

Program of the course

Topics of the lectures

Topic 1. Basic provisions of electrophysical technologies.
Introduction to electrophysical technologies. General information about electrical technologies. Advantages and disadvantages of electrical technologies over other methods of processing materials. General classification of electrophysical technologies. Basic characteristics of electrotechnological processes. Areas of possible application of electrophysical methods of material processing.
Topic 2. Magnetic pulse processing of metals.
Basic concepts and definitions. The composition and principle of operation of the magnetic pulse device. technological schemes and operations at MPP. Inductor systems of MPP, basic requirements for inductor systems, manufacturing technology. Advantages and disadvantages of MPPM.
Topic 3. Electrohydropulse processing of materials
Basic concepts and definitions. Principle of operation of electrohydraulic equipment. Electrophysical processes during electrohydraulic processing. Stages of electric discharge in liquid. Technological schemes and operations of electrohydraulic processing. Advantages and disadvantages of electrohydraulic processing.
Topic 4. Induction heating.
Induction heating. Features of induction heating. The principle of operation of induction devices. Application of induction heating. Inductor systems for induction heating. Calculation of inductor systems.
Topic 5. Ultrasonic processing of materials.

Ultrasound and its characteristics. Physical processes that occur under the influence of ultrasound. magnetostrictive and piezoelectric electroacoustic transducers. Structure and principle of action. Acoustic concentrators. Types and basic calculation parameters. Technological operations for ultrasonic processing and their features.

Topic 6. Plasma processing of materials.

Plasma and physical processes occurring during plasma processing of materials. Plasmatrons: design, characteristics, calculation. Plasma devices for electrophysical processing of products. Technological operations during plasma processing.

Topic 7. Laser processing of materials.

Laser and physical processes occurring during laser processing of materials. Technological operations during laser processing. Classification and their implementation features. Laser processing technology. Optical quantum generators: solid-state, semiconductor, gas, liquid, chemical, fiber. The principle of action.

Topics of the workshops

Topic 1. Determination of correspondence of electrophysical technology and technological operation.
Topic 2. Determining the work of deformation of workpieces during magnetic pulse processing.
Topic 3. Study of the electrical scheme of the MIU.
Topic 4. Study of inductor systems of MIU.
Topic 5. Determination of parameters of the discharge circuit of electrohydraulic equipment.
Topic 6. Study of the structure of electro-hydropulse equipment.
Topic 7. Study of the design of the induction furnace.
Topic 8. Calculation of inductor systems for induction heating.
Topic 9. Calculation of tools for ultrasonic processing.
Topic 10. Plazmotron calculation.
Topic 11. Calculation of focusing systems.
Topic 12. Methods of controlling the shape, size and intensity distribution of the focusing spot on the irradiated surface.
Topic 13. Rules for choosing the main laser parameters.

Topics of the laboratory classes

Topic 1. Study of safety techniques when working on electrophysical technological equipment.
Topic 2. Study of the structure and layout in MIU blocks.
Topic 3. Determination of own parameters of MIU.
Topic 4. The effect of electro-hydraulic shock on the destruction of plant material.
Topic 5. Determination of the time of induction heating from the material of the workpiece.
Topic 6. Study of technology and equipment for ultrasonic cleaning.
Topic 7. Structure of the emitter of a solid-state technological laser.
Topic 8. Optical resonator of a solid-state technological laser.

Self-study

The course involves individual course work. The results of the drawing calculations are drawn up in a written report. Students are also recommended additional materials (videos, articles) for independent study and analysis.

Course materials and recommended reading

1. Electrical technologies: education. manual / I. V. Batsurovska. Mykolaiv: MNAU, 2021. – 258 p.
2. Amarnath K. R. Electrotechnologies in Process Industries. Energy & Automation. 2021. P. 50–57.
3. Blinov K., Kachanov B., Blinov Y. Advanced high frequency electrotechnologies. Nternational ural conference on electrical power engineering. 2020. P. 421–425.
4. Burdo O. Electrotechnologies of Targeted Energy Delivery in the Processing of Food Raw Materials. Surface Engineering and Applied Electrochemistry. 2018. Vol. 54, no. 2. P. 210–218.
5. Kushlyk R.V., Nazarenko I.P., Kushlyk R.R. Electrical technologies and thermal processes. Melitopol: Taurus. state agricultural technology University named after Dmytra motor., 2021.105 p.

6. Non-traditional methods of mechanical processing of materials: lecture notes / compiled by: B. A. Stupin, O. V. Ivchenko, O. D. Dynnyk, R. M. Zinchenko. – Sumy: Sumy State University, 2016. – 149 p.
7. Ultrasound in the processes of self-propagating high-temperature synthesis: monograph / V.V. Klubovych, M.M. Kulak, B.B. Hina, 2006. 279 p.
8. Afanasyeva O.V., Lalazarova N.O., Fedorenko E.P. Laser surface treatment of materials / Afanasyeva O.V., Lalazarova N.O., Fedorenko E.P. Kharkiv: FOP Panov A.M., 2020. 100 p.
9. Yutkin L.A. Electrohydraulic effect and its application in industry, 1986. 253 p.
10. Anakhov S.V. Principles and methods of plasmatron design, 2018. 165 p.
11. Lyutenko L.A. Calculation and selection of the main elements of magnetic-pulse equipment [Electronic resource]: educational method. manual / L.A. Lyutenko; National technical University "Kharkiv Polytechnic Institute". - Electron. text. data. - Kharkiv, 2023. - 107 p.
https://repository.kpi.kharkov.ua/handle/KhPI-Press/65941
12. Methodical instructions for laboratory work from the course "Fundamentals of electrophysical technologies" / compiled by L.A. Lyutenko, 2023. 90 p.

Assessment and grading

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

100% of the final grade consists of the results of the assessment in the form of an exam (40%), an ongoing assessment (35%) and a coursework assessment (25%).
Exam: written assignment (3 theory questions + problem solving) and oral presentation.
Current evaluation: 7 test papers (5% each).

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 Sergey MOSTOVY
	Date, signature	Guarantor of the educational program Halyna OMELYANENKO