Syllabus
Course Program

Theory of Electric and Magnetic Fields in Electrophysical and Power Devices

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
Professional, Selective

Semester
5

Language of instruction
English, Ukrainian

Lecturers and course developers

Mykhailov Valery Mykhailovych

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Doctor of technical sciences, professor, professor of the department of engineering electrophysics of NTU "KhPI". Experience of scientific and pedagogical work - 50 years. Author and co-author of more than 160 scientific works and training manuals, including the monograph "Pulse electromagnetic fields", training manuals "Technology and electrophysics of high voltages" and "Modeling of electromagnetic fields. Laboratory practice". He prepared lecture courses and gives lectures on the disciplines "Theoretical foundations of electrical engineering. Theory of electromagnetic field", "Mathematical physics", "Methods of modeling physical fields" and "Special sections of mathematics in high voltage technology"..
More about the lecturer on the department's website

General information

Summary

The subject of the discipline "Theoretical foundations of electrical engineering" is the study of the basic laws of electromagnetic field theory and mastering the skills of their practical application for calculations of electrophysical devices.

Course objectives and goals

Mastering the fundamental concepts, theory and methodology of the electromagnetic field, forming the scientific outlook and electrotechnical culture of students.
As a result of studying the discipline, the student should know:
- definition and understanding of the concepts and categories of the electromagnetic field (introductory guide);
- theorems and equations of the electromagnetic field, the theory and methodology of the analysis of electrostatic, electric in a conductive medium and magnetic field (introductory guide);

- determination of potential coefficients, coefficients of electrostatic induction, partial capacities, capacities of two- and multi-conductor ground lines and cables, inductances and mutual inductances (conceptual and analytical);
- theory and methodology of analysis of the propagation of electromagnetic waves in a dielectric, in a medium with a conductor, in a well-conducting medium (conceptual and analytical);
- energy processes and the law of conservation of energy in electromagnetic (introductory guide);
- theory of surface effect, proximity effect, electromagnetic shielding (conceptual and analytical);
Be able:
- formulate the equation of the electromagnetic field (subject-mental);
- calculate tensions, inductions, scalar and vector potentials of electric and magnetic fields (subject-mental);
- calculate parameters of electromagnetic devices - resistances, inductances and mutual inductances, capacities (subject-practical);
- calculate electromagnetic energy, its power and transformation into other types of energy (subject-mental);
- to increase the level of knowledge in the discipline, using new literature (symbolic and intellectual);
To be familiar with the directions of modern development of the theoretical foundations of electrical engineering and their application to the design of electrophysical equipment.

Format of classes

Lectures, practical classes, laboratory works, consultations. Individual task. 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.

Learning outcomes

PRN 16. Determine the principles of construction and normal functioning of elements of electric power, electrotechnical electromechanical complexes and systems.
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 150 hours (5 ECTS credits): lectures - 32 hours, practical classes – 16 hours, laboratory classes - 16 hours, self-study - 86 hours.

Course prerequisites

The study of the discipline is based on knowledge of higher mathematics, physics, basic concepts and laws of the theory of electric circuits.

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.

Program of the course

Topics of the lectures

Introduction. Definition of the electromagnetic field as a type of matter.
Topic 1. Basic equations of the electromagnetic field in differential and integral forms.
Topic 2. Types of environments and material equations.
Topic 3. Conditions at the interfaces of media with different electrophysical characteristics.
Topic 4. Classes of electromagnetic fields accepted in the theory of the electromagnetic field.
Topic 5. Basic concepts of electrostatic field.
Topic 6. Basic equations of the electrostatic field and their solutions for some cases of distribution of electric charges.
Topic 7. Conductors in an electrostatic field.
Topic 8. Dielectrics in an electrostatic field.
Topic 9. Basic regularities and properties of a direct current electric field in a conductive medium.
Topic 10. Analogy of a direct current electric field in a conductive medium and an electrostatic field.
Topic 11. Analysis of magnetostatic fields using the vector potential of the magnetic field.
Topic 12. Scalar potential of a magnetostatic field.
Topic 13. Magnetic properties of matter and magnetization vector.
Topic 14. Equations for vectors of an alternating electromagnetic field in an area where there are no sources.
Topic 15. Propagation of a plane wave of a sinusoidal electromagnetic field in an ideal dielectric.
Topic 16. Propagation of a plane wave of a sinusoidal electromagnetic field in an electrically conductive medium.
Topic 17. Electrodynamic potentials.
Topic 18. Power balance equation in the electromagnetic field.
Topic 19. Poynting vector flow and its application in calculations of energy processes.
Topic 20. Directing electromagnetic waves and directing devices.
Topic 21. Application of electromagnetic fields in technological processes.

Topics of the workshops

Topic 1. Electrostatic field formed by electrodes of simple forms, capacitance of conducting bodies.
Topic 2. Electric field in a conductive medium formed by electrodes of simple forms.
Topic 3. Calculations of magnetostatic fields of conductors of simple forms with currents.
Topic 4. Calculations of magnetostatic fields of conductors of simple forms with currents.
Topic 5. Calculations of the distribution of an alternating electromagnetic field in conductors of simple forms.
Topic 6. Poynting vector flow and its application in calculations of energy processes.
Topic 7. Directing electromagnetic waves and directing devices.

Topics of the laboratory classes

Topic 1. Distribution of electric charges of the toroid - plane system.
Topic 2. Direct current electric field.
Topic 3. Proximity effect in the system of two parallel conductors.
Topic 4. Distribution of currents with a sharp surface effect of the toroid-plate system.
Topic 5. Determination of the shape of the electrodes according to the given distribution of the field at the boundary.

Self-study

The course involves individual calculation work. The results of calculations and drawings 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. Neuman L.R., Demirchan K.S. Theoretical foundations of electrical engineering, 1981. 416 p.
2. Bezsonov L.A. Theoretical principles of electrical engineering. Electromagnetic field, 1986. 263 p.
3. Hovorkov V.A., Kupalyan S.D. Electromagnetic field theory in exercises and problems, 1970. 304 p.
4. Yossel Yu.Ya., Kochanov E.S., Strunskyi M.G. Calculation of electrical capacity, 1981. 288 p.
5. Kalantarov P.L., Zeitlin L.A. Calculation of inductance. Reference book, 1986. 488 p.
6. Mikhailov V.M. Theory of electric and magnetic fields in tasks for term papers. Study guide, 1994. 88 p.
7. Methodical instructions for independent work from the course "Theory of electric and magnetic fields"/Editor. V.M. Mikhailov.-Kharkiv: KhPI, 1988. 34 p.
8. Modeling of electromagnetic fields. Laboratory practice: Training. Manual/N.M. Bondina, Y.I. Volchkov, O.Ya. Konovalov and others; under the editorship V.M. Mikhailov. - Kharkiv: NTU "KhPI", 2007. 168 p.

Assessment and grading

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

100% of the final grade consists of assessment results in the form of an exam (40%), current assessment (60%).
Exam: written assignment (2 questions from theories + problem solving) and an oral report.
Current assessment: 2 test papers (15% each) and an individual task (30%)..

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