Syllabus

Course Program

Theoretical Foundations of Electrical Engineering p.2.

Specialty
141 Electric power engineering, electrical engineering and electromechanics

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

Educational program
Electric power engineering

Department
Theoretical Electrical Engineering (137)

Level of education
Bachelor's level

Course type
Mandatory

Semester
4

Language of instruction
English

Lecturers and course developers

Ivan Kostiukov

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Candidate of sciences, head of the department of theoretical electrical engineering

Author of more then 50 scientific publications, lecturer on courses "Theoretical Foundations of Electrical Engineering P.1", " Theoretical Foundations of Electrical Engineering P.2", "Theory of Electrical Circuits", "Theory of Electric and Magnetic Field
More about the lecturer on the department's website

General information

Summary

The course is focused on basic laws and methods of calculation of DC and AC electric circuits and lines with distributed parameters in transient mode of operation.

Course objectives and goals

- to provide students with fundamental knowledge about the electromagnetic circuits with lumped and distributed parameters transient mode of operation.
- to enhance students capacity to analyze DC and AC circuits up to the level necessary to study and carry out research in the field determined by the specialty “Electric power engineering, electrical engineering and electromechanics

Format of classes

Lectures, workshops, laboratory works, consultations. The course ends with a final exam.

Competencies

K01. Ability to abstract thinking, analysis and synthesis.
K02. Ability to apply knowledge in practical situations.
K03. The ability to communicate in the national language both orally and in writing

K05. Ability to search, process and analyze information from
different sources.
K06. Ability to identify, pose and solve problems.
K07. Ability to work in a team.
K08. Ability to work autonomously.
K12. The ability to solve practical problems involving the methods of mathematics, physics and electrical engineering.
K20. Awareness of the need to constantly expand one's own knowledge of new technologies in electric power, electrical engineering and electromechanics

Learning outcomes

PR01. Know and understand the principles of operation of electrical systems and networks, power equipment of electrical stations and substations, protective grounding and lightning protection devices and be able to use them to solve practical problems in professional activities.
PR03. Know the principles of operation of electric machines, devices and automated electric drives and be able to use them to solve practical problems in professional activities.
PR04. Know the principles of bioenergy, wind energy, hydropower and solar energy installations.
PR05. Know the basics of electromagnetic field theory, methods
calculating electric circuits and being able to use them for
solving practical problems in professional activity.
PR07. To carry out the analysis of processes in electric power, electrotechnical and electromechanical equipment, relevant complexes and systems.
PR08. Choose and apply suitable methods for the analysis and synthesis of electromechanical and electric power systems with given indicators.
PR10. Find the necessary information in scientific and technical literature, databases and other sources of information, evaluate its relevance and reliability.
PR11. Communicate freely about professional problems in national and foreign languages orally and in writing, discuss the results of professional activity with specialists and non-specialists, argue one's position on debatable issues.
PR15. Understand and demonstrate good professional, social and emotional behavior, follow a healthy lifestyle. PR18. Be able to learn independently, acquire new knowledge and improve skills in working with modern equipment, measuring equipment and application software.
PR18. Be able to learn independently, acquire new knowledge and improve skills in working with modern equipment, measuring equipment and application software. PR19. Apply appropriate empirical and theoretical methods to reduce losses of electrical energy during its production, transportation, distribution and use.
PR26. Know and understand the processes of creating and using safe and effective electrical insulation, cable and fiber optic systems.
PR28. Know and understand the working 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, laboratory classes - 16 hours, workshops - 32 hours, self-study - 70 hours.

Course prerequisites

Within their program students are supposed to master the courses "Introduction to specialty", "Mathematics", "Physics", "Theoretical foundations of electrical engineering P. 1"

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

Students gain their knowledge by listening lectures with presentations and participating in discussions, workshops, laboratory classes, as well as by taking part problem-based learning.

Program of the course

Topics of the lectures

Topic 1. Introduction
Analysis of circuits containing reactive elements. Transient processes. The switching lows. The duration of transient processes. The time constants.
Topic 2. Transient processes in RL circuits
R-L circuits. Turning on R-L circuits to DC sources. Turning on R-L circuits to AC sources.
Topic 3. Transient processes in RC circuits
R-C circuits. Turning on R- C circuits to DC sources. Turning on R- C circuits to AC sources.
Topic 4. Transient processes in RLC circuits
Switching of R-L-C circuits to DC sources. Conditions of aperiodic and oscillatory processes appearance.
Topic 5. Transient processes in RLC AC circuits
Analysis of transient processes in a series active-inductive-capacitive circuit at its turning on to AC sources.
Topic 6. Properties of transient processes.
Isochronism and beating.
Topic 7. The analysis of trancient processes by using a Laplace transform
Operational method. Laplace transformation. Basic theorems of the operational method. Table of basic functions images by Laplace transformation. Ohm's Law and Kirchhoff's laws in the operational form.
Topic 8. Laplace transform for the elements of electrical circuits.
Operational image of a function. Operational resistance, operational EMF. Operational circuits. Definition of operational images. Definition of time originals.
Topic 9.Transition of signals through electrical circuits.
Operational and classical methods for analyzing a signal passing through an electric circuit
Topic 10. Lines with distributed parameters.
Circuits with distributed parameters. Primary line parameters. Differential line equations for instantaneous values and in the complex form. The coefficient of reflection. Direct and return waves in a line.
Topic 11. Characteristics of lines with distributed parameters
Secondary parameters. Equation of a line in the steady state sinusoidal mode.
Topic 12. Types of lines with distributed parameters
The line that does not distort a signal. Lossless lines and modes of their operation.
Topic 13.Transient processes in lines with distributed parameters.
Transient processes in the lines: the wave equation and its solution. Equivalent circuit for calculation of a reflected wave. Qualitative analysis of the transient processes in the lines using the reflection coefficient.
Topic 14. Magnetic circuits with constant flux.
Basic assumptions. Nonlinear magnetic permeability. Ferromagnetic. materials
Topic 15.Analysis of magnetic circuits.
Ohm's and Kirchhoff's laws for magnetic circles. Calculation of unbranched and branched magnetic circuits.
Topic 16. Properties of transformers with magnetic core
Transformer with a ferromagnetic core: physical processes, equations for instantaneous values and in complex form. Example of the transformer calculation.

Topics of the workshops

Topic 1.
Initial conditions, initial values. The switching laws.
Topic 2. Analysis of transient processes in simple electrical circuits
Transition processes in the first order circuits. Branched R-L and R-C circuits at DC sources application.
Topic 3. The Laplace transform-based analysis of transient processes
Ohm's and Kirchhoff's laws in the operational form. Determination of images and originals.
Topic 4. Lines with distributed parameters. Part 1
Determination of primary and secondary parameters in the circuits with distributed parameters..
Topic 5. Lines with distributed parameters. Part 2
Steady-state operation mode of lines with distributed parameters.

Topic 6. Lines with distributed parameters. Part 3
Calculation of the transient processes in circuits with distributed parameters
Topic 7. Magnetic circuits Part 1
Calculation of nonlinear magnetic circuits
Topic 8. Magnetic circuits Part 2
Calculation of the coil and the transformer with a ferromagnetic core.

Topics of the laboratory classes

Laboratory work 1.
Study of four-terminal networks
Laboratory work 2.
Study of transient processes in R-L circuits.
Laboratory work 3.
Study of transient processes in R-L-C circuits.
Laboratory work 4.
Study of nonlinear DC circuits.
Laboratory work 5.
Study of a transformer with a ferromagnetic core.
Laboratory work 6.
Study of relations for the instantaneous values of alternating currents and voltages.
Laboratory work 7.
Experimental verification of the principle of superposition in AC circuits.
Laboratory work 8.
Study of transient processes in R-L circuits.

Self-study

Individual assignment on the analysis of transient processes in electrical circuits. Preparation for workshops and laboratory works

Course materials and recommended reading

1. Md. Abdus Salam, Quazi Mehbubar Rahman. Fundamentals of Electrical Circuit Analysis Springer Nature Singapore Pte Ltd. 2018,
2. Bird J. Electrical Circuit Theory and Technology Newnes, 2003. - 1008 P.
3. Ergul Ozgur. Introduction to Electrical Circuit Analysis Wiley, 2017. — 425 p.
4. M. M. Rezynkina, I. A. Kostiukov, S. A. Lytvynenko " The Laplace transform analysis of transient processes in linear electrical circuits " Kharkiv: NTU "KhPI", 2020. – 44 p.
5. M. M. Rezynkina, I. A. Kostiukov, S. A. Lytvynenko " Guidelines of calculation and graphical performing of theindividual assignment on the topic " The analysis of transient processes in the linear electrical circuits " Kharkiv: NTU "KhPI", 2022. – 48 p.

Assessment and grading

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

Students get their final exam mark after the complete fulfillment of their individual assignments and laboratory works

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

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