Syllabus of the educational component
Program of educational discipline

Reliability and Diagnostics

Code and name of specialty
141 – Power engineering, electrical engineering and electromechanics

Institute
National Institute of Energy, Electronics and Electromechanics

Educational program
Electric drive, mechatronics and robotics

Department
Automated electromechanical systems (129)

Educational level
Master's degree

Type of discipline
professional profile training

Semester
10

Language of teaching
English

Lecturers and course developers

Serhii Pohasii

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Candidate of economic sciences, associate professor of the department of cybersecurity of National Technical University "Kharkiv Polytechnic Institute".

The number of scientific publications: more than 95, including 2 utility model patents, 6 monographs, of which 4 are collective monographs, 4 teaching aids, 4 of which bear the seal of the Ministry of Education and Science of Ukraine, 65 articles in foreign publications and specialized publications of Ukraine, with 11 of them are in the Scopus scientometric database. Leading lecturer in the disciplines: "Analog and digital electronic devices", "Internet of things and services", "Security of cloud technologies", "Fundamentals of construction and protection of modern operating systems", "Modeling of critical infrastructure systems", "Fundamentals of construction and protection of microprocessor systems ", "Security of smart technologies and Internet of things",

More about the lecturer on the department's website

general information

Abstract

The course examines the methods of calculating the reliability indicators of automated electric drives and ways of improving them at the design stage, as well as the methods of diagnosing probable malfunctions during operation.

Purpose and objectives of the disciplines

To form students' theoretical knowledge and practical skills in calculating the reliability indicators of automated electric drives and methods of diagnosing probable malfunctions.

Format of classes

Lectures, practical classes, independent work, consultations. The final control is an exam.

Competences

K01. Ability to abstract thinking, analysis and synthesis.
K04. Ability to use information and communication technologies.
K05. Ability to apply knowledge in practical situations, work independently and in a team. K06. Ability to produce new ideas, make informed decisions, show creativity and system thinking, identify and assess risks.

K12. Knowledge and understanding of patterns, mechanisms and consequences of equipment failures, the ability to develop and implement measures to increase reliability, efficiency and safety in the design and operation of equipment and objects of the power industry, electrical engineering and electromechanics.
K14. Knowledge and understanding of modern technological processes and systems of technological preparation of production, technical characteristics, design features, purpose and rules of operation of electric power and electrotechnical equipment.
K15. Ability to apply acquired theoretical knowledge, scientific and technical methods and appropriate software to solve scientific and technical problems and conduct scientific research in the field of electric power engineering, electrical engineering and electromechanics.
K16. Ability to apply existing and develop new methods, techniques, technologies and procedures for solving engineering tasks, including in the design and operation of power engineering, electrical engineering and electromechanics facilities.
K17. Ability to apply analytical methods of analysis, mathematical modeling and perform physical, mathematical and computational experiments to solve engineering problems and when conducting scientific research.
K18. Ability to apply information and communication technologies and programming skills to solve typical tasks of engineering and scientific activities in electric power, electrical engineering and electromechanics.

Learning outcomes

PR01. Find options for increasing energy efficiency and reliability of electric power, electrotechnical and electromechanical equipment and corresponding complexes and systems.
PR02. Reproduce processes in electric power, electrotechnical and electromechanical systems during their computer simulation.
PR03. Master new versions or new software designed for computer modeling of objects and processes in electric power, electrical engineering and electromechanical systems.
PR04. Determine a plan of measures to increase the reliability, safety of operation and prolong the resource of electric power, electrotechnical and electromechanical equipment and relevant complexes and systems.
PR05. Analyze processes in electric power, electrotechnical and electromechanical equipment and corresponding complexes and systems.
PR06. To have the methods of mathematical and physical modeling of objects and processes in electric power, electrotechnical and electromechanical systems.
PR08. Search for sources of resource support for additional training, scientific and innovative activities.
PR10. Adhere to the principles and rules of academic integrity in educational and scientific activities.
PR14. Reconstruct existing electrical networks, stations and substations, electrotechnical and electromechanical complexes and systems in order to increase their reliability, efficiency of operation and extension of the resource.
PR19. To master new methods of synthesis of electric power, electrotechnical and electromechanical installations and systems with specified indicators.
PR22. Be able to use modern methods of mathematical apparatus in designing electromechanical systems, microprocessor control systems for electric drives of mechatronic systems.

Scope of the discipline

The total volume of the discipline is 150 hours. (5 ECTS credits): lectures – 32 hours, practical classes – 32 h., independent work - 86 h.

Prerequisites for studying the discipline (prerequisites)

To successfully complete the course, you must have a 1st (bachelor's) level qualification preparation of the educational program "Electric drive, mechatronics and robotics" or other educational programs of the specialty "Electric power engineering, electrical engineering and electromechanics".

Features of the discipline, methods and technologies of education

Lectures are conducted interactively using multimedia technologies. Lectures are conducted using lecture texts prepared and distributed to students in advance. Practical classes use a project approach to learning, game methods.

Program of educational discipline

Topics of lectures

Topic 1. General reliability characteristics of electric drives.
The main indicators of reliability. Working on rejection. Probability of trouble-free operation. Exponential law of failure distribution. Intensity of failures according to statistical data.Topic 2. Calculation of failure intensity of linear elements of electrical circuits.
Basic and operational intensity of failures of linear elements of electrical circuits: resistors, capacitors, coils. The influence of external factors and modes of operation on the intensity of failures. Coefficients of influence on the intensity of failures.
Topic 3 Calculation of failure intensity of semiconductor elements: diodes, LEDs, zener diodes, thyristors, triacs. Ways to increase reliability.
Basic and operational failure rates of semiconductor elements. The influence of external factors and modes of operation on the intensity of failures. Influence coefficients.
Topic 4 Calculation of the failure intensity of transistors: bipolar, field, BTIZ transistors Ways of increasing reliability.
Basic and operating failure intensity of transistors. The influence of external factors and modes of operation on the intensity of failures. Influence coefficients.
Topic 5. Calculation of the intensity of failures of analog and digital microcircuits and the intensity of failures of electrical devices.
Basic and operational intensities of failures of microcircuits. The influence of external factors and modes of operation on the intensity of failures. Influence coefficients.
Topic 6. Calculation of the intensity of failures of DC and AC motors.
Basic and operational intensity of failures. The influence of external factors and operating modes on the intensity of engines. Influence coefficients.
Topic 7. Technical means for diagnostics of electric drives
Electromeasuring arrow devices. Analog and digital multimeters and oscilloscopes. Current measuring clamps. Megaohmmeters.
Topic 8. Diagnostics of automated direct current drives.
Diagnostics of DC motors. Methods of setting the armature current switching modes. Diagnostics of control systems of thyristor converters.
Topic 9. Diagnostics of automated asynchronous electric drives.
Diagnosis of asynchronous motors. Diagnosis of short-circuited turns in windings. Diagnostics of control systems of frequency converters.
Topic 10. Diagnostics of diodes, LEDs, zener diodes, thyristors and triacs.
Structure and principle of action. Diagnostics of current-voltage characteristics. Diagnostic methods using digital multimeters.
Topic 11. Diagnostics of transistors.
Diagnostics of current-current characteristics of bipolar, field-effect and BTIZ transistors. Methods of diagnosing transistors using digital multimeters. Diagnostics of analog and digital microcircuits.
Topic 12. Diagnostics of linear elements of electric circuits.
Resistors, capacitors and coils: structure and principle of operation, parameters and their marking. Fault analysis and diagnostic methods.

Topics of practical classes

Topic 1. Analysis of electrical circuits of electric drives for calculating reliability indicators.Principles of operation of circuits of direct and alternating current electric drives.
Topic 2. Calculation of the failure intensity of resistors, capacitors and coils.

Selection of coefficients of influence of external factors, calculation of failure intensity taking into account operating conditions.
Topic 3. Calculation of the failure intensity of diode elements.
Selection of coefficients of influence of external factors, calculation of failure intensity taking into account operating conditions. Calculation of power thyristor protection schemes.
Topic 4. Calculation of the intensity of transistor failures.
Selection of coefficients of influence of external factors, calculation of failure intensity taking into account operating conditions. Calculation of power transistor protection schemes against emergency modes.
Topic 5. Calculation of the intensity of failures of microcircuits.
Selection of coefficients of influence of external factors, calculation of failure intensity taking into account operating conditions
Topic 6. Analysis of schemes and means for increasing the interference resistance of control systems.
Schemes and methods of protection of control systems from inductive, capacitive and galvanic disturbances.Theme 7. Electrical measurements in semiconductor electric drives of direct and alternating currents.
Methods and means of measuring the average, active, and amplitude values of voltage and current of the armature of a direct current motor and in the stator circuit of asynchronous motors when powered from semiconductor converters.
Topic 8. Diagnostics of direct current electric drives.
Methods of installing brushes on the geometric neutral for setting the sparkless switching mode.
Topic 9. Diagnostics of asynchronous electric drives.
Checking the marking of the terminals of the stator windings. Diagnosis of insulation of stator windings.Topic 10. Diagnostics of thyristors and triacs.
Compilation of schemes for diagnostics of thyristors and triacs. Methods of testing using a multimeter.
Topic 11. Diagnostics of transistors.
Compilation of circuits for diagnostics of transistors. Determining the marking of the terminals with a digital multimeter
Topic 12. Diagnostics of the capacitor and the coil.
Checking the operability of the electrolytic capacitor and coil with digital multimeters and special testers.
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Topics of laboratory works

Laboratory classes are not provided.

Independent work

The course involves the performance of an individual task on the calculation of the reliability of the electric drive and its diagnostics. Independent study of topics and issues that are not taught in lectures classes Preparation for practical classes. Elaboration of lecture material.

Literature and educational materials

Basic literature.
1 O. Yu. Lozinskyi. Calculation of the reliability of electric drives / O. Yu. Lozinskyi, Ya. Yu. Marushchak, P. P. Kostrobiy. - Lviv: Publishing House "Lviv Polytechnic", 1996. - 234 p.
2 Kalkamanov S. A. Synopsis of lectures on the disciplines "Technical diagnostics of electromechanical systems". -Kh.: XNUMG, 2014. – 152 p.
3 Shavkun V. M. Modern technologies of diagnostics of electromechatronic systems: summary of lectures (for students of all forms of education at the "master's" level in the specialty 141 - Power engineering, electrical engineering and electromechanics) / V. M. Shavkun; Kharkiv. national city university farm named after O. M. Beketova. – Kharkiv: XNUMX named after O. M. Beketova, 2019. - 89 p.

.Additional literature.

1. Yesaulov S. M. Synopsis of lectures on the discipline "Diagnostics of electrical equipment of vehicles" - Kh.: KhNAMG, 2012. - 98 p.

2. Rozhkov P. P. Synopsis of lectures on the discipline "Reliability of electrical networks" for masters of full-time study in the specialty 141 - Power engineering, electrical engineering and electromechanics / P. P. Rozhkov, S. E. Rozhkova.– Kharkiv: XNUMX named after O. M. Beketova, 2017. – 85 p.

Evaluation system

Criteria for evaluating student performance and distribution of points

100% of the final grade consists of assessment results in the form of an exam (40%) and current assessment (60%).
Exam: written assignment (2 questions on theory + problem solving) and an oral report. Current assessment: 2 online tests and a calculation task (20% each).

Rating scale

Total points	National assessment	ECTS
90–100	Perfectly	A
82–89	Fine	B
75–81	Fine	C
64–74	Satisfactorily	D
60–63	Satisfactorily	E
35–59	Unsatisfactorily (further study required)	FX
1–34	Unsatisfactorily (re-study required)	F

Norms of academic ethics and policy of the course

The student must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": show discipline, education, benevolence, honesty, responsibility.
Conflict situations should be openly discussed in study groups with the teacher, and if it is impossible to resolve the conflict, it should be brought to the attention of the employees of the institute's directorate. Regulatory and legal support for the implementation of the principles of academic integrity of NTU
"KhPI" is located on the website:http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Coordination

Syllabus approved	21/09/2023, SIGNATURE	Head of Department Bohdan VOROBYOV
	21/09/2023, SIGNATURE	Guarantor of EP Vera SHAMARDINA