Syllabus of the educational component
Program of educational discipline

Intelligent Control Systems in Mechatronics

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

Institute
Educational and Scientific 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
Mandatory

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", "Information and communication systems in the field of national security" for undergraduate and graduate students, Section "Information security of cloud services", "Modern methods of protection of socio-cyber-physical systems", "Modeling of mechanisms cyber security" for graduate students.

More about the lecturer on the department's website

general information

Abstract

The discipline is aimed at mastering the theoretical foundations and practical skills in the field of intelligent control of electromechanical systems, studying the basic principles of building neural network control systems, the basics of their synthesis and application for typical single- and dual-mass electric

drives that are unstable in the open state or operate in self-oscillation mode.

Purpose and objectives of the disciplines

Course goals, knowledge and skills that can be acquired as a result of training are presented in a form that is understandable for the student.

Format of classes

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

K01. Ability to abstract thinking, analysis and synthesis.
K12. The ability to solve practical problems involving the methods of mathematics, physics and electrical engineering.
K15. The ability to solve complex specialized tasks and practical problems related to the operation of electric machines, devices and automated electric drives.
K17. The ability to develop projects of electric power, electrotechnical and electromechanical equipment in compliance with the requirements of legislation, standards and specifications.
K19. Awareness of the need to increase the efficiency of electric power, electrotechnical and electromechanical equipment.
K20. Awareness of the need to constantly expand one's own knowledge of new technologies in electric power, electrical engineering and electromechanics.
K24. Obtaining and using professional knowledge and understanding related to the process of using and consuming electricity by means of an electric drive in compliance with the specified parameters of technological processes and the quality of electricity.
K25. Obtaining and using professional knowledge and understanding related to the development and operation of mechatronic devices and systems in compliance with the specified parameters of technological processes.

Learning outcomes

PR02. To know and understand the theoretical foundations of metrology and electrical measurements, the principles of operation of automatic control devices, relay protection and automation, to have the skills to perform appropriate measurements and use these devices to solve professional tasks.
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.
PR05. Know the basics of electromagnetic field theory, methods of calculating electric circuits and be able to use them to solve practical problems in professional activities.
PR07. To carry out the analysis of processes in electric power, electrotechnical and electromechanical equipment, relevant complexes and systems.
PR17. Solve complex specialized problems in the design and maintenance of electromechanical systems, electrical equipment of power stations, substations, systems and networks.
PR19. Apply appropriate empirical and theoretical methods to reduce losses of electrical energy during its production, transportation, distribution and use.
PR23. To know and understand the processes of using and consuming electricity by means of an electric drive in compliance with the specified parameters of technological processes and the quality of electricity.
PR24. Know and understand the principles of organizing the processes of development and operation of mechatronic devices and systems in compliance with the specified parameters of technological processes.

Scope of the discipline

The total volume of the discipline is 90 hours. (3 ECTS credits): lectures – 32 hours, laboratory work – 16 hours, independent work – 42 hours.

Prerequisites for studying the discipline (prerequisites)

To successfully complete the course, you must have knowledge and practical skills in the following disciplines: "Higher mathematics", "Physics", "Theory of automatic control", "Theory of electric drive", "Dynamics of electromechanical systems", "Dynamic characteristics of mechatronic systems".

Features of the discipline, methods and technologies of education

Lectures are conducted interactively using multimedia technologies. During the lectures, the discipline materials prepared and distributed to the students in advance are used.

At the same time, there is a possibility of a more detailed review of some sections of the lecture material and conducting current and test control.
When conducting laboratory classes, methods of problem-based and partially search-based presentation are used, in which the teacher poses a problem and formulates a task, guides and controls its solution step by step, and students organize an active search, provide ways to solve the task. This method involves the use of printed manuals and reference books, lecture materials. When performing laboratory and individual tasks, students perform computer modeling of processes in electromechanical systems as means of synthesis.

Program of educational discipline

Topics of lectures

Topic 1. Introduction to intelligent control systems. Stages of development. Classification. Goals and objectives of the course.
Topic 2. Models of neurons and neural networks. Activation functions of neurons. Architectures of neural networks.
Topic 3. Training of neural networks. Classification of teaching methods, their advantages and disadvantages. Learning criteria.
Topic 4. The method of reverse error propagation. Genetic operations. Genetic algorithm method. Topic 5. Synthesis of a neural network for controlling a single-mass electromechanical system in generalized parameters with a frictional load.
Topic 6. The influence of the structure of the neural network, the parameters of the control object on the quality indicators of the dynamic processes of a single-mass electric drive.
Topic 7. Synthesis of a neural network for controlling a two-mass electromechanical system in generalized parameters with a frictional load.
Topic 8. The influence of the structure of the neural network, the parameters of the control object on the quality indicators of the dynamic processes of the two-mass electric drive.
Topic 9. One-mass electromechanical system with a neural network and nonlinear friction. Topic 10. Two-mass electromechanical system with a neural network and nonlinear friction. Topic 11. Neural network synthesis for one- and two-mass electromechanical systems in physical parameters with nonlinear friction.
Topic 12. Elimination of disruptive self-oscillations in electromechanical systems with a neural network.
Topic 13. Synthesis of an electromechanical system with a neural network of an electric drive of a mine electric locomotive with a DC motor of serial excitation.
Topic 14. Synthesis of the neural network of the electric drive of the arrow transfer.
Topic 15. Synthesis of an electromechanical system with a neural network and an asynchronous motor. Topic 16. Neural network control system of a linear motor.

Topics of practical classes

Practical classes are not provided according to the plan.

Topics of laboratory works

Topic 1. Synthesis and analysis of the operation of a single-mass neural network control system electromechanical system in generalized parameters. Issuance of an individual task. Topic 2. Creation of libraries in the Pascal language for the synthesis of neural networks.
Topic 3. Working with the Mendel 4 program.
Topic 4. Modeling of neural networks in the Matlab package.
Topic 5. Synthesis of a neural network for a DC motor with independent excitation Topic 6. Synthesis of a neural network for an asynchronous motor.

Topic 7. Synthesis of a neural network for a linear motor.

The course involves the implementation of an individual calculation task on the topic: "Synthesis and research of a neural network control system for a single-mass electromechanical system in generalized parameters." Based on the results of the calculations, a written report is drawn up. After checking the report, the student must defend the calculation task.

Literature and educational materials

1. I.V. Hoop. Synthesis of electromechanical systems with a neural network and a friction system load [Electronic resource]: dissertation…… Ph.D. technical Sciences: spec. 05.09.03 : branch of knowledge 14 /
Ihor Volodymyrovych Obruch; of science manager V. B. Klepikov; National technical University "Kharkiv Polytechnic Institute". Kharkiv, 2019. 188 pp. Bibliography: pp. 148 – 159. Ukrainian.
2. I.V. Hoop. Synthesis of electromechanical systems with a neural network and a friction system load [Electronic resource]: autoref. thesis ... candidate technical Sciences: spec. 05.09.03 / Ihor Volodymyrovych Obruch; [science manager V. B. Klepikov] ; National technical University "Kharkiv Polytechnic Institute". - Kharkiv, 2019. 20 p. Bibliography: pp. 15 – 17. Ukrainian.
3. Black. O.P. Modeling of electromechanical systems: a textbook for universities / O.P. Chornyi, A.V. Lugovyi, D.Y. Rodkin, G.Yu. Sisyuk, O.V. Garden. Kremenchuk, 2001. – 410 p.
4. Popovych M. G., Kovalchuk O. V. Theory of automatic control: A manual. - 2nd ed., revision. and added - Kyiv: Lybid, 2007. - 656 p.
5. M. G. Popovych, O. Yu. Lozinskyi, V. B. Klepikov, and others. Electromechanical automatic control systems and electric drives: Training. assistant editor M. G. Popovych, O. Yu. Lozynskyi. – Kyiv: Lybid, 2005. – 680 p.
6. Rudenko O.H., Bodyanskyi E.V. Artificial neural networks - Study guide for students of higher educational institutions - Kyiv: SMIT Company, 2006, - 404 p.
7. Tymoshchuk P.V. Artificial neural networks – Study guide – Lviv: Lviv Polytechnic Publishing House, 2011. – 444 p.
8. McCulloch WS, Pitts W. A Logical Calculus of the Ideas Immanent in Nervous Activity. Bulletin of Mathematical Biophysics. 1943. Vol. 5, P. 115–133
9. De Jong KA Genetic Algorithms: A 10 Year Perspective // In: Process of the First Int. Conf. on Genetic Algorithms, 1985. P. 167 – 177
10. Lytvyn V.V., Pasichnyk V.V., Yatsyshyn Yu.V. Intelligent systems: Textbook. - Lviv: "New World." - 2000", 2020 - 406 p.
11. Matlab. The language of technical computing. Using Simulink. - The MathWorks Corporation, 2016.
12. Drury B. The Control Techniques Drives and Controls Handbook, 2nd Edition, - The Institution of Engineering and Technology, United Kingdom, 2009. - 765 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 ongoing assessment (60%).

Exam: a written task (2 questions on theory) and an oral presentation.
*current*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 posted on the website:http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Coordination

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