Syllabus of the educational component

Program of educational discipline

Mobile Mechatronic and Robotic Systems

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

Chair
Automated electromechanical systems (129)

Educational level
Master's degree

Type of discipline
Selective

Semester
1

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 discipline is aimed at mastering the basics of the theory and design of mobile robots. The types and characteristics of such robots, the principles and means of their construction and programming are considered, examples of modeling, hardware and software are given.

Purpose and objectives of the disciplines

Develop the student's theoretical ideas and practical skills regarding the creation and application of

technical and software tools of mobile robots.

Format of classes

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

Competences

K01. Ability to abstract thinking, analysis and synthesis.
K02. Ability to use a foreign language for professional, scientific and technical activities and communication.
K03. Ability to search, process and analyze information from various sources. K04.
Ability to use information and communication technologies.

K05. Ability to apply knowledge in practical situations, work independently and in a team. K13. Awareness of the need to constantly expand one's own knowledge of new technologies in electric power, 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, electrotechnical and electromechanical equipment and 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, electrical engineering and electromechanics.
K16. The 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. The 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.
K 22. The ability to analyze the current state and determine trends in the development of electric drive systems and the theory of automatic control, numerical control systems, mechatronic systems, metal cutting machines, industrial and mobile robots.
K23. The ability to use modern methods of mathematical apparatus in the design of electromechanical and mechatronic systems and microprocessor control systems of electric drives
K25. The ability to develop and calculate schemes of electrical installations for various purposes, determine the composition of their equipment and calculate their operating modes.
K26. The ability to use modern means of computer technology, communication and communication in carrying out technical calculations of means of automation of enterprises and designing mechatronic systems and modules.
K27. The ability to use modern methods of design and calculation of individual mechatronic systems and modules and methods of mathematical and computer modeling to study the dynamic characteristics of mechatronic and robotic systems.

Learning outcomes

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, electrotechnical and electromechanical 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.
PR12. Communicate freely orally and in writing in national and foreign languages on modern scientific

and technical problems of electric power, electrical engineering and electromechanics.
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.
PR18. To analyze the current state and determine trends in the development of electric drive systems and the theory of automatic control, numerical control systems, mechatronic systems, metal cutting machines, mobile and industrial robots.

PR19. To be able to use modern methods of mathematical apparatus when designing electromechanical systems, microprocessor control systems for electric drives of mechatronic systems.
PR21. To be able to use modern means of computer technology, communication and communication in carrying out technical calculations of enterprise automation and designing mechatronic systems and modules.
PR22. To be able to use modern methods of design and calculation of individual mechatronic systems and modules and methods of mathematical and computer modeling for the study of di-
characteristics of mechatronic and robotic systems.
PR24. To be able to use modern means of computer technology, communication and communication in carrying out technical calculations of enterprise automation and designing mechatronic systems and modules.
PR25. To be able to use modern methods of design and calculation of individual mechatronic systems and modules and methods of mathematical and computer modeling to study the dynamic characteristics of mechatronic and robotic systems

Scope of the discipline

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

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. The project method, the methods of active, problem-based and partially searching presentation are used during the classes. Most of the theoretical topics are supported by practice in laboratory classes on the use of modern robot design software.

Program of educational discipline

Topics of lectures

Topic 1. Goals and objectives of the course. Fields of application of mobile robots. Overview of sources of information. Topic 2 The process of designing mobile robots.
Topic 3. Designing requirements for mobile robots.
Topic 4 Classes of mobile robots.
Topic 5 Movement mechanisms of mobile robots.
Topic 6 Ways of turning and types of wheels in the design of wheeled robots
Topic 7. Modeling of robot movement, kinematic and dynamic models of movement mechanisms.
CAD of robots.
Topic 8. Construction options and transmission characteristics of mobile robots.
Topic 9. Parts of the electric drive of mobile robots. Power sources.
Topic 10. Control systems for electric drives of robot wheels.
Topic 11. Sensors of control systems of mobile robots.
Topic 12. Microprocessor means of motion control systems of mobile robots. Topic
13. Means of localization and navigation.

Topic 14. Special types of robots: walking, balancing, swimming robots. UAV Topic 15. Examples of analysis of the technical level of mobile robot projects.
Topic 16. Trends in the development of mobile robots.

Topics of practical classes

Practical classes within the discipline are not provided

Topics of laboratory works

Topic 1. Analysis of the field of application of mobile robots.
Topic 2. Analysis of the context and problems of robot design.
Topic 3. Forms for submission of job requirements.
Topic 4. Analysis of requirements for a mobile robot. Topic 5. CAD user interface of robots.
Topic 6. A virtual model of the movement of a wheeled robot.
Topic 7. Study of the rotation of the robot.
Topic 8. Kinematic model of a mobile robot. Topic 9. A model of the dynamics of a mobile robot.
Topic 10. Modeling of the electric wheel drive control system. Topic 11. Study of characteristics of motor drivers.
Topic 12. Software control of the electric drive of the robot wheels.
Topic 13. Application of an ultrasonic rangefinder in mobile work. Topic 14. Virtual models of movement in an environment with obstacles.
Topic 15. Programming in CAD of robots.
Topic 16. Programming of robot control interfaces.

Independent work

The course involves the completion of an individual task on the topic: "Conceptual design of a mobile robot". Based on the results of independent work, a report on its implementation is drawn up.

Literature and educational materials

1. Nevlyudov I.Sh., Andrusevich A.O., Yevseev V.V. Designing mobile robots on the basis single-board computers (Raspberry Pi and Python 3.6 languages): Textbook. – Kharkiv: 2020.-257 p.
2. Vykovych I.A. Theory of movement of vehicles: textbook. - Lviv: Publishing House of Lviv Polytechnic, 2013.
3. Theory of car movement: textbook / V.P. Volkov, G.B. Vilsky. - Sumy: University Book, 2015. - 320 p.
4. Cook, Gerald, Mobile robots : navigation, control and remote sensing, 2011.
5. Thomas Bräunl. Embedded robotics, Third Edition, 2008.

Evaluation system

Criteria for evaluating student performance and distribution of points

100% of the final grade consists of the results of the assessment in the form of an exam (10%) and the current assessment (90%).

Exam: written assignment and oral report. Current: implementation individual settlement task, semestercontrol work and laboratory practice (30% 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