MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

Black Sea National University named after Petro Mohyla

Faculty of Computer Sciences

Department of automation and computer-integrated technologies

"I APPROVE"
The first vice-rector
Yu. V. Kotlyar
"28" 02 2024 year

WORKING PROGRAM OF EDUCATIONAL DISCIPLINE

Scientific basis of the robotization (in English)

Specialty 174 "Automation, computer-integrated technologies and robotics"

Developer	O. Trunov
E.D. Head of the Dept. of Developer's	M. Sidelev
E.D. Head of the Dept. of specialty	M. Sidelev
Guarantor of the educational program	O. Trunov
Dean of the faculty	A. Boyko
Head of the TMD	S. Shkirchak

Mykolayiv – 2024

Description of the academic discipline

Name of the indicator	Characteristics of the discipline	
Name of discipline	Scientific basis of robotization (in English)	
The branch of knowledge	17 Electronics, automation and electronic communications	
Specialty	174 "Automation, computer-integrated technologies and robotics"	
Specialization (if any)		
Educational program	Automation, computer-integrated technologies and robotics	
Level of higher education	Master's degree	
Discipline status	Normative	
Curriculum	1, 2	
Academic year	2024-2025	
Number(s) of semesters:	Day form	Correspondence form
	2,3	---
Total number of ECTS credits/hours	6 creed /180 hours.	
Course structure: – Lectures – seminar classes (practical, laboratory, semi-group) – hours of independent student work	Day form 33 33 0 114	Correspondence form ---
Percentage of classroom load	37%	
Language of teaching	English	
Intermediate control form (if any)		
Final control form	Credit -2. Exam - 3	

1. **Purpose, tasks, competences and program results of training in the discipline**

Purpose: students to acquire fundamental and applied knowledge of the basics and principles of operation of robotics tools; general principles of building robots; features of executive mechanisms of robots; from the fundamental foundations of the structure of mathematical models of robots, robotic systems and complexes and the principles of adaptive and intelligent control of robots.

The tasks of studying the academic discipline are:

- formation of fundamental theoretical knowledge, from vector and matrix algebra, which allow to perform the analysis and synthesis of complex robotic systems and complexes based on synergistic relationships and information characteristics;

- formation of applied skills in the design of robot elements and robotization of technological processes, taking into account the scientific basis of the description of kinematics, dynamics, properties of types of drives, brakes and features of technological

processes for use in the structure of the SAC for setting and solving problems of the introduction of computer-integrated technologies and structure SAC, production sites, separate MRTS and nodes and aggregates in the implementation of unmanned technologies.

Integral competence

IC The ability to solve complex tasks and problems in the field of automation or in the learning process, which involves conducting research and/or implementing innovations and is characterized by the uncertainty of conditions and requirements

General competences:

GC1. Ability to conduct research at the appropriate level.

GC4. The ability to generate new ideas (creativity).

Special competences:

SC3. The ability to apply modeling and optimization methods to research and create effective management systems for complex technological and organizational and technical objects.

SC5. The ability to understand processes and phenomena in technological complexes of a separate industry (according to specialization), to analyze production and technological systems and complexes as objects of automation, to determine methods and strategies of their automation.

SC6. The ability to apply modern methods of the theory of automatic control for the development of automated control systems for technological processes and objects and robotic complexes and systems of unmanned air surface and underwater robots.

Additional special competencies to the master's educational and scientific training program

SC9. The ability to apply modern technologies of scientific research of processes, equipment, means and systems of automation, control, diagnostics, testing and management of complex organizational and technical objects, technological processes and robot-technical systems.

Program learning outcomes:

PLO3. Apply specialized conceptual knowledge, including modern scientific achievements, as well as critical understanding of modern problems in the field of automation and computer-integrated technologies to solve complex problems of professional activity.

PLO4. Apply modern approaches and methods of modeling and optimization for research and creation of effective automation systems of complex technological and organizational and technical objects.

PRN5. Develop computer-integrated management systems for complex technological and organizational-technical objects, applying a systematic approach taking into account non-technical components of the evaluation of automation objects.

PLO6. Communicate freely in national and foreign languages orally and in writing to discuss professional problems and results of activities in the field of automation and computer-integrated technologies, presentation of research results and innovative projects.

PLO8. Apply modern mathematical methods, methods of automatic control theory, reliability theory and system analysis to research and create automation systems of

complex technological and organizational-technical objects, cyber-physical productions and robotic-technical complexes and systems of unmanned air surface and underwater robots.

Additional requirements for learning outcomes under the educational and scientific program of master's training

PLO13. Apply modern technologies of scientific research, specialized mathematical tools for research, modeling and identification of objects of automation and robotic technical complexes and systems of unmanned air surface and underwater robots.

PLO19 Develop presentations of scientific projects, research in the official Ukrainian, English and, if necessary, in other languages.

2. Program of academic discipline

Full-time:

	Теми	Лекції, годин	Практичні (семінарські, лабораторні, півгрупові)	Самостій на робота
1	Second semester Topic 1 Introduction to robotics, classification, status and development trends. Lecture 1 Introduction to robotics, classification, examples, structure, kinematic schems. 1.1. Introduction to robotics. Types of robots. Classification of robots. 1.2. Industrial Robots. Structure and relationship of nodes and systems. 1.3. Kinematic schemes. Lecture 2 Robotic and technical complexes structure, drives and elements of mechatronic systems 1.4. Types of drives. Features of the structure of drivers 1.5. Robotic and technical complexes (RTK). Types of existing RTK 1.6. Types of robotic mechatronic systems depending on their functional purpose.	4	2	12
2	Topic 2 The scientific foundations of establishing the vector-matrix relationship of vectors in different coordinate systems Lecture 3 The scientific basis of description of kinematics of manipulators and robots 2.1. The basic mathematical principles of describing a point given by a vector in different coordinate systems.	4	4	16

	2.2. Direct and inverse rotation matrices. 2.3 Sequence of rotations as a sequence of multypliers in the product of matrices Lecture 4 Types of motions actuated by drives, description of motions of drivers 2.4. The basic mathematical principles of describing the movement of a point and a link of robots 2.5. Homogeneous coordinates and transformation matrices 2.6. Relationship between matrices in Euclidean and homogeneous coordinates			
3	Topic 3. Scientific foundations of establishing the interrelationships of links and presenting them in vector-matrix form. Lecture 5 Construction of models of kinematics and mechanics of manipulators 3.1. Scientific foundations of kinematics models and tasks of mechanics for Manipulators 3.2. Kinematic analysis of the component links of the manipulator. Denavit and Hartenberg method. 3.3. Representation of the transition matrix from system O_i to system O_{i-1} through the product of matrices Lecture 6 Solutions of direct and inverse kinematics problems 3.4. Representation of the position of some arbitrary point M in the coordinate system of the adjacent link. 3.5. The solution of the direct problem of kinematics for an arbitrary point M 3.6. The solution of the inverse kinematics problem for an arbitrary point M	4	6	20
4	Topic 4 Drives of industrial robots. The principle of operation, design features and parameter calculations Lecture 7 IR drivers, structure and design features 4.1. Drives of industrial robots. Types of drives and their elements. Comparative characteristics of IR drives 4.2. Pneumatic drive. Elements of a pneumatic drive. Typical scheme and control elements.	6	6	24

	4.3. Operating time of the pneumatic cylinder. Damping of the pneumatic drive. 4.4. Damper braking. Damping force. Lecture 8 Braking and positioning of a pneumatic and hydraulic device 4.5. Braking of the piston using the working body. Back pressure braking operation. 4.6. Positioning of the pneumatic drive. Tracking pneumatic drive Lecture 9 Structure, models of Electric drives and devices, and their transmission functions 4.7. Hydraulic drive 4.8. Electric drive. 4.9. Functional diagram of the electric drive 4.10. Direct current drive 4.11. Stepper drive			
5	Third Semestr Topic 5 Gearbox for the mechanical driver of IR Lecture 10 Reducers for manipulator drives 5.1. Planetary transmission. Principle of operation. 5.2. Determination of the transmission ratio in planetary mechanisms. Inversion method 5.3 Efficiency of planetary mechanisms 5.4 Wave transmission. The principle of operation, design and calculation features.	2	2	8
6	Topic 6 Braking systems, purpose and features of design and calculation Lecture 11 Braking systems 6.1 Braking devices. Purpose and types 6.2. Operational requirements and design features of brakes and braking systems 6.3. Calculation of brakes.	2	2	8
7	Topic 7. Grippers and devices for fixing the working tool Lecture 12 Grippers of robots and manipulators and fixation devices 7.1. Types of clamping devices. Classification of Captures 7.2. Grippers quality indicators* 7.3 Calculation of Capture. Calculation of the clamping force of the part in the grippers	2	2	8
8	Topic 8 Formulation and solution of the direct problem of MRTS dynamics	6	6	10

	Lecture No. 13 Kinematics of MRTS 8.1. Coordinate systems, in problems of dynamics of the MRTS. 8.2. Kinematic parameters of mobile robotic systems and equations of connection with rotational motion of MRTS Lecture 14 Kinematic parameters and general forms of the equations of motion of MRTS 8.3.Kinematic parameters and equations of connection with translational motion 8.4.General forms of the equations of motion of MRTS. Inertia matrices 8.5. Derivation of the equations of motion of apparatus with variable body geometry. Lecture 15 External forces and moments of forces 8.6. Derivation of equations describing external forces and moments of forces 8.7. Forces and moments arising as a result of the operation of the manipulator and other additional e/lements 8.8. Solution of the generalized equations of motion ABPA, as for a completely rigid body			
9	Topic 9 Methods of constructing equations of statics and dynamics of manipulators Lecture 16 Tasks of Mechanics of Manipulator 9.1. Dynamics of manipulators of industrial robots. 9.2. Power calculation of the manipulator. 9.3. Compilation of manipulator dynamics equations. 9.4. Dynamics equation of manipulators Lecture 17 Lagrange's equation of the second kind 9.5. Lagrange's equation of the second kind 9.6. Generalized coordinates 9.7. Kinetic energy of the manipulator 9.8. Generalized forces 9.9. Potential energy of the manipulator 9.10. Dynamics of manipulators	3	3	8
	Total	**33**	**33**	**114**

4. Content of the academic discipline

4.1. Lecture plan

№	Lesson topic / plan
1	Second semester Topic 1 Introduction to robotics, classification, status and development trends. Lecture 1 Introduction to robotics, classification, examples, structure, kinematic schems. 1.1. Introduction to robotics. Types of robots. Classification of robots. 1.2. Industrial Robots. Structure and relationship of nodes and systems. 1.3. Kinematic schemes. Lecture 2 Robotic and technical complexes structure, drives and elements of mechatronic systems 1.4. Types of drives. Features of the structure of drivers 1.5. Robotic and technical complexes (RTK). Types of existing RTK 1.6. Types of robotic mechatronic systems depending on their functional purpose.
2	Topic 2 Scientific foundations of establishing the vector-matrix relationship of vectors in different coordinate systems Lecture 3 Scientific basis of description of kinematics of manipulators and robots 2.1. The basic mathematical principles of describing a point given by a vector in different coordinate systems. 2.2. Direct and inverse rotation matrices. 2.3 Sequence of rotations as a sequence of monographs in the product of matrices Lecture 4 Types of drives, drive drivers 2.4. The basic mathematical principles of describing the movement of a point and a link of robots 2.5. Homogeneous coordinates and transformation matrices 2.6. Relationship between matrices in Euclidean and homogeneous coordinates
3	Topic 3. Scientific foundations of establishing the interrelationships of links and presenting them in vector-matrix form. Lecture 5 Construction of models of kinematics and mechanics of manipulators 3.1. Scientific foundations of kinematics models and tasks of mechanics for Manipulators 3.2. Kinematic analysis of the component links of the manipulator. Denavit and Hartenberg method. 3.3. Representation of the transition matrix from system O_i to system O_{i-1} through the product of matrices Lecture 6 Solutions of direct and inverse kinematics problems 3.4. Representation of the position of some arbitrary point M in the coordinate system of the adjacent link. 3.5. The solution of the direct problem of kinematics for an arbitrary point M 3.6. The solution of the inverse kinematics problem for an arbitrary point M

4	Topic 4 Drives of industrial robots. The principle of operation, design features and parameter calculations Lecture 7 IR drivers, structure and design features 4.1. Drives of industrial robots. Types of drives and their elements. Comparative characteristics of IR drives 4.2. Pneumatic drive. Elements of a pneumatic drive. Typical scheme and control elements. 4.3. Operating time of the pneumatic cylinder. Damping of the pneumatic drive. 4.4. Damper braking. Damping force. Lecture 8 Braking and positioning of a pneumatic and hydraulic device 4.5. Braking of the piston using the working body. Back pressure braking operation. 4.6. Positioning of the pneumatic drive. Tracking pneumatic drive Lecture 9 Structure, models of Electric drives and devices, and their transmission functions 4.7. Hydraulic drive 4.8. Electric drive. 4.9. Functional diagram of the electric drive 4.10. Direct current drive 4.11. Stepper drive
5	Third Semestr Topic 5 Gearbox for the mechanical driver of IR Lecture 10 Reducers for manipulator drives 5.1. Planetary transmission. Principle of operation. 5.2. Determination of the transmission ratio in planetary mechanisms. Inversion method 5.3 Efficiency of planetary mechanisms 5.4 Wave transmission. The principle of operation, design and calculation features.
6	Topic 6 Braking systems, purpose and features of design and calculation Lecture 11 Braking systems 6.1 Braking devices. Purpose and types 6.2. Operational requirements and design features of brakes and braking systems 6.3. Calculation of brakes.
7	Topic 7. Grippers and devices for fixing the working tool Lecture 12 Grippers of robots and manipulators and fixation devices 7.1. Types of clamping devices. Classification of Captures 7.2. Grip quality indicators* 7.3 Calculation of Capture. Calculation of the clamping force of the part in the grip

8	Topic 8 Formulation and solution of the direct problem of MRTS dynamics Lecture No. 13 Kinematics of MRTS 8.1. Coordinate systems, in problems of dynamics of the MRTS. 8.2. Kinematic parameters of mobile robotic systems and equations of connection with rotational motion of MRTS Lecture 14 Kinematic parameters and general forms of the equations of motion of MRTS 8.3.Kinematic parameters and equations of connection with translational motion 8.4.General forms of the equations of motion of MRTS. Inertia matrices 8.5. Derivation of the equations of motion of apparatus with variable body geometry. Lecture 15 External forces and moments of forces 8.6. Derivation of equations describing external forces and moments of forces 8.7. Forces and moments arising as a result of the operation of the manipulator and other additional e/lements 8.8. Solution of the generalized equations of motion ABPA, as for a completely rigid body
9	Topic 9 Methods of constructing equations of statics and dynamics of manipulators Lecture 16 Tasks of Mechanics of Manipulator 9.1. Dynamics of manipulators of industrial robots. 9.2. Power calculation of the manipulator. 9.3. Compilation of manipulator dynamics equations. 9.4. Dynamics equation of manipulators Lecture 17 Lagrange's equation of the second kind 9.5. Lagrange's equation of the second kind 9.6. Generalized coordinates 9.7. Kinetic energy of the manipulator 9.8. Generalized forces 9.9. Potential energy of the manipulator 9.10. Dynamics of manipulators

4.2.Plan of practical classes

№	Lesson topic / plan	години
	Second Semester	
1	Topic 1 Introduction to robotics, the scientific basis of establishing the vector-matrix relationship of vectors in different coordinate systems Practical No. 1 Vector-matrix relationship of vectors in different coordinate systems	2
2	Topic 2 Scientific foundations of establishing the vector-matrix relationship of vectors in different coordinate systems Practical No. 2 Vector-matrix relationship of vectors in different coordinate systems in HC Practical No. 3 Representation of the transition matrix from the Oi system to the Oi-1 system	4

3	Topic 3 Scientific foundations of establishing the interrelationships of links and presenting them in vector-matrix form. Practical lesson No. 4 Types of motions actuated by drives, description of motions Practical lesson No. 5 Types of motions actuated by drives, under of propousd kinematic scheme/kinetostatics. Practical lesson No. 6 Types of motions actuated by drives, under of propousd kinematic scheme	6
4	Topic 4 Drives of industrial robots. The principle of operation, design features and parameter calculations Practical lesson No. 7 Drives of industrial robots CD motor. Practical lesson No. 8 Drives of industrial robots Stepper motor.. Practical lesson No. 9 Gear box, transmisions	6
5	Third Semestr Topic 5 Gearbox for the mechanical driver of IR Practical lesson No. 10 Drive reducers.	2
6	Topic 6 Braking systems, purpose and features of design and calculation Practical lesson No.11 Brake systems	2
7	Topic 7 Grips and devices for fixing the working tool Practical 12 Clamps and devices for fixing the working tool	2
8	Topic 8 Formulation and solution of the direct problem of MRTS dynamics Practical lesson No. 13 Kinematics of MRTS Practical lesson No. 14 Methods of constructing equations of statics and dynamics of manipulators Practical lesson No. 15 Methods of constructing Lagrange equations of the second kind to describe the dynamics of manipulators	6
9	Topic 9 Methods of constructing equations of statics and dynamics of manipulators Practical lesson No. 16 Methods of constructing the equations of statics and dynamics of the MRTS	3
	Total	33

4.3. Tasks for home (independent) work

Second semester
Task 1
Direct problem of point kinematics.
Task 2
A direct problem of the kinematics of the center of mass point of the manipulator gripper.
Task 3
Kineto statics. Determination of reactions in joints and drive parameters.

Third semester

Task 1

A invers problem of the kinematics of the center of mass point of the manipulator gripper.

Task 2

A direct problem of the dinamics of the center of mass point of the manipulator links and
gripper with into object.

Task 3

Dynamics of two links of the manipulator

Task 4

Syntez of motion on trajectory

Task 4 (As Alternative task)

Kinematic parameters of mobile robotic systems and equations in connection with rotational motion of MRTS

4.4. Ensuring the educational process

Mechanics laboratory equipment: calipers, micrometers, scales, torsion scales, electronic scales, scales for hydrostatic weighing, equipment for testing the law of conservation of momentum, Maxwell's pendulum, equipment for measuring the adiabatic index, viscosity index, surface tension coefficients, rolling friction. Equipment for studying mechanical vibrations.

Laboratory of electricity and magnetism: generators, oscilloscopes, analog and digital, inductance capacity meters and multimeters, equipment for the study of electrical processes and oscillations.

Specialized audience of Automation and RTS

Stands for testing the grippers (catcher of objects of undetermined shape, soil, loose materials

Drive test stands (linear-180 mm, 450 mm)

Tare stand for RTS Capacitive sensors, eddy current, force, tenso sensors)

Tare stand for rangefinder sensors

Drives, ball guides, ball-screw transmissions, gearboxes

Wireless and wired cameras, endoscopes

Grips, sensitized grip layout,

Manipulators are operating models controlled by a radio channel

Mini-tank Robot with Bluetooth - 3 pcs.

Balboa 32U4 balancing 2-wheeled robot from Pololu - 3 pcs

A set for collecting manips. "Robotic hand" from Keyestudio - 4 pcs.

Quadcopter, autocar, balancer

Digital oscilloscopes of types SDS1022-1 pc.

Digital oscilloscopes of types DSO138- -4 pc.
Digital oscilloscopes of types UNI-T UTD2025C -1 pc
A set of Super Arduino Starter Kit id Keyestudio
Board Arduino Mega 2560 Rev3 (original, Italy) A000067
Raspberry Pi 4 Model B 2GB Mini Computer Board
IR motion sensor HC-SR505 for Arduino
Weight sensor (strain sensor) 1, 5, 10, 20 kg
Waterproof ultrasonic sensor
IR motion sensor HC-SR505 for Arduino
Accelerometer and gyroscope MPU-6050 module 6DOF.

4.5. **Final control**

1. Introduction to robotics. Types of robots. Classification of robots.
2. Industrial robots (IR). Structure and relationship of nodes and systems.
3. Kinematic schemes. Drive types, comparison drivers
4. Robotic complexes. Types of existing RTK. Kinematic schemes.
5. Types of robotic mechatronic systems depending on their functional purpose.
6. Scientific bases of describing the kinematics of manipulators and robots
7. The basic mathematical principles of describing the movement of a point and a link of robots
8. Rotation matrices
9. Homogeneous coordinates and transformation matrices
10. Construction of models of kinematics and mechanics of manipulators
11. Scientific foundations of kinematics models and tasks of Manipulator mechanics
12. Kinematic analysis of the component links of the manipulator. Denavit and Hartenberg method.
13. Representation of the transition matrix from system Oi to system Oi-1 through the product of matrices
14. Representation of the position of some arbitrary point M in the coordinate system of the adjacent link. The solution of the direct problem of kinematics for an arbitrary point M
15. Drives of industrial robots. Types of drives and their elements. Comparative characteristics of IR drives
16. Pneumatic drive. Elements of a pneumatic drive. Typical scheme and control elements.
17. Time of operation of the pneumatic cylinder. Damping of the pneumatic drive.
18. Damper braking. Damping force.
19. Piston braking using a working body. Back pressure braking operation.
20. Positioning of the pneumatic drive. Tracking pneumatic drive
21. Hydraulic drive
22. Electric drive.
23. Functional diagram of the electric drive
24. Direct current drive
25. Stepper drive

26. Reducers of manipulator drives, general characteristics and features of application
27. Planetary transmission. Principle of operation.
28. Determination of the transmission ratio in planetary mechanisms. Inversion method
29. Efficiency of planetary mechanisms
30. Wave transmission. The principle of operation, design and calculation features.
31. Braking devices. Purpose and types
32. Operational requirements and design features of brakes and braking systems
33. Calculation of brakes.
34. Captures of robots and manipulators and fixation devices
35. Types of clamping devices. Classification of Captures
36. Grip quality indicators*
37. Calculation of Capture. Calculation of the clamping force of the part in the gripper
38. Coordinate systems, in problems of MRTS dynamics
39. Kinematic parameters of mobile robotic systems and equations of connection with rotational motion of MRTS
40. Kinematic parameters and general forms of the equations of motion of MRTS
41. Kinematic parameters and equations of connection with translational motion
42. General forms of the equations of motion of MRTS. Inertia matrices
43. Derivation of the equations of motion of a PA with variable body geometry.
44. External forces and moments of forces
45. Derivation of equations describing external forces and moments of forces
46. Forces and moments arising as a result of the operation of the manipulator and other additional elements
47. Solution of the generalized equations of motion ABPA, as for a completely rigid body
48. Methods of constructing equations of statics and dynamics of manipulators and RTS
49. Manipulator Mechanics Tasks
50. Dynamics of manipulators of industrial robots.
51. Power calculation of the manipulator.
52. Compilation of manipulator dynamics equations.
53. Dynamics equation of manipulators
54. Lagrange's equation of the second kind
55. Generalized coordinates
56. Kinetic energy of the manipulator
57. Generalized forces
58. Dynamics of manipulators
59. Ejector model. Description of the operation and construction of the ejector model in the form of a second-order DE.
60. Solution of the pusher model's control system and initial conditions.
61. Model of an electromagnetic brake. Description of operation and construction of a brake model in the form of a second-order DE.
62. Solution of the remote control model of the electromagnetic brake and initial conditions.
63. Description of the operation of the DC motor drive model in the form of a remote control system. Solution of DE, initial conditions. Transfer Function

64. Stepper motor model. Description of operation and construction of a stepper motor model in the form of a second-order remote control system.
65. Representation of vectors in different coordinate systems Kinematic analysis of manipulator components.
66. Denavit and Hartenberg method. Representation of the transition matrix from system Oi to system Oi-1 through the product of matrices
67. Representation of the position of some arbitrary point M in the coordinate system of the adjacent link.
68. Solution of the direct problem of kinematics for an arbitrary point M
69. Dynamics of manipulators of industrial robots.
70. Power calculation of the manipulator, compilation of manipulator dynamics equations using the Newton-Dalembert method.
71. Balancing mass model
72. Creation of a speed model for a three-link manipulator
73. General features of process management
74. Management of the technological process
75. Technological process control systems
76. Complex automation of technological process Full automation
77. Basic principles of computer-integrated control
78. Types of technological process management. Manual control of TP. Automated management of TP

5. Evaluation criteria and tools for diagnosing learning outcomes

5.1. Second semester

№	Type of activity (task)	Maximum number of points
1*	Practical tasks performed in lesons or individual homework (5 points*2)	10
2	Individual independent tasks. Assignment #1, 20 points	20
3	Individual independent tasks. Assignment #3,4 (20 points*2))	40
4*	Additional tasks are given only once per semester for students who missed classes and do not have points for item 1* 1) Defense of the task: one per topic, five points per task, a task from the number of tasks on SR that has been solved. 2) Preparation of an audio personal presentation, for one's own SR task, five points per presentation, only one per semester 3) Demonstration preparation five points for one demonstration, only one per semester 4) Preparation of a presentation in English	10

5	Test	30
	Totaly	**100**

**Additional tasks are issued at the request of students, one per semester, including in English, under these conditions, a maximum of 10 points, tasks that replace item 1*

Third semester

№	Type of activity (task)	Maximum number of points
1*	Practical tasks performed in lesons or individual homework (5 points*2)	10
2	Individual independent tasks. Assignment #1, 2 -15 points, (15*2 points))	30
3	Individual independent tasks. Assignment #3,4 (10 points*2))	20
4*	Additional tasks are given only once per semester for students who missed classes and do not have points for item 1* 1) Defense of the task: one per topic, five points per task, a task from the number of tasks on SR that has been solved. 2) Preparation of an audio personal presentation, for one's own SR task, five points per presentation, only one per semester 3) Demonstration preparation five points for one demonstration, only one per semester 4) Preparation of a presentation in English	10
5	Test	40
	Totaly	**100**

**Additional tasks are issued at the request of students, one per semester, including in English, under these conditions, a maximum of 10 points, tasks that replace item 1*

5.2. Criteria for evaluating tasks to achieve the maximum number of points

Verification of acquired knowledge and skills by students takes place by conducting an oral survey in practical classes and performing independent homework (individual task).

The current rating consists of the points that the student receives during the study of this course - completion and prezentation of homework, performances in practical classes. If the student has successfully (with positive grades according to the national scale) completed all types of educational work provided for in this course, he is admitted to the exam.

During the semester, the student performs three types of tasks: Solving problems according to course topics in the classroom; Solving problems on course topics at home and defending them in the classroom; presentation of work in the form of a report.

If minor inaccuracies are allowed in the student's performance, the number of points is reduced by 5%. If significant inaccuracies are allowed in the student's performance, but the principles are not distorted, then by 10%, if the errors are significant, then the points are reduced by 20%.

The form of the final study control is the credit.

Evaluation of students' work is carried out according to the principles of the rating system. All work for the semester is evaluated at 100 points. A student receives thirty points under conditions of high-quality passing of the exam. If passing the final inspection is evaluated as "good" or "satisfactory", this corresponds to 20 and 15 points. The distribution of the maximum number of points for questions is carried out evenly - ten points for each question. The tasks are evaluated as follows: one task 3.33 points and three - ten.

5.4. Tickets for final control:

Second semester

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

Black Sea National University named after Petro Mohyla

Faculty of Computer Sciences

Department of AKIT, Specialty "Automation, KIT and Robotics"

Discipline “ Scientific basis of the robotization (in English)”

Ticket No. 0

1. Types of robotic mechatronic systems depending on their functional purpose.

2. Generalized coordinates. Formulation of equations for a two-link manipulator

3. Electric drive model. Description of work and construction of a model in the form of a second-order DE system. Remote control system solution, transfer function.

Doctor of Science,

Professor _____ O.M. Trunov

Head of department _____ M. I. Sydelev

"____"_____ 20__ "____"_____ 20__

Third semester

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Faculty of Computer Sciences

Department of AKIT, Specialty "Automation, KIT and Robotics"

Discipline " Scientific basis of the robotization (in English)"

Ticket No. 0

1. Lagrange's equation of the second kind. Generalized coordinates. Formulation of equations for a two-link manipulator
2. Planetary transmission. Determination of the transmission ratio in planetary mechanisms. Inversion method
3. Kinematic parameters and equations of connection with translational motion. General forms of the equations of motion of MRTS. Inertia matrices

Doctor of Science,

Professor _____ O.M. Trunov

Head of department _____ M. I. Sydelev

"____"_____ 20__ "____"_____ 20__

6 Recommended sources of information

The main sourses:

1. Алехандро Гутьєррес-Гілес, Хав'єр Плієго-Хіменес, Марко А. Артеага. Local Stability and Ultimate Boundedness in the Control of Robot Manipulators. Springer.2022 рік
2. Larry T. Ross, Stephen W. Fardo, Michael F. Walach. Industrial-Robotics-Fundamentals. Fourth Edition. Goodheart-Willcox Company, Incorporated, Publisher Tinley Park, IL www.g-w.com 30 Aug. 2021 г. - P: 512. **ISBN13:** 9781649259783 **ISBN10:** 1649259786
3. Alysson Nascimento de Lucena, Bruno Marques Ferreira da Silva. Micro aerial vehicle with basic risk of operation. July 2022. Scientific Reports 12(1) DOI: 10.1038/s41598-022-17014-4
4. Nikolaus Correll, Bradley Hayes, Christoffer Heckman, and Alessandro Roncone Introduction to Autonomous Robots: Mechanisms, Sensors, Actuators, and Algorithms v3.0, December 1, 2021

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