Ministry of Science and Higher Education of the Russian Federation
Federal State Autonomous Educational Institution of Higher Education
Perm National Research Polytechnic University

APPROVED BY
Pro-rector for Academic Affairs
_____ N.V. Lobov
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ACADEMIC COURSE WORKING PROGRAM

Academic course: Robotic Design
(Name)

Form of education: Full-time studies
(full-time / part-time / correspondence)

Level of higher education: Bachelor's program
(Bachelor's program / Specialist program / Master's program)

Workload in hours (in credits): 144 (4)
(Hours (CU))

Training program (degree): 15.03.06 Mechatronics and robotics technology
(Code and denomination of degree)

Direction: Mechatronics and robotics technology
(Title of curriculum)

Perm 2021

1 General Provisions

1.1 Goals and Objectives of the Course

The goal of the course is to make the students aware of the main stages of robotic systems, to provide insight into mathematical models and methods of robotics.

1.2 Prescribed Objects of the Course

Robots, robotic systems, its design and configuration, main stages of design robotic systems, stages of the process of development and synthesis of control systems, methods of linearization models, modern tools of automation.
Main instruments under development at different stages of design, robot software, principles of testing.

1.3 Starting Conditions

Unstipulated

2 Planned Results of the Course Training

Competence	Indicator's Index	Planned Results of the Course Training (to know, to be able, to master)	Indicator of Attaining Competence which the planned results of training are correlated with	Means of Assessment
GPC-11	**IA-1$_{GPC-11}$**	**To know** methods and software for designing devices and subsystems of mechatronic and robotic systems.	**Knows** methods and software tools for designing devices and subsystems of mechatronic and robotic systems.	Test
GPC-11	**IA-1$_{GPC-11}$**	**To be able to** use software tools for the development of hardware and software for mechatronic and robotic systems.	**Is able to** apply software tools for the development of hardware and software for mechatronic and robotic systems.	Laboratory work presentation
GPC-11	**IA-1$_{GPC-11}$**	**To master the skills** in using standard executive and control devices, automation equipment, measuring technology to create devices and systems for mechatronics and robotics.	**Has mastered the skills** of using standard actuators and control devices, automation tools, measuring equipment for the creation of devices and systems of mechatronics and robotics.	Test

3 Full time and forms of academic work

Form of academic work	Hours in all	Distribution in hours according to semesters
		Number of semester
		7
1 Holding classes (including results monitoring) in the form: 1.1 Contact classwork, including:	54	54
- lectures (L)	24	24
- laboratory work (LW)	16	16
- practice, seminars and/or other seminar-type work (PW)	10	10
- control of self-work (CSW)	4	4
- test paper		
1.2 Students' self-work (SSW)	90	90
2. Interim/midterm assessment		
Exam		
Grading test	9	9
Test		
Course Project (CP)		
Course Work (CW)		
Workload in hours	**144**	**144**

4 Course contents

Name of the units with the course outline	Full time of classroom activity in hours according to the forms			Full time of extracurricular work in hours according to the forms
	L	LW	PW	SSW
7th semester				
General design information robotic systems, process steps development, the content of the stages and the description of the main documents being developed.	4	2	0	15
General information about designing robots. Robot design principles.				
Robot design principles and tools automation of various stages of development of robotic systems.	4	2	2	15
Computer-aided design systems simulation and analysis of robots.				
Fundamentals of math development descriptions of the robot.	4	2	2	15
Using scilab and python for developing computational robot models. Equations of the mathematical model of the robot. Synthesis of controls based on simplified robot				

models.				
The main stages of creating robot models.	4	2	2	15
Basic standards and guidelines for development project documentation ESPD, ESKD GOSTs 2, 19, 34				
Model analysis and systems synthesis procedures robot control.	4	4	2	15
Determination of controls providing steady motion. Robot model research.				
Model linearization methods, stability and controllability analysis, synthesis of linear-quadratic and position-tractor controllers.	4	4	2	15
Synthesis of a linear-quadratic controller with using the scipy package. Position-trajectory controller synthesis.				
Total with regard to 7th semester	**24**	**16**	**10**	**90**
Total with regard to the course	**24**	**16**	**10**	**90**

Topics of exemplary practical work

№	Topic of practical (seminars) work
1	development of structural and algorithmic support for the project
2	calculation of robot system reliability

Topics of exemplary laboratory work

№	Topic of laboratory work
1	synthesis of a linear-quadratic regulator using the SciPy
2	determination of controls that provide steady motion
3	synthesis of a position-trajectory controller

5 Organizational and Pedagogical Conditions

5.1 Educational Technologies Used for Competences Formation

Holding lectures in the discipline is based on the active method of training in the process of which students are not passive but active participants of the lesson answering questions of the teacher. Teacher's questions are aimed at activating the process of learning material as well as at the development of logical thinking. The questions stimulating associative thinking and connecting new material with the previous one are identified by the teacher in advance.

Practical lessons are held by realization of the method based on active training: problem areas are determined, groups are formed. The following aims are pursued in the process of practical education: use of definite disciplines, knowledge and creative methods in solving problems and decision-making; students' skill-building of teamwork, interpersonal communication and development of leadership skills; consolidation of the basic theoretical knowledge.

Laboratory classes are based on an interactive learning method in which students communicate not only with the teacher but also with each other. At the same time, students ' activity in the learning process dominates. The teacher's place in interactive classes is reduced to orienting students ' activities to achieve the goals of studies.

Interactive lectures, group discussions, role-playing games, training sessions, and analysis of situations and simulation models are used in academic studies.

5.2 Students' Manual for the Course Study

Learning the course, it is advisable for students to implement the following recommendations:
1. Learning of the discipline should be done systematically.
2. After learning one of the course units with the help of the text-book or lecture notes it is recommended to reproduce the basic terms, definitions, notions of the unit from memory.
3. Special attention should be paid to the reports on practical studies and individual complex tasks for self-work.
4. The topics list for individual study is given by the teacher at the lectures. The teacher also provides students with literary sources (first of all, new ones in the periodical scientific literature) for a more detailed understanding of the issues presented at the lectures.

6 List of Teaching Materials and Information Supply for Students' Self work in the Discipline

6.1 Paper-based courseware

№	Bibliographic entry (author, title, mode of publication, place, publishing house, year of publication, number of pages)	Number of copies in the library
	1 Basic literature	
1	Aguilar J. A review on locomotion robophysics: the study of movement at the intersection of robotics, soft matter and dynamical systems / Jeffrey Aguilar, Tingnan Zhang, Feifei Qian, Mark Kingsbury, Benjamin McInroe, Nicole Mazouchova, Chen Li, Ryan Maladen, Chaohui Gong, Matt Travers, Ross L. Hatton, Howie Choset, Paul B. Umbanhowar, Daniel I. Goldman. School of Physics, Georgia Institute of Technology, Atlanta, GA, USA 2016 URL: arxiv.org/pdf/1602.04712.pdf	10
	2 Additional literature	
	2.1 Educational and scientific literature	
1	Minaie A., Sanati R. An international study of robotics courses in the computer science/engineering curriculum. American Society for Engineering Education, 2006	6
2	Gunsing J. Adaptive Robotic Systems Design in University of Applied Sciences / Jos Gunsing, Fons Gijselhart, Nyke Hagemans, Hans Jonkers, Eric Kivits, Peter Klijn, Bart Kapteijns, Diederich Kroeske, Hans Langen, Bart Oerlemans, Jan Oostindieand, Joost van Stuijvenberg. Avans University of Applied Sciences, Centre of Expertise for Sustainable Innovation, Research Group for Robotics & Mechatronics, Breda's-Hertogenbosch, The Netherlands 2016 URL: https://www.matec-conferences.org/articles/matecconf/pdf/2016/15/matecconf_icdes2016_02007.pdf	5
	2.2 Periodical literature	
	2.3 Standardized and Technical literature	
	3 Students' manual in mastering discipline	

4 Teaching and learning materials for students' self-work		

6.2 Electronic Courseware

Kind of literature	Name of training tool	Reference to information resource	Accessibility of EBN (Internet / local net; authorized / free access)
Additional literature	A trusted hub for electronics enthusiasts	https://www.electronicshub.org/	free access
Additional literature	Online Robotics Trade Magazine Industrial Automation, Robots and Unmanned Vehicles	https://www.roboticstomorrow.com/	free access

6.3 License and Free Distributed Software used in the Course Educational Process

Type of Software	Software branding
Operating systems	Debian (GNU GPL)
Development, testing and debugging environments	NetBeans (SUN PUBLIC LICENSE)
Development, testing and debugging environments	PIP (The Python Package Installer) Free

6.4 Modern Professional Databases and Inquiry Systems Used in the Course Educational Process

Branding	Reference to information resource
Scopus Database	https://www.scopus.com/
Scientific Library of Perm National Polytechnic Research University	http://lib.pstu.ru/
Lan' Electronic library system	https://eJanbook.com/
IPR books Electronic library system	http://www.iprbookshop.ru/
Information resources of Consultant+ web	http://www.consultant.ru/

7 Logistics of the Course Educational Process

Type of classes	Name of the necessary basic equipment	Number of units
Practicals	Laptop computer	30
Practicals	Multimedia projector or TV	1

8 Fund of the Course Evaluating Tools

Described in a separate document