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
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"__" _____ 2021

ACADEMIC COURSE WORKING PROGRAM

Academic course: Theoretical background of computer-aided manufacturing control
(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): 216 (6)
(Hours (CU))

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

Direction: Mechatronics and Robotics
(Title of curriculum)

Perm 2021

1 General Provisions

1.1 Goals and Objectives of the Course

The goal of the course is to form the set of knowledge, skills and abilities relating to development and appliance of computer-aided management systems in the production environment.

1.2 Prescribed Objects of the Course

Computer-aided control systems, computer-aided manufacturing, MRP, ERP, PLM, mathematical support for computer-aided control systems, algorithmic support for computer-aided control systems, information support for computer-aided control systems, mathematical support for computer-aided control systems, tool support for computer-aided control systems, ergonomic support for computer-aided control systems, organizational support for computer-aided control systems, design of computer-aided control systems, CASE-technologies.

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
PC-2.6	**IA-1$_{PC-2.6}$**	**To know** methods of determining functional indicators of flexible production systems	**Knows** methods of determining functional indicators of flexible production systems	Test
PC-2.6	**IA-2$_{PC-2.6}$**	**To be able to** calculate performance indicators for flexible production systems.	**Is able to** calculate performance indicators for flexible production systems.	Internship report
PC-2.6	**IA-3$_{PC-2.6}$**	**To master the skills** of definition of functional indicators of flexible production systems.	**Has mastered the skills** of definition of functional indicators of flexible production systems.	Internship report

3 Full time and forms of academic work

Form of academic work	Hours in all	Distribution in hours according to semesters
		Number of semester
		4
1 Holding classes (including results monitoring) in the form: 1.1 Contact classwork, including:	72	72
- lectures (L)	32	32
- laboratory work (LW)		
- practice, seminars and/or other seminar-type work (PW)	36	36
- control of self-work (CSW)	4	4
- test paper		
1.2 Students' self-work (SSW)	108	108
2 Interim/midterm assessment		
Exam	36	36
Grading test		
Test		
Course Project (CP)		
Course Work (CW)	36	36
Workload in hours	**216**	**216**

4 Course contents

Course units with brief contents	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
4th semester				
General characteristic of computer-aided control. Computer-aided systems forming methodology.	4	0	0	10
Definition of computer-aided control. Main features of computer-aided control. Classification of computer-aided control systems. Key formation and development stages of computer-aided control. Subsystem approach to computer-aided control. Procedural representation.				
Computer-aided control models.	4	0	0	10
MRP/ERP models. PLM models. Models of flexible manufacturing computer-aided factory. Models of adaptive computer-aided control.				
Functional and structural analysis of computer-aided systems.	4	0	0	10
System engineering as an analysis tool of computer-aided control systems. Information-logical model				

computer-aided control systems. Functional model of computer-aided control systems. Functional analysis based on business processes.				
Mathematical and algorithmic support for computer-aided control systems.	4	0	18	25
Formalization and algorithmization of decision-making processes under conditions of computer-aided control. Making decisions based on artificial intelligence technology. Mathematical support of tactical planning and strategic control objectives. Mathematical support of operational control objectives. Mathematical and algorithmic support for adaptively computer-aided control.				
Information support for computer-aided control systems.	4	0	0	10
Information support for computer-aided control systems based on the database technology. Development of information support for computer-aided control systems based on object-oriented, object-relational and distributed databases.				
Tool, ergonomic and organizational support for computer-aided control systems.	4	0	0	10
Software-based, technical and telecommunication tools of computer-aided control systems. Ergonomic and organizational support for computer-aided control systems. Online documentation, desk procedures.				
Design basis computer-aided control systems.	4	0	18	25
General characteristic of computer-aided control systems design. Special features of computer-aided control systems design during different approaches to their design. CASE-technologies. Quality estimation of computer-aided control systems.				
Service provider organization of computer-aided control systems.	4	0	0	8
The basic principles and methods of service provider organization of computer-aided control systems.				
Total with regard to 4th semester	32	0	36	108
Total with regard to the course	32	0	36	108

Topics of exemplary practical work

№	Topic of practical (seminars) work
1	Description of functional requirements to computer-aided control systems software by means of UML use case diagrams.
2	Description of computer-aided control systems software operation algorithm by means of UML activity diagrams.
3	Constriction of UML class diagrams when developing computer-aided control systems software.
4	Constriction of UML component and deployment diagrams when developing computer-aided control systems software.

5	Business process modeling with the use of IDEF0 methodology.
6	Data modeling when developing computer-aided control systems.
7	Automation of solving techno-economic planning problems.
8	Automation of solving maintenance supply and distribution problems.
9	Automation of solving marketing problems.
10	Automation of solving strategic management problems.
11	Automation of solving problems of core production operating management.
12	Making requirements documents for developing computer-aided control systems.

Topics of exemplary course project/work

№	Topic of exemplary course project/work
1	Design of computer-aided techno-economic planning systems.
2	Design of computer-aided maintenance supply and distribution systems.
3	Design of computer-aided strategic control systems.
4	Design of computer-aided core production operating control systems.

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.

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 under-standing 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	Emelyanov S. V. Selected Proceedings (To the 85th Anniversary): Automatic Control Systems with Variable Structure. System Design of Automation Means. Binary Systems. New Feedback Types / S. V. Emelyanov – Moscow : Krasand, 2014	
2 Additional literature		
2.1 Educational and scientific literature		
1	Garcia E. 1st International Conference on Application and Theory of Automation in Command and Control Systems / E. Garcia – Barcelona : Publisher info, 2011	
2	Svensson N. L. Introduction to engineering design / N. L. Svensson - Bath : Pitman Publ., 1976	
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	Dustin E. Automated Software Testing Introduction Management And Performance	https://priscilla.work/download/4574591-automated-software-testing-introduction-management-and-performance	local net; free access

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

Type of Software	Software branding
Operating systems	Windows 10 (Azure Dev Tools for Teaching)
Office applications	Microsoft Office Professional 2007. license 42661567
General purpose application software	Microsoft Office Visio Professional 2016 (Azure Dev Tools for Teaching)
Development, testing and debugging environment	Java (JDK + JRE) Sun License (GPL) Free Software

Development, testing and debugging environment	Microsoft Visual Studio (Azure Dev Tools for Teaching)
Development, testing and debugging environment	NetBeans (SUN PUBLIC LICENSE)

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

Branding	Reference to information resource
Virtual reading room of the Russian State Library	https://dvs.rsl.ru/
Scopus Database	https://www.scopus.com/
Electronic Scientific Library Database	http://elibrary.ru/
Scientific Library of Perm National Polytechnic Research University	http://lib.pstu.ru/
Lan' Electronic library system	https://e.lanbook.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
Course work	Personal computers	20
Lecture	Multimedia projector, laptop computer	1
Practice work	Personal computers	20

8 Fund of the Course Evaluating Tools

Described in a separate document