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
"25" 11 2021

ACADEMIC COURSE WORKING PROGRAM

Academic course: Production Systems with Artificial Intelligence
(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): 180 (5)
(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 knowledge, abilities and skills in the field of artificial intelligence methods used in the production systems.

1.2 Prescribed Objects of the Course

Intelligent systems, production systems, knowledge models, fuzzy logics, neural networks, expert systems, artificial intelligence agents, intelligent control.

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-2.4	**IA-1**$_{PC-2.4}$	**To know** the high-level programming languages and modern problem-solving environments for managing flexible production systems with the artificial intelligence.	**Knows** high-level programming languages and modern software environment for managing flexible production systems.	Test
PC-2.4	**IA-2**$_{PC-2.4}$	**To be able to** develop programs using high-level programming languages and robot control programs for flexible production systems with artificial intelligence.	**Is able to** develop programs in high-level programming languages and management programs for flexible production systems.	Laboratory work presentation
PC-2.4	**IA-3**$_{PC-2.4}$	**To master the skills** of choosing the right combination of problem-solving environments for controlling flexible production systems with the artificial intelligence and the software debugging for the control system	**Has mastered the skills** of choosing the optimal combination of software environment for managing flexible production systems and debugging software for the flexible production system control.	Course project

		of the flexible production systems with the artificial intelligence.		

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	8
1 Holding classes (including results monitoring) in the form: 1.1 Contact classwork, including:	64	34	30
- lectures (L)	18	10	8
- laboratory work (LW)	22	12	10
- practice, seminars and/or other seminar-type work (PW)	20	10	10
- control of self-work (CSW)	4	2	2
- test paper			
1.2 Students' self-work (SSW)	116	38	78
2 Interim/midterm assessment			
Exam			
Grading test	9		9
Test	9	9	
Course Project (CP)	36	36	
Course Work (CW)			
Workload in hours	**180**	**72**	**108**

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
7th semester				
Logic and semantic knowledge models.	4	6	4	19
Knowledge models on the basis of predicate logic. Knowledge models on the basis of fuzzy logic. Semantic networks. Active semantic networks. Frames. Production systems. Examples of using logic and semantic knowledge models in production.				
Neural network knowledge model.	6	6	6	19
Knowledge models on the basis of perceptrons. Kohonen Self-organizing maps. Knowledge models on the basis of Hopfield and Hamming networks. Knowledge models on the basis of stochastic neural net. Theory of adaptive resonance. Examples of using neural nets in production.				
Total with regard to 7th semester	**10**	**12**	**10**	**38**
8th semester				
Expert systems.	4	4	4	39
The structure of the expert system. Problem solver. Knowledge database. Knowledge acquisition. Spheres of expert systems use. Expert systems' peculiarities on the basis of neural nets. Smart decision making in the production sphere. Toolkit for intelligent systems creation.				
Intelligent agents and intelligent control.	4	6	6	39
Complexity of calculating in intelligent systems. Intelligent agents. Mobile robots' control. Intelligent systems for commercials. Intelligent systems for technology control.				
Total with regard to 8th semester	**8**	**10**	**10**	**78**
Total with regard to the course	**18**	**22**	**20**	**116**

Topics of exemplary practical work

№	Topic of practical (seminars) work
1	The use of knowledge model on the basis of fuzzy logic in production systems.
2	The use of semantic nets in production systems.
3	The use of neural nets in production systems.
4	The use of expert systems in deciding production tasks.
5	The use of intelligent agents in production systems.

6	The basis of mobile robots' control.

Topics of exemplary laboratory practices

№	Topics of laboratory work
1	Creation of logic knowledge database.
2	Creation of knowledge database using semantic network.
3	Studying perceptron.
4	Creation of self-organizing maps.
5	Studying Hopfield and Hamming networks.
6	Developing an expert system's problem solver.
7	Working with the expert-system shell.
8	Emulation of mobile robots.

Topics of exemplary course projects/works

№	Topics of course project
1	The use of fuzzy logic in economic system control.
2	Developing a forecasting system on the basis of an intelligent model.
3	Developing a pump control system with the help of a neural net.
4	Developing a mobile robot knowledge database.
5	Developing computer vision system elements.

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 achievement of 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	Mylnikov. L., Krause. B., Kuetz M., Bade K. Intelligent Data Analysis in the Management of Production Systems (Approaches and Methods). Ed.: Shaker Verlag, 2018.	1
2 Additional literature		
2.1 Educational and scientific literature		
1	Kurfess F. Parallelism in Logic: Its Potential for Performance and Program Development. Ed.: Vieweg, 1991	1
2	Holmes W., Bialik M., Fadel C. Artificial Intelligence in Education. Promise and Implications for Teaching and Learning. Publ.: Center for Curriculum Redesign, 2019	
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	Russel S., Norvig P. Artificial Intelligence: A modern approach. Third edition	https://readyforai.com/article/best-books-on-artificial-intelligence-for-beginner-with-pdf-download/	Internet; authorized 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. licence 42661567
General purpose application software	Microsoft Office Visio Professional 2016. (Azure Dev Tools for Teaching)
Development, testing and debugging environments	Java (JDK + JRE) Sun License (GPL) copyleft Software
Development, testing and debugging environments	Microsoft Visual Studio (подп. Azure Dev Tools for Teaching)
Development, testing and debugging environments	NetBeans (SUN PUBLIC LICENSE)

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

Branding	Reference to information resource
eLIBRARY.RU Database	https://elibrary.ru/
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/
Online reference room of the Russian State Library	https://dvs.rsl.ru/
Information resources of Consultant+ web	http://www.consultant.ru/
Information and reference system of normative and technical documentation "Techexpert: norms, rules, standards and legislation of Russia"	https://техэксперт.сайт/

7 Logistics of the Course Educational Process

Type of classes	Name of the necessary basic equipment	Number of units
Course Project	Laptop computer	20
Laboratory class	Laptop computer	20
Lecture	Multimedia projector, laptop	1
Practicals	Laptop computer	20

8 Fund of the Course Evaluating Tools

Described in a separate document