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: Mathematics, special chapters
(Name)

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

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

Workload in hours (in credits): 108 (3)
(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 goals of the discipline are mastering the basic methods of the mathematical apparatus necessary for the study of general theoretical and special disciplines; development of logical and algorithmic thinking; raising the general mathematical culture; developing skills in formalizing models of real processes; analysis of systems, processes and phenomena when searching for optimal solutions and choosing the best ways to implement these solutions; development of research skills and abilities of independent analysis of applied problems.

Objectives of the course are

- study of basic mathematical provisions, laws;
- study of basic concepts, methods and techniques of discrete mathematics;
- formation of the ability to use the basic laws of natural science disciplines in professional activities;
- formation of the ability to research and solve mathematically formalized problems;
- formation of the ability to use the methods of discrete analysis in solving professional problems;
- development of skills in solving typical problems in the main sections of the course, using the methods of discrete mathematics;
- development of skills in analyzing the results obtained.

In the process of studying this discipline, the student masters the parts of professional competencies:
Is able to solve problems concerning professional activity using methods of modelling, of mathematical analysis, natural-science and general engineering knowledge (GPC-1).

1.2. Prescribed Objects of the Course

Mathematical objects (sets, logical functions, combinatorial connections, graphs); Operations on objects and their properties; Analysis of the obtained results of solving mathematical problems.

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-1	**IA-1$_{gpc-1}$**	**To know** basic definitions of set theory; definition of a logical function; a method for checking the basicity of a system of logical functions; determination of the main combinatorial compounds; basic concepts of graph theory.	**Knows** basic definitions of set theory; definition of a logical function; a method for checking the basicity of a system of logical functions; definition of combinatorial compounds; basic concepts of graph theory	

GPC-1	**IA-2$_{gpc-1}$**	**To be able to** perform operations on sets; to prove the simplest identities of Boolean algebra; write down the perfect normal form of a logical function and minimize it; count the number of combinatorial compounds; build the adjacency and incidence matrices of the graph.	**Is able to** do operations on sets; prove the simplest identities of Boolean algebra; write the perfect normal form of a logical function and minimize it; count the number of combinatorial connections; build the adjacency and incidence matrices of the graph	
GPC-1	**IA-3$_{gpc-1}$**	**To master** basic methods of set theory; methods of constructing and minimizing normal forms; the main methods of combinatorics.	**Masters the skills** basic methods of set theory; methods of constructing and minimizing normal forms; the basic methods of combinatorics	

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:		
- lectures (L)	16	16
- laboratory work (LW)		
- practice, seminars and/or other seminar-type work (PW)	34	34
- control of self-work (CSW)	4	4
- test		
1.2. Students' self-work (SSW)	54	54
2. Interim/midterm assessment		
Exam		
Grading test		
Test (Credit)		
Course Project (CP)		
Course Work (CW)		
Workload in hours	**108**	**108**

4. Course outline

Course sections 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
Semester 7				
Sets, relations and mathematical logic	8		16	30
Sets and relations: Sets and operations on them. Basic Identities of Set Theory. Relations on sets, their properties and types. Equivalence relations, order relations. *Algebra of propositions*: Propositions. Basic operations on propositions. Equivalence of propositional algebra formulas. Inference rules. Normal forms. Zhegalkin's algebra. *Predicates and quantifiers*: Definition of a predicate. Quantifiers of generality and existence, their properties.				
Combinatorial analysis	4		8	8
Combinatorial compounds: Combinatorial compounds, their properties. Binomial Newton, binomial formula.				
Graph theory	4		10	16
Types of graphs: Definition of a graph, types of graphs. Digraphs, tree graphs. *Graph properties*: Connectivity, planarity. Euler and Hamiltonian graphs. Coloring of graphs. Graphs and codes.				
Total with regard to semester	**16**		**34**	**54**
Total with regard to the course	**16**		**34**	**54**

Topics of exemplary practical work

Sl. №	**Topic of practical work (seminars)**
1	Sets. Operations on sets.
2	Relations and their properties. Equivalence and order relations.
3	Algebra of propositions. Operations on statements.
4	Proof of the identities of the propositional algebra. Application of inference rules.
5	Construction of normal forms and perfect normal forms.
6	Zhegalkin's algebra. Checking the completeness of the system of logical functions.
7	Predicates and quantifiers.
8	Control work on mathematical logic.
9	Combinatorial compounds and their properties.
10	Counting the number of combinatorial connections.
11	Binomial theorem. Polynomial formula.
12	Control work on combinatorics.
13	Graphs. Graph operations. Addition. Isomorphic graphs.
14	Building an adjacency matrix and an incidence matrix. Control work.
15	A tree graph and its basic properties.
16	Determination of graph connectivity. Finding connectivity components. Planar graphs.
17	Graphs and codes.

Topics of exemplary laboratory practice

Sl. №	Topic of laboratory work

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 hold 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 students are recommended to fulfill the following positions:

1. Learning of the discipline should be done systematically.
2. After learning one of the course unit 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, laboratory works 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

Sl.№	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	
	Balakrishnan V. K. Introductory Discrete Mathematics. - New York: Dover, 1997.	
	Bobrow L. S. and Arbib M. A. Discrete Mathematics: Applied Algebra for Computer and Information Science. - Philadelphia, PA:	

	Saunders, 1974.	
	Dossey J. A., Otto A. D., Spence L. and Eynden C. V. Discrete Mathematics, 3rd ed. - MA: Addison-Wesley, 1997.	
	Hall C. and O'Donnell J. Discrete Mathematics Using a Computer. - London: Springer-Verlag, 2000.	
2. Additional literature		
2.1. Educational and scientific literature		
	Lipschutz S. and Lipson M. L. 2000 Solved Problems in Discrete Mathematics. - New York: McGraw-Hill, 1991.	
	Rosen K. Applications of Discrete Mathematics, 4th ed. - New York: McGraw-Hill, p. 1998.	
	Rosenstein J. G., Franzblau D. S. and Roberts F. S. Discrete Mathematics in the Schools. - Providence, RI: Amer. Math. Soc., 1997.	
2.2. Standardized and Technical literature		
	No provision	
3. Students' manual in mastering discipline		
	No provision	
4. Teaching and learning materials for students' self work		
	No provision	

6.2. Electronic Courseware

Kind of literature	Name of training tool	Reference to information resource	Accessibility of EBN (Internet/local net; authorized free assess)

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

Type of Software	Software branding
Operating system	Windows 10 (Azure Dev Tools for Teaching)
Office application	Adobe Acrobat Reader DC
Image processing software	Corel CorelDRAW Suite X4
General purpose application software	Mathematica Professional Version (license L3263-7820*)
General purpose application software	Microsoft Office Visio Professional 2016 (Azure Dev Tools for Teaching)
General purpose application software	WinRAR (license №879261.1493674)
Management systems for projects, research, development, design, modeling and implementation	Autodesk AutoCAD 2019 Education Multi-seat Stand-alone

6.4. Modern Professional Data bases and Inquiry Systems Used in the Course Educational Process

Branding	Reference to information resource
Scopus database	*https://www.scopus.com/*
Web of Science Database	*https://www.webofscience.com/*
Scientific electronic library database (eLIBRARY.RU)	*https://elibrary.ru/*
Scientific Library of the Perm National Research Polytechnic University	*https://lib.pstu/*
Lan Electronic Library System	*https://e.lanbook.com/*
Electronic library system IPRbooks	*https://www.iprbookshop.ru/*
Information resources of the Network ConsultantPlus	*https://www.consultant.ru/*
Company database EBSCO	*https://www.ebsco.com/*

7. Logistics of the Course Educational Process

Type of classes	Name of the necessary basic equipment	Number of units
Lecture	Projector	1

8. Fund of the Course Evaluating Tools
