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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ACADEMIC COURSE WORKING PROGRAM

Academic course: Materials Science
(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. GeneralProvisions

1.1.Goals and Objectives of the Course

To acquaint students with the properties and structure of the main classes of metallic and non-metallic materials; show the possibilities of controlling the properties and structure of materials based on knowledge of the patterns of structure formation.

1.2.Studied Objects of the Course

Materials used in industry; marking and material properties; methods of changing the structure and properties.

1.3. Starting Conditions

Unstipulated

2. Planned Results of the Course Training

Competence	Indicator's Index	Planned Result softhev Course Training (to know, to know how, to master)	Indicator of Attaining Competence which the planned results of training are correlated with	Means of Assess-ment
GPC-1.	**IA-1$_{gpc-1.}$**	**To know** principle features of modelling mathematical, physical and-chemical processes assigned for definite technological processes.	**Knows** the ways to solve problems related to professional activity, using methods of modeling, mathematical analysis, natural science and general engineering knowledge.	Test (Credit)
GPC-1.	**IA-2$_{gpc-1.}$**	**Is able to** use general-laws of the discipline soft mechanical-engineering module; to use general laws of natural-scientific disciplines, the rules of technical drafting and plotting.	**Is able to** solve problems relating to the professional activity, using simulation techniques of mathematical analysis, natural science and general engineering knowledge.	Practice report
GPC-1.	**IA-3$_{gpc-1.}$**	**Masters** basic procedures of technological and economic analysis, has the skill of drafting asa	**Masters** of solving problems related to profes-sional activity, using	Protecti ng laborato ry work

		member of creative team; partic ipates know ledgeably in the work a imedat production processes improv ementusing experimental data and result sofmodelling; masters business interaction with maintenance department and can estimate their recommendations taking into account experimental work of the enterprise technological department.	methods of modeling, mathematical analysis, natural science and general engineering know-ledge	

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.Contactclasswork, including:	45	45
- lectures (L)	16	16
- laboratory work (LW)	18	18
-practice, seminar sand/orother seminar-type work (PW)	9	9
- control of self-work (CSW)	2	2
- test		
1.2. Students' self-work (SSW)	63	63
2. Intermediate attestation		
Exam		
Grading test		
Test (Credit)	9	9
Course Project (CP)		
Course Work (CW)		
Workload in hours	**108**	**108**

4. Course outline

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
semester				
Properties of metals and alloys	2	4	2	12
The history and present day of materials science. The value and objectives of the discipline of materials science in the general curriculum. The structure of the course and a brief description of its main sections.				

Mechanical and consumer properties of metals and alloys. Technological properties: casting, workability by pressure, cutting, weldability. Operational properties. The concept of strength, ductility, toughness of metallic materials. Criteria for evaluating mechanical properties.				
The structure of metallic materials. Alloy theory.	4	5	2	13
The structure of metals. Amorphous and crystalline state. Metallic bond. Crystalline forms and polymorphism of metals. Imperfections of the crystal structure and their influence on the properties of metals. Formation of the structure of metals and alloys during crystallization. Crystallization from the standpoint of traditional metallurgy. Structure control factors (grain size and shape). Ingot defects. Amorphous metals. Plastic deformation. Recrystallization. Basic elements of the theory of alloys.				
Heat treatment of metallic materials	4	4	3	13
Theory and technology of heat treatment of steels. Chemical heat treatment of metallic materials. Basic laws of chemical heat treatment (CHT). Types of CHT. Practice of carburizing, nitriding, nitrocarburizing, diffusion metallization.				
Metallic materials	4	5	2	13
Structural and tool steels. Consumption structure of materials. Economic assessment of steels based on the composition and range of steels. Case hardened, tempered, spring, wear-resistant steels and alloys. Classification of tool materials. Requirements for materials, composition, structure, hardening treatment, properties and applications of materials. Steel for cutting tools. Special steel and non-ferrous alloys.				
Non-metallic and composite materials	2	0	0	12
Composite materials. Ceramics. The main types of non-metallic materials. Polymers: structure, properties, application. Plastics: thermoplastic, thermosetting, gas-filled. Rubber: obtaining properties. Glass: inorganic and organic, sitalls, metallic glasses. Polymorphic modifications of carbon. Nanomaterials and new carbon materials.				
Total with regard to semester	16	18	9	63
Total with regard to the course	16	18	9	63

Topics of exemplary practical work

Sl. №	**Topic of practical (seminar) work**
1	Marking of steels and alloys in Russia and in accordance with European standards
2	Determination of the parameters of the crystal structure of metals
3	Determination of hardenability and hardenability of machine-building steels

4	Determination of the optimal tempering temperature of hardened steel to obtain a given set of properties

Topics of exemplary laboratory practice

Sl. №	Topic of laboratory work
1	Measurement of the hardness of metals and alloys
2	Determination of the microstructure of Fe -C-alloys
3	Heat treatment of steels
4	Determination of the effect of heat treatment on the structure and properties of aluminum alloys

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 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 in memory the basic terms, definitions, notions of the unit.
3. Special attention should be paid to the reports on practical studies, laboratory works and individual complex tasks for self-work.
4. The topic of questions studied individually is given by the teacher at the lectures. Also the teacher refers to the literary resources (first of all, to the newly published in periodicals) in order the students understand the problems touched on the lectures in detail.

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		
1	Mercier J. P., Zambelli G., Kurz W. Introduction to materials science. - Elsevier, 2012.	electronic version
2	Rolf E. Understanding Materials Science: History, Properties. - Hummel, 2006	electronic version
2. Additional literature		
2.1. Educational and scientific literature		
1	Mitchell B.S. An introduction to Materials Engineering and Science for Chemical and Materials Engineers. Hoboken : Wiley-Interscience, 2004. 954 p.	1
2.2. Standardized and Technical literature		
1	Journal Metal Science and Heat Treatment	electronic version
2	Metallurgist	electronic version
3. Students' manual in mastering discipline		
	Not used	
4. Teaching and learning materials for students' self work		
	Not used	

6.2. Electronic Courseware

Kind of literature	Name of training tool	Reference to information resource	Accessibility of EBN (Internet/local net; authorized free assess)
Additional literature	Mercier J. P., Zambelli G., Kurz W. Introduction to materials science. - Elsevier, 2012.		Internet / free assess
Additional literature	Rolf E. Understanding Materials Science: History, Properties. - Hummel, 2006		Internet / free assess
Additional literature	Srinivasan R. Engg Materials And Metallurgy. – NewDelhi, 2010		Internet / free assess
Additional	W. A. Wood The Study of		Internet / free

literature Additional literature	Metal Structures and Their Mechanical Properties: Pergamon Unified Engineering. - Series Elsevier, 2014		assess

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

Type of Software	Software branding
	Not required

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

Branding	Reference to information resource
Scientific Library of the Perm National Research Polytechnic University	http://lib.pstu.ru/
Elsevier	https://elsevierscience.ru/
Electronic library system IPRbooks	http://www.iprbookshop.ru/

7. Logistics of the Course Educational Process

Type of classes	Name of the necessary basic equipment	Number of units
Laboratory work	Microscopes MIM-7	
Laboratory work	Heating furnaces, Rockwell hardness tester, Brinell hardness tester	
Lectures	Projector	
Practice, seminar sand/orother seminar-type work	Projector	

8. Fund of the Course Evaluating Tools

Will be presented in a separate document