National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Department of Biomedical Engineering

Materials Science and Construction Materials

Syllabus of the academic discipline (Syllabus)

Educational requirements disciplines

Level of higher education	***First (bachelor's)***
Branch of knowledge	*16 Chemical and Bioengineering*
Specialty	*163 Biomedical Engineering*
Educational program	*163B MI - Medical Engineering (EDEBO id: 28920); 163B RBI - Regenerative and Biopharmaceutical Engineering (EDEBO id: 32311);163B MI+ - Medical Engineering (EDEBO id: 58753); 163B RBFI+ - Regenerative and Biopharmaceutical Engineering (EDEBO id: 58754)*
Discipline status	*Regulatory*
Form of study	*Full-time (day)*
Year of training, semester	*2nd year, fall semester*
Scope of the discipline	*4 Cred. ECTS (120 hours) (Lectures 36 hours, Practice 36 hours, SRS 48 hours)*
Semester control/control measures	*Final tests, MCW, essay*
Class schedule	*Lectures – every week, practical classes – every week, https://schedule.kpi.ua*
Language of instruction	*Ukrainian / English*
Information about the course leader/teachers	*Lecturer: Candidate of Physical and Mathematical Sciences, Associate Professor, Solomin Andriy Vyacheslavovich, a.solomin@kpi.ua ; andr-sol@i.ua* *Practical: : Candidate of Physical and Mathematical Sciences, Associate Professor, Solomin Andriy Vyacheslavovich, a.solomin@kpi.ua ; andr-sol@i.ua*
Course placement	*https://do.ipo.kpi.ua/course/view.php?id=8041*

Training program disciplines

1. Description of the academic discipline, its purpose, subject of study and results teaching

The academic discipline "Materials Science and Construction Materials" studies:

- the relationship between the composition, structure and properties of materials;
- phase transformations, thermal effects, surface phenomena, other factors affecting the basic properties of materials;
- basics of thermal, chemical-thermal treatment and other methods of strengthening materials;
- patterns of changes in the properties of materials under external physical and chemical influences; nomenclature of construction materials used in the field of biomedical engineering;
- theoretical foundations of creating new materials with specified properties.

While studying the discipline, students acquire skills and experience in the practical application of knowledge in materials science for the informed choice of construction materials with predetermined properties, taking into account the conditions of their processing and operation.

The purpose of the academic discipline is to develop students' competencies in accordance with the educational and professional program "Medical engineering.

According to the educational and professional programs (EPP) of the first "bachelor's" level of

higher education, after studying the discipline, students must acquire the following **competencies:**

IC - The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms.

PC 5 - Ability to apply physical, chemical, biological, and mathematical methods in the analysis and modeling of the functioning of living organisms and biotechnical systems.

PC 6 - Ability to effectively use tools and methods for analysis, design, calculation, and testing in the development of biomedical products and services.

PC 8 - Ability to conduct research and observation on the interaction of biological, natural, and
artificial systems (prostheses, artificial organs, etc.).

According to the EPP, as a result of mastering the academic discipline, students must demonstrate the following program learning outcomes:

PLO 1 - The ability to apply knowledge of the fundamentals of mathematics, physics and biophysics, bioengineering, chemistry, engineering graphics, mechanics, materials resistance and strength, properties of gases and liquids, electronics, computer science, signal and image acquisition and analysis, automatic control, system analysis, and decision-making methods at a level necessary for solving biomedical engineering tasks.

PLO 9 - Understand theoretical and practical approaches to the creation and application of artificial biological and biotechnical objects and materials for medical purposes.

PLO 11 - Conduct quality control and operational monitoring of medical equipment and
materials for medical purposes, artificial organs, and prostheses.

PLO 15 - Select and recommend appropriate medical equipment and biomaterials for equipping medical institutions and ensuring the main stages of the technological process of diagnosis, prevention, and treatment.

PLO 19 – Proficiency in engineering methods for calculating components of medical devices and systems, modern methods for experimental verification of integrity and functionality of biotechnical systems and determination of their characteristics, methods for selecting conventional and advanced construction materials, as well as tools for designing devices, instruments, and systems for medical and biological purposes.

PLO 22 – Knowledge of general principles and structure of complex biological systems, including the human body and its functions from the perspective of a systemic approach and their utilization in biomedical engineering, as well as basic methods and tools used for quantitative assessment of physiological system functioning.

2. Prerequisites and postrequisites of the discipline (place in the structural and logical scheme of study according to the relevant educational program)

In the structural and logical schemes of educational and professional programs for training a specialist of the first (bachelor's) level of higher education, the academic discipline "Materials Science and Construction Materials" is included in the list of normative disciplines of the professional training cycle aimed at the formation of professional competencies of a specialist.

Prerequisites - the academic discipline is taught in the 3rd semester of the 2nd year of study in the first (bachelor's) level of higher education and is based on knowledge of Physics and Biochemistry.

Post-requisites - theoretical knowledge and practical skills obtained during the study of the academic discipline "Materials Science and Construction Materials" can be used in the future when mastering the academic disciplines "Mechanics and Biomechanics", "Biophysics", "Biomaterials and Biocompatibility" and in further practical work in the specialty.

3. Course content

Section 1. Fundamentals of Metallurgy

Topic 1.1. Atomic and Crystalline Structure of metals and their

properties.

Topic 1.2. Metal alloys. Phase diagrams of binary systems.

Topic 1.3. Iron and its alloys. Iron-carbon phase diagram.

Section 2. Fundamentals of Heat Treatment of metals and alloys

Topic 2.1 Theory of heat treatment. Transformations during heat treatment of

steel.

Topic 2.2. Surface hardening of metals and alloys.

Section 3. Construction materials – classification, properties, purpose

Topic 3.1. Alloy steels.

Topic 3.2. Metals and alloys with special properties.

Topic 3.3. Non-ferrous metals and alloys based on them.

Topic 3.4. Composite materials.

Topic 3.5. Non-metallic construction materials.

4. Educational materials and resource

To prepare for lectures and practical classes, modular tests, individual assignments (essays), independent work, etc., basic and additional literature (hereinafter referred to as literature) is used. The literature that must be used to master the discipline is studied by students independently using Internet resources. In distance learning, you can prepare using the literature posted in electronic form on the Sikorsky platform, the course "Materials Science and Construction Materials".

Basic literature

1. Технологія конструкційних матеріалів та матеріалознавство, розділ Матеріалознавство: Навчальний посібник / Л.Г. Бодрова, Г.М. Крамар, Я.О. Ковальчук, І.В. Коваль – Тернопіль: ФОП Паляниця В.А., 2023. – 157 с. - Назва з екрана. https://elartu.tntu.edu.ua/handle/lib/41575
2. Матеріалознавство та конструкційні матеріали. Конспект лекцій [Електронний ресурс] : навчально-методична праця для здобувачів ступеня бакалавра за спеціальністю 163 Біомедична інженерія / КПІ ім. Ігоря Сікорського ; уклад.: Л. Д. Тарасова. – Електронні текстові дані (1 файл: 3,41 Мбайт). - Київ : КПІ ім. Ігоря Сікорського, 2021. - 201 с. - Назва з екрана. https://ela.kpi.ua/handle/123456789/68765
3. Матеріалознавство та конструкційні матеріали. Практикум [Електронний ресурс] : навчальний посібник для здобувачів ступеня бакалавра за освітніми програмами «Медична інженерія», «Регенеративна та біофармацевтична інженерія» спеціальності 163 «Біомедична інженерія» / Л. Д. Тарасова ; КПІ ім. Ігоря Сікорського. – Електронні

текстові дані (1 файл: 2,53 Мбайт). – Київ : КПІ ім. Ігоря Сікорського, 2022. – 143 с. – Назва з екрана. https://ela.kpi.ua/handle/123456789/48262
4. Матеріалознавство: навч. посіб. / В.І. Бузило, В.П. Сердюк, А.В. Яворський, О.А. Гайдай / М-во освіти і науки України, Нац. техн. ун-т «Дніпровська політехніка» – Дніпро: НТУ «ДП», 2021. – 243 с. – Назва з екрана. https://ir.nmu.org.ua/entities/publication/9cbea2d3-7e9a-4c9f-9783-d9e16f0e0fd3
5. Основи матеріалознавства. Частина 2. Метали та сплави. Неметалеві матеріали. Конспект лекцій для студентів хімічного факультету / Укладачі: Юрченко О.М., Кормош Ж.О., Парасюк О.В. – Луцьк: Вежа-друк, 2018. – 56 с. – Назва з екрана. https://evnuir.vnu.edu.ua/bitstream/123456789/18410/1/materialozn_2.pdf
6. Матеріалознавство та конструкційні матеріали. Практикум [Електронний ресурс] : навч. посіб. для студ. спеціальності 163 «Біомедична інженерія», для всіх спеціалізацій / І. Ю. Худецький, К. В. Ляпіна, Ю. В. Антонова-Рафі; КПІ ім. Ігоря Сікорського. – Електронні текстові данні (1 файл: 6,19 Мбайт). – Київ : КПІ ім. Ігоря Сікорського, 2018. – 147 с. – Назва з екрана. https://ela.kpi.ua/items/91a29a11-4598-4403-8970-e42af9e1ae3a
7. Афанасьєва О.В. Матеріалознавство та конструкційні матеріали. Навч. посібник. – Харків: ХНУРЕ, 2016. – 188 с. – Назва з екрана. https://openarchive.nure.ua/entities/publication/c5a109b2-5c47-427d-9374-c3d8baf27f83
8. Марочник сталі та сплавів. Режим доступу: http://www.splav-kharkov.com/choose_type.php
9. Callister, William D. Materials Science and Engineering: an introduction / William D. Callister, Jr., David G. Rethwisch – 8th ed. Copyright 2014, John Wiley & Sons, Inc. Режим доступу: https://www.academia.edu/34295998/Materials_Science_by_D_Callister
10. Steimel, Joshua P., Materials Science and Engineering (2019). Pacific Open Texts. 8. Режим доступу: https://scholarlycommons.pacific.edu/open-textbooks/8

Additional literature

1. Методичні вказівки до виконання практичних робіт з дисципліни «Фізичне матеріалознавство» для здобувачів першого (бакалаврського) рівня вищої освіти зі спеціальності 104 Фізика та астрономія всіх форм навчання / Укл.: Лисенко О.Б, Калініна Т.В. Кам'янське, ДДТУ, 2019 - 64с.
2. Шаповал С. В. Конспект лекцій з дисципліни «Матеріалознавство» (для студентів 2 курсу денної форми навчання освітнього рівня «бакалавр» спеціальності 185 – Нафтогазова інженерія та технології) / С. В. Шаповал ; Харків. нац. ун-т міськ. госп-ва ім. О. М. Бекетова. – Харків : ХНУМГ ім. О. М. Бекетова, 2017. – 122 с.
3. Кшнякін В. С. Основи фізичного матеріалознавства : навч. посіб. : у 2 ч. / В.С. Кшнякін, А. С. Опанасюк, К. О. Дядюра. – Суми : Сумський державний університет, 2015. – Ч. 2. – 291 с. ISBN 978-966-657-586-2, ISBN 978-966-657-588-6.
4. Афтанділянц Є. Г., Зазимко О. В., Лопатько К. Г. Матеріалознавство: Підручник. К.: Вища освіта, 2012.- с 548.

Educational content

5. Methodology for mastering an academic discipline (educational component)

To study the discipline, 18 lectures and 18 practical classes (PC) are planned, during which modular tests and assessments are planned.
The following teaching methods are used when studying the educational material:
Lectures are held using the explanatory and illustrative method, the problem-based presentation method, and the interactive method, which is used to establish a dialogue with the audience.

Practical classes are held using:
1) A reproductive method, thanks to which students consolidate the studied theoretical material and learn to use it in specific situations tasks.
2) Partial search, or heuristic method, which teaches how to find the right paths and methods of solving problems tasks.
3) An interactive method used during practical classes to involve students in the problem-

solving processes and the theoretical facts used for this.
4) Presentation and discussion of the results involves the use of problem-based and interactive methods teaching.

Below is the distribution of classroom hours by course topics and the calendar of their implementation.

Chapter and topic names	Lectures		Practical classes		ISW	Assessment of practical classes (PC)
	Weekly teaching	Hours	Weekly teaching	Hours	Hours	
Chapter 1. Fundamentals of Metallurgy						
Topic 1.1. Atomic-crystalline structure of metals and their properties.	1-4	8	1-5	10	6	PC 1- PC 4
Topic 1.2. Metal alloys. Phase diagrams of binary systems.	5-6	4	6-8	6	3	PC 5 – PC 6
Topic 1.3. Iron and its alloys. Iron-carbon phase diagram.	7-8	4	9-10	4	2	PC 7
Chapter 2. Fundamentals of heat treatment of metals and alloys						
Topic 2.1 Theory of heat treatment. Transformations during heat treatment of steel.	9-10	4	11	2	2	PC 8
Topic 2.2. Surface hardening metals and alloys.	11	2	12	2	2	PC 9
Section 3. Structural materials – classification, properties, purpose						
Topic 3.1. Alloy steels.	12	2	13	2	2	PC 10
Topic 3.2. Metals and alloys with special properties.	13	2	14	2	2	PC 11
Topic 3.3. Non-ferrous metals and alloys.	14-15	4	15-16	4	3	PC 12-PC 13
Topic 3.4. Composite materials	16	2	17	2	2	PC 14
Topic 3.5. Non-metallic structural materials.	17-18	4			1	
Modular test work			18	2	2	MTW
Essay			16-18		15	Essay
Test			19	(2)	6	
Total hours		**36**		**36**	48	

The correspondence of teaching and assessment methods is reflected in the rating system of assessment, which includes: defense of reports from practical classes, modular test work, essay, and final test.

Recommendations for mastering the training sessions (in the form of a detailed description of each session and planned work):

5.1. Lectures classes

List of didactic aids for lectures: Lecture notes, projection multimedia equipment; Power Point presentation, methodological materials on the Sikorsky platform (Moodle); for distance learning, the Zoom platform.

No. salary	Title of the lecture topic and list of main questions (*list of didactic aids, tasks for the SRS with references to literature*)	Number of hours
Chapter 1. Fundamentals of Metallurgy		
Topic 1.1. Atomic and crystalline structure of metals and their properties.		
1	**The role of materials in modern technology. Classification of materials. Atomic-crystalline structure of metals.** The concept of materials science as a science. The role of domestic and foreign scientists in the development of materials science. Factors	**2**

	influencing the choice of materials. Operating conditions of biomedical equipment. The importance of using the basics of resistance and strength of materials to solve biomedical engineering problems. Physical and mathematical methods in the analysis and modeling of the functioning of biotechnical systems. General characteristics of metals. Crystalline structure of metals. Types of unit cells, their quantitative characteristics. Temperature polymorphism of metals. Basic parameters of crystal lattices: coordination number, compactness coefficient, indices of planes and directions. Anisotropy of crystals. **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of literary sources [2, Lecture 1]	
2	**Crystalline structure defects.** Classification of defects. Characteristics of point defects (vacancies, interstitial atoms, Frenkel and Schottky defects, substitutional and penetration impurity atoms). Linear defects (edge and screw dislocations, Burgers vector, dislocation density). Surface defects (interfaces between individual grains or subgrains in a polycrystalline metal). Volumetric defects (clusters of point defects that form pores, inclusions of another phase). Slip planes. Influence of crystal lattice defects on crystal strength. **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of literary sources [2, Lecture 2 ; 1, Topic 1]	**2**
3	**Plastic deformation and recrystallization.** The mechanism of plastic deformation and its effect on the micro-, submicrostructure and dislocation density. The relationship between the main characteristics of the structure and mechanical properties. The essence of the phenomenon of hardening and its practical use. The effect of heating on the structure and properties of the deformed metal. The essence of the processes of restoration, primary and secondary recrystallization. Cold and hot plastic deformation. Recrystallization annealing and its purpose. optoelectronic devices. **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of literary sources [2, Lecture 4 ; 1, Topic 4]	**2**
4	**Mechanical properties of materials and methods for their determination.** Deformations and stresses. Hooke's law, the limits of its application. Standard mechanical properties. Characteristics determined during tension. Analysis of conditional and working diagrams. Strain energy. Hardness and methods for its determination (Brinell, Rockwell, Vickers method). Safety margin. Impact strength, fatigue resistance. Tools and methods for analysis, design, calculation and testing in the development of biomedical products and services related to the selection, preparation and operation of materials. Principles of the structure of complex biological systems, including the human body and its functions from the standpoint of a systems approach based on materials science and their use in biomedical engineering. Engineering methods for calculating elements of medical devices and systems, testing the experimental integrity and operability of biotechnical systems and determining their characteristics, selecting classical and modern structural materials, and designing devices, instruments and systems for medical and biological purposes. **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of literary sources [2, Lecture 3; 1, Topic 5,6]	**2**
Topic 1.2. Metal alloys. Phase diagrams of binary systems		
5	**Alloy phase diagrams.** Alloy, system, component, phase. Gibbs phase rule. Types of interaction of alloy components. Solid solutions of substitution and penetration. Thermodynamic foundations of phase transformations of metals. Crystallization process.	**2**

	Construction of alloy phase diagrams.. Rule of segments - determination of the composition and amount of each phase. Main types of alloy phase diagrams: I, II, III, IU type. Relationship between the type of alloy phase diagram and the properties of alloys according to M.S. Kurnakov. **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of literary sources [2, Lecture 5,6]	
6	**State diagrams of iron-cementite Fe-Fe $_{with}$ C. Phase composition, structural components of iron-carbon alloys and their properties. Main phases of iron -** carbon alloys: ferrite, austenite, cementite, pearlite, ledeburite, graphite. Characteristic points of the diagram. Microstructures of iron-carbon alloys. Morphological forms of graphite **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of literary sources [2, Lecture 7,8; 5, 4.1, 4.2]	**2**
	Topic 1.3. Iron and its alloys. Iron-carbon phase diagram.	
7	**Carbon steels.** Composition of carbon steels, structure and properties depending on the content of permanent impurities. Classification and marking of carbon steels by production method; by carbon content; by quality. Steels of ordinary quality (groups A, B, C); high-quality carbon steels (S < 0.04%, P < 0.04%) and high-quality steels (S and P < 0.03%), their use. Classification of steels by the method of shaping and sizing - cast, forged, rolled; by structure - hypoeutectoid (ferrite + pearlite), eutectoid (pearlite), hypereutectoid (pearlite + cementite); by purpose - structural (up to 0.7% C), tool (0.7-1.35% C), free-cutting and boiler steels. Carbon tool steels, their marking and purpose. **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of literary sources [2, Lecture 9; 1, Topic 8]	**2**
8	**Machine-building cast irons. Structure, properties and use.** White, gray, malleable, high-strength cast irons. Their microstructure and forms of graphite. Dependence of mechanical characteristics of cast irons on the shape, size, quantity and natu of the location of graphite inclusions. Modification of cast iron. Transformations occurring dur the graphitization of cast iron. The influence of impurities and cooling rate on the structure a properties of cast iron. Classification, marking and purpose of machine-building cast irons. Alloyed cast irons (corrosion-resistant, heat-resistant and heat-resistant, wear-resistant, non-magnetic and others), their purpose. **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of literary sources [2, Lecture 12; 1, Topic 10]	**2**
	Chapter 2. Fundamentals of heat treatment of metals and alloys	
	Topic 2.1 Theory of heat treatment. Transformations during heat treatment of steel.	
9	**Technological processes of heat treatment.** Annealing of the first type and its varieties (recrystallization, homogenization (diffusion, etc.). Annealing of the second type. Complete, incomplete, spheroidizing, isothermal and normalizing annealing. Quenching and its types. Hardening, quenching (annealing) of steels. Quenching methods. Tempering low, medium, high. Aging and its types. Heat treatment of cast iron. **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of	**2**

	literary sources [2, Lecture 10; 1, Topic 11]	
10	**Theory of heat treatment of steel.** Fundamentals of the theory of heat treatment of steel. Phase transformations and basic structures during heating and cooling of steel. Transformation of pearlite into austenite and austenite into pearlite. Transformation of austenite into martensite. Effect of heating on the structure and properties of deformed metal. Tempering, recovery, polygonization, recrystallization. **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of literary sources [2, Lecture 10; 1, Topic 11; 5, 4.5]	**2**
Topic 2.2. Surface hardening of metals and alloys		
11	**Chemical-thermal treatment (CHT) of steel.** Technological processes of CHT: dissociation, adsorption (sorption), diffusion. Cementation. Mechanism of formation and structure of the cemented layer. Cementation with a solid carburizer. Gas cementation. Heat treatment of steel after cementation and properties of cemented parts. Nitriding. Mechanism of formation of the nitrided layer. Steels for nitriding. Technology of the nitriding process. Nitrocementation. Cyaniding. Boriding. Diffusion metallization. Chemical-thermal treatment of cast iron. **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of literary sources [2, Lecture 10; 1, Topic 12; 5, 4.5]	**2**
Section 3. Structural materials – classification, properties, purpose		
Topic 3.1. Alloy steels		
12	**Structural and tool alloy steels.** The influence of alloying elements on critical points, structure and properties of steels. Classification of alloy steels. Structural alloy steels. Areas of use of structural steels. Steel products. Marking of structural steels. Classification and marking of tool steels depending on the purpose: for cutting tools (high-speed cutting); for measuring tools; stamping steels for cold deformation; stamping steels for hot deformation; hard alloys. Operational properties of tool steels. **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of literary sources [2, Lecture 13; 1, Topic 13]	**2**
Topic 3.2. Metals and alloys with special properties		
13	**Metals and alloys with special properties.** Corrosion-resistant steels, their properties, structure, use. Types of corrosion failure. Heat-resistant and heat-resistant steels and alloys. Methods of their processing and application. Magnetic steels and alloys. Alloys with a given temperature coefficient of linear expansion. Steels and alloys with special elastic properties. Refractory metals and their alloys, characteristics, properties and areas of application. Materials for medical and biological purposes. Steel marking. Prospects for the development and creation of new materials. Laser doping with chromium/nitrogen atoms. Radiation-resistant materials. Modern nanomaterials and nanotechnologies. **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of literary sources [2, Lecture 13; 5, 6.1-6.4]	**2**
Topic 3.3. Non-ferrous metals and alloys		
14	**Non-ferrous metals and their alloys. Copper and nickel-based alloys. Alloys with special electrophysical properties.** Copper and its alloys. Classification of copper	**2**

	alloys, their composition, marking system, properties and areas of application. Mechanical properties of copper and brasses. Permissible loads on copper alloys depending on the operating temperature. Bronzes. Mechanical properties of some bronzes and their use. Heat-resistant copper alloys and their purpose. Nickel and its alloys. Purpose, grades and physicomechanical properties of nickel and its alloys. Alloys for thermocouples, their characteristics. Alloys for electric heaters, their physicomechanical properties. Materials for medical and biological purposes. **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of literary sources [2, Lecture 14; 1, Topic 16; 5, 5.1]	
15	**Non-ferrous metals and their alloys. Alloys based on aluminum, magnesium, titanium.** Basic properties of aluminum. Classification of aluminum alloys (deformed, cast, sintered). Thermally non-hardenable and thermally hardenable alloys, their properties, marking, purpose. Technological methods for manufacturing products from alloys of each group. Areas of use of deformed and cast magnesium alloys. General characteristics of titanium. Allotropic modifications of titanium. Influence of alloying elements and impurities on the mechanical properties of titanium. Heat treatment of titanium alloys. Marking system and areas of use **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of literary sources [2, Lecture 15; 1, Topic 15; 5, 5.2]	**2**
	Topic 3.4. Composite materials	
16	**Composite materials.** The concept of composite materials (CM). Structure and classification of CM. Composite materials with a metal matrix based on aluminum, magnesium, titanium, nickel - their properties and applications. Antifrictional CM based on lead, reinforced with stainless steel or tin bronze wire. Dispersion-reinforced CM - their properties and applications. CM with a polymer matrix reinforced with fiber. Types of reinforcing fibers and polymer binders. Reinforcement schemes. Ceramic composite materials. Pseudoalloys, their properties and applications. **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of literary sources [2, Lecture 16; 5, 7.1]	**2**
	Topic 3.5. Non-metallic structural materials.	
17	**Non-metallic structural materials. Plastics.** Classification of plastics by purpose. Physical and mechanical properties and areas of application of thermoplastic plastics (thermoplastics). Characteristics of the most common thermoplastics based on polyethylene, polypropylene, fluoroplastics, polyamide, organic glass. The aging process of plastics. Foams. Thermosetting plastics (thermoplastics). Classification of thermosetting plastics by the form of fillers. Powdered, fibrous and layered thermosetting plastics. **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of literary sources [2, Lecture 17,18; 1, Topic 17; 5, 7.3]	**2**
18	**Other non-metallic structural materials.** Rubber engineering materials. General information. Main ingredients of rubber mixture. Mechanical properties of rubbers. General and special-purpose rubbers, their characteristics and areas of	**2**

	use. Adhesives and their composition. Classification of adhesives by type of base. Sealants and their classification. Features of the application of adhesives and sealants. Inorganic glass. Mechanical and physical properties of glass and methods of its strengthening. Main types of inorganic glass (quartz, shatterproof, electrically conductive, foam glass, glass fiber) and areas of its application. Sieves. Types of technical ceramics and features of its application. Research and observation using materials science methods on the interaction of biological, natural and artificial systems, in particular in prosthetics, engineering of artificial organs. Theoretical and practical approaches to the creation and application of artificial biological and biotechnical objects and medical materials. Quality control and operating conditions of medical equipment and medical materials, artificial organs and prostheses. Practical approaches to the selection and recommendations for appropriate medical equipment and biomaterials for equipping medical institutions and ensuring the main stages of the technological process of diagnostics, prevention and treatment. **List of teaching aids:** Lecture notes; projection multimedia equipment; Power presentation Point, methodological materials on the Sikorsky platform (Moodle); for distance learning - the Zoom platform. **Tasks for the CTC:** 1. Review the lecture material, prepare for practical classes on these sections, study of literary sources [2, Lecture 17,18; 5, 7.3-7.4]	
Total		**36**

5.2. Practical classes

Topics of practical classes (PC)

1. Crystalline structure of metals and alloys.
2. Indexing of nodes, directions, and planes in crystal lattices.
3. Reticular, linear and planar density of crystal structures.
4. Mechanical properties materials.
5. Plastic deformation and strengthening mechanisms.
6. Quantitative composition of metal alloys.
7. A phase diagram of a system whose components form a continuous series of liquid and solid solutions.
8. State diagram of a system with no mutual solubility of components in the solid state.
9. State diagrams of a system with limited solubility of components in the solid state.
10. State diagram of the iron-cementite system.
11. Diffusion processes during chemical-thermal treatment steel.
12. Kinetics of phase transformations.
13. Thermophysical properties of construction materials.
14. Electrical conductivity of metals.
15. Modular test work.

Distance learning platform

For better assimilation of the material of the academic discipline during the period of remote work, e-mail, chat groups in Telegram and WhatsApp messengers, the distance learning platform "Sikorsky" and ZOOM are used, with which you can:

- the placement of methodological recommendations, educational materials, literature, etc. is simplified;
- feedback is provided to students regarding learning tasks and content academic discipline;
- completed tasks are checked and evaluated;
- Records are kept of students' implementation of the academic discipline plan, adherence to the

schedule for submitting academic/individual assignments and their evaluation.

6. Independent work student (self-study, ISW)

Independent work (ISW) involves: preparation for lectures and practical classes, completion of tasks on the topic of practical classes, preparation for modular tests, essays, and tests.

6.1. *Preparation for lectures and practical classes*. To prepare for lectures and practical classes, the student must study the planned basic and auxiliary literature, recommended sources and prepare material for discussion in class. The student is allocated 11 hours for this IW.

6.2. *Completion of tasks on the topic of practical classes*. 14 hours of independent work are allocated for performing calculations and preparing the results of the practical classes.

6.3. *Modular test work*. On preparation to MCW is given 2 hours IW.

6.4. *Essay*. On preparation and design essay 15 hours IW is given. The student must select essay topic and approve from the teacher no later than 4 weeks from the beginning of the academic semester. Terms presentation essay to the teacher not later 17th week. Essay protection planned for an unscheduled session from 16 to 18 weeks.

6.5. *Credit*. Credit is taken during the credit session, after completing the practical classes, modular test work and defending an individual task (essay). Based on the results of the rating points scored for the semester, the applicant receives credit without additional tests, if the sum of the points scored is not less than 60. Applicants who have fulfilled all the conditions for admission to the credit and have rating points from 31 to 59, or wish to improve their result, take a credit test or undergo an interview on credit questions. 6 hours of IW are allocated for preparation for the credit. In terms of distance learning, credit can be taken according to the schedule using the platform for conducting online conferences Zoom.

No.	Types of independent work	Number hours
1	Preparation for lectures and practical classes	11
2	Completion of tasks on the topic of practical classes	14
3	Preparation for the modular test work	2
4	Writing an essay	15
5	Test	6
Together		**48**

Approximate topics of essays

1. Modern methods macrostructural analysis metals and alloys.
2. Research methods macrostructures.
3. Microstructure research methods. The influence of pore size and shape on properties materials.
4. Linear defects in the crystal structure of metals. Edge and screw dislocations. Burgers vector. Formation dislocations and their reproduction. Movement and interaction dislocations.
5. Carbon construction steels. Marking, properties and application.
6. Heat treatment (HT) of carbon steels. Main types of heat treatment. Hardening methods steels.
7. Surface hardening steels.
8. Diffusion mechanisms in metals and alloys. Exchange, cyclic, interstitial, vacancy mechanisms. Conditions for the implementation of the mechanism diffusion.
9. Types of chemical-thermal treatment, their essence and appointment.
10. Means of protecting metals and alloys from corrosion.
11. Corrosion-resistant steels. Electrochemical corrosion. Corrosion-resistant passivating metals. Corrosion-resistant non-passivating metals.

12. Heat-resistant steels. Chemical corrosion. Heat resistance of metals. Criteria for heat resistance of materials. Main groups of heat-resistant materials.
13. Construction strength of materials and criteria for its assessment. Strength criteria. Reliability. KCV and KCT parameters. Durability. Cyclic durability.
14. Aluminum, its alloys, marking, properties and application.
15. Copper, its alloys, marking, properties and application.
16. Antifriction materials. Structure, chemical composition, properties, labeling.
17. Shape memory alloys. Properties, application.
18. Electrical conductivity of metals. Properties of conductors. High conductivity materials. Superconductors and cryoconductors.
19. Fullerenes: characteristics, properties and application.
20. Structure and physicochemical properties of fullerenes. Prospects for use in biomedicine engineering.
21. Carbon nanotubes their obtaining and properties.
22. Construction features of thermoplastic and thermosetting polymers. Their advantages, disadvantages and industries application.
23. Mechanical testing of plastics. Tests on stretching.
24. Mechanical testing of plastics. Conditions for conducting static tests bend.
25. Conditions for conducting dynamic strength tests of plastics. Determination of impact strength.
26. Determination of the hardness of plastics. Empirical relationships between hardness and the modulus of elasticity in compression, the value of Poisson's ratio, the yield strength, the breaking tension.
27. Polymeric materials with shape memory effect. Properties, application.
28. Principles of construction of composite materials, their classification.
29. Methods assessments warehouse and structures composite materials.
30. Processes of forming the structure of thermal insulation materials.
31. Composite materials on metal basis.
32. Polymer composite fillers materials.
33. Fiberglass: properties, technical specifications, application.
34. Carbon fiber: properties, technical specifications, application.
35. Mechanical strength of glass. Griffiths strength theory. Static strength theory. Factors determining strength glass.
36. Methods strengthening glass: digestion surfaces, ionic exchange, thermal processing.
37. Glass ceramics (sitals). Composition, structure, physical and mechanical properties, application in biomedical engineering.
38. Ceramic materials. Influence of phase composition on mechanical properties properties.
39. The main characteristics of rubber sealants, their composition, properties, advantages, disadvantages, application.
40. Nanostructures and nanomaterials. Main types of nanomaterials, their physicochemical and pharmacological properties properties.
41. Modern instrumental methods for analyzing medical materials appointment.

Politics and Control

7. Academic discipline policy (educational component)

7.1. Incentives points

Incentive points	
Criterion	Weighted score
Taking additional distance learning courses on topics that are agreed with teacher	5 points
Preparation of scientific work for participation in the student research paper competition	10 points

Writing theses, articles, participation in international, all-Ukrainian and/or other events or competitions on the subject of the academic discipline	5 points

However, according to position https://osvita.kpi.ua/node/37 clause 2.7, sum encouraging points not may exceed 10% of the rating scales

7.2. Visiting rules classes

Attendance at lectures is not mandatory. Attendance at practical classes is desirable, as they briefly explain theoretical material, assess the level of its assimilation during an oral interview, develop skills and abilities necessary for completing tasks. The assessment system is focused on obtaining points for the student's professional activity in defending reports on practical work, as well as completing tasks that are capable of developing practical skills.

7.3. Rules for performing individual task

The main goal of the essay is to deepen and expand students' theoretical knowledge on individual topics of the academic discipline, to gain experience in independent work with educational and scientific literature. A student can write an essay only on a topic agreed upon with the teacher. The essay is written in the form of an analytical review of modern sources on a given topic and with a focus on aspects that are subject to further study. Each applicant has a separate essay topic.

The title page of the essay should have the following content: name of the university; name of the faculty; name of the department; name of the specialty, name of the educational and professional program, name of the academic discipline; topic of the essay; surname and first name of the student, course, academic group number, year.

The title page is followed by a detailed plan (table of contents) of the essay, which should include an introduction, sections of the main content (the main topics that will be considered), their subdivisions (if necessary), a conclusion, and a list of sources used. The table of contents indicates the page numbers of the beginning of each question on the right. Each section begins with a new page.

The total length of the essay, depending on the chosen topic, can vary from 15 to 30 pages of the main text (as agreed with the teacher). The length of the essay is determined by the student's ability to concisely and at the same time comprehensively explain and analyze the information learned.

The essay is evaluated according to the following criteria: logical presentation of the material; completeness and depth of disclosure of the topic; compliance with the requirements for design; presence of all necessary structural elements; substantiation of the student's own opinion regarding the content and relevance of the topic.

Deadline for submitting an essay for review: 16-18th week of study. The essay defense is held in weeks 16-18.

The essay is not checked for plagiarism, but must meet the requirements of academic integrity. If academic dishonesty is detected, the work is canceled and not checked.

7.4. Deadline policy and rearrangements

Practical work submitted for review after the deadline and after the deadline of current certifications (or credit), not are evaluated.

Skipping the module test is not is being worked out.

An essay submitted for review with a significant violation of the deadline will not be accepted and will not be evaluated.

7.5. Procedure for appealing test results events

Students have the opportunity to raise any issue related to the procedure of control measures and expect that it will be considered in accordance with predetermined procedures. The student has the right to appeal the results of the control measure in accordance with the approved regulation On appeals at Igor Sikorsky Kyiv Polytechnic Institute (approved by order No. HOH/128/2021 dated 20.05.2021) - https://osvita.kpi.ua/index.php/node/182

7.6. Remote teaching

Distance learning takes place through the Distance Learning Platform "Sikorsky" training.

Distance learning through additional online courses on a specific topic is permitted subject to agreement with students. If a small number of students wish to take an online course on a specific topic, studying the material through such courses is permitted, but students must complete all tasks provided for in the curriculum discipline.

The list of courses is offered by the teacher after students express their desire (since the bank of available courses is updated almost every monthly).

The student provides a document confirming completion of the distance learning course (in the case of completing the full course) or provides completed assignments from the distance learning course and, subject to passing an oral interview with the teacher on the topics covered, may receive grades for the control measures provided for the topics studied (express control / test tasks).

Practical classes, as well as writing an essay, are carried out during independent work of students in remote mode (with the possibility of consulting with the teacher via email, social networks).

7.7. Studying in a foreign language

Teaching in English is carried out only for foreign students. At the request of students, it is allowed to study the material using English-language online courses on topics that correspond to the topics of specific classes.

7.8. Politics at the university

Academic virtue

Policy and principles academic virtue defined in section 3 of the Code honor National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". More details: https://kpi.ua/code

Norms of ethical behavior

The norms of ethical behavior of students and employees are defined in Section 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute ". More details: https://kpi.ua/code

8. Types of control and rating system for assessing learning outcomes (RSA)

Current control: is carried out under time educational classes and has on goals verify the level of students' preparation for classes.
During practical classes, software reports are completed and defended.
Modular test work.
Completion and defense of an individual assignment (essay).

Calendar control: is carried out twice a semester as a monitoring of the current status of the

implementation of the syllabus requirements. There are two possible results of the calendar control: certified (a) and not certified (n/a). The result depends on the number of points scored at the time of the calendar control. The RSA indicates the required number of points for certification during the first and second calendar control.

Criteria		First certification	Second certification
Certification period		7th week	13th week
Current rating		≥ 12 points*	≥ 22 points*
Conditions for obtaining certification	practical classes reports No.1-5	+	+
	practical classes reports No.6-9	+	+
	MCW	-	-
	Essay	Readiness is no less than 25%	Readiness is no less than 80%

*- 60% of the results of the "Ideal Student"

Semester control: final tests

Evaluation and control measures

Control measures evaluation system:

No.	Control measure	%	Weighted score	Number	Total
1.	practical classes execution and protection	56	4	14	56
2.	Modular control work	20	20	1	20
3	Essay	24	24	1	24
	Total				100

1. Execution and defense of reports from practical classes

14 practical classes are planned. The weighted score of the practical class is 4 points. The

maximum number of points for the software reports is 4 points x 14 reports = 56 points.

Report evaluation criterion

"**Excellent**": work done accurately, in full volume, at defense demonstrated complete and solid knowledge of the relevant material. Report provided timely and in compliance with all requirements for its registration.	4-3.6 points
"**Good**": minor inaccuracies were made in the work, knowledge of the relevant material was demonstrated during the defense with minor inaccuracies. The report was submitted on time and all requirements for it design were met.	3.5-3 points
"**Sufficient**": the work contains some errors that are made due to negligence and lack of consistent skills, when defending the relevant material, the student's answer is incomplete or contains an inaccurate answer to theoretical questions. The report was submitted untimely, without complying with all requirements.	2.9-2.4 points
"**Unsatisfactory**": the work contains fundamental errors, incomplete (incorrect) calculations, incomplete or inaccurate (incorrect) answers to theoretical questions. The work report was not submitted and was not defended without a valid reasons.	0 points

2. Modular test work

The weighted score of the MCW is 20 points.

MCW evaluation criterion

"**Excellent**": answers are complete and correct (at least 90% of necessary information)	20-18 points
"**Good**": sufficiently complete answers (at least 75% of necessary information)	17-15 points
"**Sufficient**": incomplete answers (at least 60% of the required information)	14-12 points
"**Unsatisfactory**": answers are missing or incorrect (less than 60% necessary information)	0 points

3. Essay

Weighted score – 24 points.

The essay is evaluated according to the following criteria: logical presentation of the material; completeness and depth of disclosure of the topic; compliance with the requirements for design; presence of all necessary structural elements; justification of the student's own opinion regarding the content and relevance topics.

Criteria for evaluating the components of an essay

"**Excellent**": the main requirements for the components are listed the essay is fully completed (at least 90%)	24-22 points
"**Good**": the main requirements for the components of the essay are met with comments (at least 75%)	21-18 points
"**Sufficient**": the main requirements for the components of the essay are not all met (not less than 60%)	17-14 points
"**Unsatisfactory**": the main requirements for the components of the essay are not met	0 points

In order to get the highest rating, the student needs to: complete the assignments on time, prepare and defend practical classes reports and essays and complete MCW in a timely manner.

A student may appeal a teacher's grade by submitting a complaint to the teacher no later than the day after the student is familiarized with the grade. The complaint will be considered according to the procedures established university.

Conditions for admission to semester final tests: absence of arrears from practical classes, performance and defense essay.

A student receives *a* credit without additional tests if the sum of the points scored is not less than 60. A student who received more than 60 points in the semester, but wishes to improve his/her result, can take part in a credit test or a survey on questions before the credit test. In this case, the final result consists of the points obtained in the credit test or during survey, and essay defense.

Applicants who have met all the admission requirements and have a rating score of less than 60 points take a credit test. The final result consists of the points obtained in the credit test and the defense of the essay.

The final test is conducted at the final session.

The final test is evaluated with a rating of 76 points, and the final semester grade of the applicant will consist of the points received for completing the individual test semester assignment (24 points) and passing the test (76 points) and is determined as the sum of the points for the test and the points for the individual semester assignment (essay). In this case, the size of the assessment scale for the test is reduced by the maximum value of the points provided for the essay (24 points). https://osvita.kpi.ua/node/37 (clause 3.12)

The final test consists of 4 questions (with examples), each of which is worth 19 points.

Based on the size of the scale **RD** = **R** $_{test}$ + **R** $_{essay}$ = 100 points

R $_{test}$ = **RD** - **R** $_{essay}$ = 100 - 24 = 76 points

Maximum points: 19 points x 4 questions = 76 points.

Criteria for evaluating a credit question

*"**Excellent**": the answer is correct (at least 90% of the required information)*	*19-17 points*
*"**Good**": there are insignificant mistakes in answers (not Less 75% necessary information)*	*16-14 points*
*"**Sufficient**": there are disadvantages in answers and certain mistakes (not Less 60% of the required information)*	*13-11,4 points*
*"**Unsatisfactory**": the answer is missing or does not meet the requirements for "Sufficient"*	*0 points*

Table of correspondence of rating scores to university scale grades

Number points	**Score**
100-95	Excellent
94-85	Very good
84-75	Good
74-65	Satisfactory
64-60	Enough
Less 60	Unsatisfactory
Not fulfilled conditions admission	Not admitted

9. Additional information on the discipline (educational component)

Scientific and pedagogical workers can make clarifications to the content modules, RSA and tasks for the practical classes, MCW and essay, taking into account their own methodological developments and the surrounding situation.

Distance learning

Distance learning through additional online courses on a specific topic is permitted subject to agreement with students. If a small number of students wish to take an online course on a specific topic, studying the material through such courses is permitted, but students must complete all tasks provided for in the curriculum. discipline.

The list of courses is offered by the teacher after students express their desire (since the bank of available courses is updated almost every monthly).

The student provides a document that confirms completion of the distance learning course (in case of completing the full course) or provides completed laboratory tasks from the distance learning course and subject to passing an oral interview with the teacher can receive grades for the control measures provided for the topics studied (quick-test/test tasks, laboratory work) for the topics covered.

Inclusive learning Allowed.

Appendix 1 to the discipline syllabus

"Materials Science and Construction Materials"

List of questions/tasks for preparation for the MCW and credit

1. Dates definition elementary collars. Types and parameters crystalline cells. IN Why What is the essence of polymorphism? Give examples of this phenomenon.
2. Crystal lattice characteristics: coordination number, compactness factor for PC, bcc, fcc crystal cells. Anisotropies crystals.
3. The effect of the crystal structure of a material on its density. Determine the theoretical density of copper under the following conditions: fcc crystal structure, atomic radius 0.128 nm, molar mass 63.5 g/ mole.
4. Miller indices: node, direction, plane indices – rules for determination. Basic crystallographic formulas for cubic crystals.
5. Classification of imperfections of real crystal structures. Structure of ideal and real crystals. Give a characteristic of point defects. Determination of equilibrium concentration vacancies.
6. Types of crystal lattice defects. Dislocations and their structure. Reasons for easy movement in crystalline lattice, influence on mechanical and physical properties.
7. Quantitative characteristics regional and screw dislocations: contour and vector Burgers.
8. Dislocation density. Dependence of strength on dislocation density. Determine the total length of dislocations in 1000 mm ^{3} of material at a dislocation density of 10^5 mm^2.
9. The structure of metals and alloys in the solid state. The concept of solid solutions, chemical compounds, phase mixtures.
10. General method construction diagrams state for different cases interactions components in solid condition.
11. Construction of heating and cooling curves using the phase rule. Explain the following concepts: component, phase, physicochemical system, number of stages freedom.
12. Phase diagrams for cases of unlimited and limited solubility of components in a solid condition, and also at education in system chemical compounds.
13. Phase diagram of alloys whose components are limitedly soluble in the solid state and form eutectics. Determination of the composition of phases and their quantitative correlation.
14. The relationship between the properties of alloys and the type of phase diagram (rule Kurnakova).
15. Describe the main sections of the working tension diagram. Analyze the working and conditional tension diagrams, characterize each point diagrams.
16. Explain the method of determining the elastic properties of materials using a conventional tension diagram.
17. Explain the method of determining the strength characteristics of materials using a conventional tensile diagram.
18. Conditional border fluidity and methods its definition. Characteristics plasticity.
19. Explain method definition residual deformations at stretching on conditional diagram. Describe plastic and brittle materials, their features and significant differences at trials on stretch and compression
20. Explain the method of determining energy characteristics using a conditional diagram stretching.
21. Allowable stress for ductile and brittle materials. Factors influencing the choice of safety factor strength.
22. The effect of dislocations on the strength of a metal? Explain the discrepancy between theoretical and actual strength?
23. What understood under hardness material. Essence method definition hardness by Brinell, Rockwell, Vickers. For what purpose are different methods of determining hardness used?
24. Dynamic trial materials. Shocking viscosity materials and methods its definition.

25. The essence of the phenomenon of defamation and its practical application using.
26. What components does the iron-cementite system consist of ? Describe their main properties.
27. What polymorphic transformations occur in iron? Indicate the temperatures. How many single-phase regions are there in the iron-cementite diagram? How many two-phase regions are there in the diagram iron-cementite?
28. Define ferrite, austenite, cementite, pearlite, and ledeburite. State their crystal lattice type. How does the structure of ledeburite change with temperature ? (room temperature, above eutectoid 727°C)?
29. How to determine the mass number of phases and their chemical composition in a given alloy at a given temperature composition?
30. Name the solidus line on the iron-cementite diagram. On which lines of the iron-cementite diagram and from which phase is primary, secondary, and tertiary?
31. What transformations occur when cooling from the liquid state to room temperature in a hypoeutectoid, hypereutectoid, hypoeutectic, eutectic, or hypereutectic alloy? What phases do hypereutectoid steels consist of at room temperature?
32. Which lines of the iron-cementite diagram correspond to the peritectic, eutectic, and eutectoid transformations? Describe the nature of the peritectic, eutectic, and eutectoid transformations transformations.
33. Determine from the iron-cementite diagram what phases steel with 0.47 % C consists of at temperatures of 100 and 1000°C?
34. is the difference between gray and white cast iron? Classification and marking of gray cast iron. Structures of gray cast iron? How is high-strength cast iron obtained? Its structure, properties and purpose.
35. Compare the mechanical properties of gray, malleable, and high-strength cast irons. Which form of graphite is most favorable for obtaining high mechanical properties? properties?
36. 36. Which lines on the iron-carbon phase diagram are designated as A_1, A_2, A_3, A_4, Am? What transformations occur at these temperatures? Name the main parameters of heat treatment.
37. 37. Name the main types of purely thermal processing. Give definitions and general characteristics.
38. WITH which one purpose appoint full and incomplete annealing hypoeutectoid steel and to What temperatures, respectively, are these steels heated to? For what purpose is annealing of hypereutectoid steels prescribed? steels.
39. What heat treatment is called normalizing? To what temperatures are eutectoid and hypereutectoid steels heated when normalization?
40. What heat treatment is called hardening? What structures can form in steels at different cooling rates from austenitic will I become?
41. To what temperatures are steels of different chemical compositions heated during quenching? What is the critical cooling rate of steels ? Describe the structure "martensite"
42. For which steels is low, medium and high tempering prescribed? What heat treatment of steels is called improvement?
43. of chemical-thermal treatment. Cementation. Nitriding. Cyaniding. Diffusion metallization. Advantages of CTP and surface hardening compared to bulk thermal processing.
44. The influence of saturation temperature, process duration, and alloy chemical composition on the depth of diffusion layer.
45. How are construction steels classified according to heat treatment technology? Product requirements, What are subject to cementation?

Description of the material, technical and information support of the discipline

Discipline syllabus, RSA, textbook (electronic edition), online course in Moodle, URL https://do.ipo.kpi.ua

The working program of the academic discipline (syllabus):
Compiled by Solomin A.V.
Approved Department of BMI (minutes No. 16 dated 06/21/2024)
Approved by the methodological committee of the faculty (minutes No. 9 dated 06/26/2024)

Appendix 2 to the discipline syllabus

"Materials Science and Construction Materials"

Program learning outcomes (extended form)

As a result of studying the academic discipline "Materials Science and Construction Materials", students will be able to:

Learning outcomes		Relevance of learning outcomes to competencies in SHE [1]
		Special competences (professional)
PLO 1	*The ability to apply knowledge of the fundamentals of mathematics, physics and biophysics, bioengineering, chemistry, engineering graphics, mechanics, materials resistance and strength, properties of gases and liquids, electronics, computer science, signal and image acquisition and analysis, automatic control, system analysis, and decision-making methods at a level necessary for solving biomedical engineering tasks.*	*PC 5 - Ability to apply physical, chemical, biological, and mathematical methods in the analysis and modeling of the functioning of living organisms and biotechnical systems.*
PLO 9	*Understand theoretical and practical approaches to the creation and application of artificial biological and biotechnical objects and materials for medical purposes.*	*PC 8 - Ability to conduct research and observation on the interaction of biological, natural, and artificial systems (prostheses, artificial organs, etc.)*
PLO 11	*Conduct quality control and operational monitoring of medical equipment and materials for medical purposes, artificial organs, and prostheses.*	*PC 8 - Ability to conduct research and observation on the interaction of biological, natural, and artificial systems (prostheses, artificial organs, etc.)*
PLO 15	*Select and recommend appropriate medical equipment and biomaterials for equipping medical institutions and ensuring the main stages of the technological process of diagnosis, prevention, and treatment.*	*PC 6 - Ability to effectively use tools and methods for analysis, design, calculation, and testing in the development of biomedical products and services.*
PLO 19	*Proficiency in engineering methods for calculating components of medical devices and systems, modern methods for experimental verification of integrity and functionality of biotechnical systems and determination of their characteristics, methods for selecting conventional and advanced construction materials, as well as tools for designing devices, instruments, and systems for medical and biological purposes.*	*PC 6 - Ability to effectively use tools and methods for analysis, design, calculation, and testing in the development of biomedical products and services.*
PLO 22	*Knowledge of general principles and structure of complex biological systems,*	***IC** - The ability to solve complex, specialized problems and practical problems in biomedical*

Learning outcomes		Relevance of learning outcomes to competencies in SHE [1]
		Special competences (professional)
	including the human body and its functions from the perspective of a systemic approach and their utilization in biomedical engineering, as well as basic methods and tools used for quantitative assessment of physiological system functioning.	*engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms.*

[1] Order of the Ministry of Education and Science of Ukraine No. 1264 dated November 19, 2018 "On approval of the standard of higher education in the specialty 163 Biomedical Engineering" for the first (bachelor's) level of higher education".