GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Materials Science I, PG_00055734		
Field of study	Mechanical and Medical Engineering		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2022/2023
Education level	first-cycle studies	Subject group	Obligatory subject group in the field of study Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	1	ECTS credits	5.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Institute of Manufacturing and Materials Technology -> Faculty of Mechanical Engineering and Ship Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Marek Szkodo	
	Teachers	dr inż. Magdalena Jażdżewska dr inż. Marcin Wekwejt dr inż. Łukasz Pawłowski dr hab. inż. Marek Szkodo dr inż. Alicja Stanisławska	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	45.0	0.0	30.0	0.0	0.0	75

E-learning hours included: 0.0

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	75	2.0	48.0	125

Subject objectives

The aim of the course is to familiarize students with the structure of various groups of engineering materials, both at the atomic and microscopic level. Students learn about different types of crystal lattices occurring in metal and ceramic materials, and the defects of these lattices and their influence on macroscopic properties, learn about the types of phases occurring in alloys and learn to read information from the phase equilibrium systems of two-component alloys. They will learn the Fe-Fe3C equilibrium system.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U07] he/she is able to identify the problem and list simple engineering tasks to solve this problem in practice, he/she is able to critically analyze the proposed technical solutions and conclude whether these solutions can be implemented to solve problems related to design of mechanical devices and mechanical-medical devices	Student can solve a simple scientific and technical problem, plan an experiment, analyze the obtained results and formulate appropriate conclusions.	[SU3] Assessment of ability to use knowledge gained from the subject
[K6_U09] he/she is able to select proper constructive materials to design the device	Student can use the available tools (catalog cards, standards, literature) in order to select the appropriate material for a given destination.	[SU3] Assessment of ability to use knowledge gained from the subject
[K6_W04] he/she has skills in the field mechanical testing of materials used in engineering and mechanical-medical area	Student has basic theoretical knowledge, is able to indicate the essential properties of various materials and uses his knowledge for practical issues.	[SW1] Assessment of factual knowledge

Subject contents	Matter and its components. Interatomic bonds. Technical materials: natural and engineering - dependencies of structure, properties and applications. Crystalline, amorphous and glassy bodies. Basic characteristics of the main groups of engineering materials. Technological processes for obtaining metals and alloys. Basic metal alloys. Ceramic materials: structure and application. Polymer materials: structure and application. Characteristics of composite materials. Structures of materials. Description of crystalline bodies: lattice, knots, lines and lattice planes. Types of spatial lattice. Miller indices. Metal spatial networks. Structures of ceramic materials. Structures of polymeric materials. Crystal structure defects. Point defects: Frenkel and Schottky defects, vacancies. Diffusion: diffusion equations, diffusion mechanisms - interstitial, vacant, rotational (exchange). Influence of point defects on diffusion and methods of use. Linear defects: misalignment and dislocations. Unit and partial dislocations, edge and screw dislocations. Edge dislocation movement. Contour and vector of burger. Low- and high-angle grain boundaries, disorientation angle, conjugated, non-conjugated and semi-conjugated boundaries. Influence of point defects on mechanical properties. Construction of metal alloys. Continuous and discontinuous in-node and inter-node solids. Superstructures. Strengthening of solid solutions in technological processes. Intermetallic phases: Lavesa, electronic. Inter-node phases. Phase equilibrium systems. Thermodynamic equilibrium. The concept of component and phase. The rule of leverage. Gibbs rule of phases. Phase equilibrium systems. Two-component phase equilibrium systems. The system of elements with insolubility in the solid and liquid state. System of elements with insolubility in the solid state. A system of elements with excellent mutual solubility in the solid state. System of elements with partial solubility in solid state with eutectic and eutectoid mixtures. System of elements with partial solubility in solid state with perytectic and perytectoid mixtures. Ternary phase equilibrium systems. Four-component phase equilibrium systems. Iron-carbon and iron-cementite phase equilibrium systems. Phase and structural components: ferrite, austenite, primary, secondary and tertiary cementite, perlite and ledeburite. Phase transitions during cooling of iron-carbon alloys. Receipt of materials. Crystallization. Thermodynamic equilibrium of crystallization and subcooling. Crystallization seeds. Homogeneous and heterogeneous nucleation. Crystallization kinetics. Manufacturing technologies: foundry and powder metallurgy. Plastic processing. Plastic deformation mechanisms: slip and twinning. Recrystallization and recovery. Basics of heat treatment. Forms of heat treatment. Heat treatment of steel. Steel transformation during cooling. Martensitic, bainitic and pearlitic transformation. CTP curves. Steel transformation during heating. Selection of heating time and medium. Bainitic and martensitic hardening. Surface hardening. The concept of hardenability. Letting go. Structures of tempered steels. Subzero machining. Solutioning and aging. Properties of materials. Physical properties: density, magnetic properties. Chemical properties: corrosion resistance. Mechanical properties: tensile, compression, bend and fatigue tests. Hardness and microhardness tests. Material degradation. Brittle cracking. Fatigue of materials. High temperature degradation. Chemical, electrochemical and biological corrosion. Cavitation erosion. Iron alloys. Alloy and unalloyed steels. Carbon and alloy cast steel. Carbon and alloy cast iron. Structures and application.
Prerequisites and co-requisites	

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
written exam, exam duration 45 min	50.0%	100.0%

Recommended reading

Basic literature	1. Introduction to Materials Science for Engineers 8th Edition by James Shackelford 2. Materials Science and Engineering: An Introduction by David G. Rethwisch, William Callister
Supplementary literature	1. Callister W.D.: Materials Science and Engineering. Wiley and Sons, 2000-2006. 2. Fundamentals of Materials Science: The MicrostructureProperty Relationship Using Metals as Model Systems by Eric J. Mittemeijer
eResources addresses	Adresy na platformie eNauczanie:

Example issues/ example questions/ tasks being completed

1. List the types of atomic bonds, indicate strong and weak bonds and schematically draw a metallic bond
2. Draw a diagram explaining the dependence of the mechanical properties of metals on the dislocation density in their crystal lattice
3. Draw and describe in phase (structurally) the equilibrium diagram of two components that do not dissolve each other in the solid state and with eutectic. Calculate the percentages of phases in thermodynamic equilibrium using the lever rule and indicate their chemical compositions on the graph.
4. Discuss the dispersion hardening of Al alloys.

Work placement	Not applicable

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