



Subject card

Subject name and code	, PG_00072210						
Field of study	Mechanical and Medical Engineering						
Date of commencement of studies	October 2024		Academic year of realisation of subject		2026/2027		
Education level	first-cycle studies		Subject group				
Mode of study	Full-time studies		Mode of delivery		at the university		
Year of study	3		Language of instruction		Polish		
Semester of study	5		ECTS credits		2.0		
Learning profile	general academic profile		Assessment form		assessment		
Conducting unit	Division of Biomaterials Technology -> Institute of Manufacturing and Materials Technology -> Faculty of Mechanical Engineering and Ship Technology -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Marcin Wekwejt				
	Teachers		dr inż. Marcin Wekwejt dr inż. Magda Rościszewska				
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	15.0	0.0	0.0	30
	E-learning hours included: 0.0						
	eNauczanie source addresses: Moodle ID: 7907 Materiały ceramiczne w inżynierii medycznej, PG_00072210 https://enauczanie.pg.edu.pl/2025/course/view.php?id=7907						
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	30		1.0		19.0	50
Subject objectives	The aim of the course is to familiarize students with the fundamentals of the structure, properties, processing methods, and characterization of ceramic materials used in medical engineering. The course provides knowledge of the relationships between the composition, structure, physicochemical and mechanical properties of bioceramics and their biological response and potential medical applications. Particular emphasis is placed on ceramic materials used for bone tissue regeneration and reconstruction, including bioactive and resorbable ceramics as well as bone cements. The laboratory classes are aimed at developing practical skills in the preparation, modification, and basic characterization of ceramic materials and in the interpretation of experimental results in the context of their potential biomedical applications.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K6_U04] is able to utilize empirical, analytical, simulation, and computer-based methods to formulate and solve engineering tasks in the field of medical and mechanical engineering	The student is able to conduct basic experimental studies of ceramic materials, process and analyze the obtained data, and interpret the results in relation to the composition, structure, and properties of the investigated material. The student is able to formulate conclusions regarding the influence of material and processing parameters on the properties of bioceramics and their potential suitability for medical applications.	[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject [SU5] Assessment of ability to present the results of task
	[K6_U03] is able to use information and communication skills or research techniques to solve typical engineering tasks related to design, production and manufacturing of materials or machine components	The student is able to apply selected methods for the fabrication, processing, and modification of ceramic materials used in medical engineering and perform their basic characterization. The student is able to correctly use selected experimental techniques, laboratory equipment, and measurement procedures applied to evaluate the properties of bioceramics.	[SU1] Assessment of task fulfilment [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools
	[K6_W05] has knowledge in the areas of design, manufacturing, and operation of materials, machine parts, or technical devices, with a solid understanding of design principles and technical documentation preparation	The student has knowledge of the structure, composition, and physicochemical, mechanical, and biological properties of ceramic materials used in medical engineering. The student knows the basic methods of their fabrication, processing, and modification and understands the relationships between composition, structure, material properties, function, and medical application.	[SW1] Assessment of factual knowledge [SU3] Assessment of knowledge contained in written work and projects
	[K6_U06] can identify and formulate specifications for simple practical engineering tasks, and critically analyze existing technical solutions, evaluating their functionality, particularly in the context of designing mechanical and medical-mechanical devices	The student is able to select an appropriate ceramic material for a specific medical application, considering its composition, physicochemical and mechanical properties, biocompatibility, bioactivity, and behavior in the biological environment. The student is able to compare different groups of bioceramics and critically evaluate their advantages, limitations, and suitability for selected medical applications.	[SU1] Assessment of task fulfilment [SU3] Assessment of ability to use knowledge gained from the subject [SU5] Assessment of ability to present the results of task
Subject contents	Course content – lecture The lecture covers the structure, composition, properties, fabrication, and processing of ceramic materials used in medical engineering. Relationships between the composition, structure, microstructure, and properties of ceramic materials and their relevance to medical applications are discussed. The fundamentals of bioceramic interactions with the biological environment are presented, including biocompatibility, bioactivity, degradation, and resorption, together with methods used for the characterization of ceramic materials. The lecture also addresses the design, modification, and functionalization of bioceramics. Particular attention is given to the main groups of bioceramics and their applications, including oxide ceramics, calcium phosphates, bioactive glasses and glass-ceramics, and ceramic bone cements. The lecture is complemented by scientific literature-based activities focused on the critical analysis of research publications and the selection and design of material solutions for specific medical problems.		
	Course content – laboratory The laboratory classes cover practical aspects related to the fabrication, modification, and characterization of ceramic materials used in medical engineering. Students become familiar with selected methods for the synthesis and processing of bioceramics, including self-setting and bioactive materials as well as materials modified with functional additives. The influence of material composition and processing parameters on the structure and properties of the obtained materials will be analyzed. The classes also include the application of selected methods for evaluating the physicochemical, microstructural, mechanical, and functional properties of bioceramics, as well as the processing, analysis, and interpretation of experimental results in the context of their potential medical applications.		

Prerequisites and co-requisites	Basic knowledge of materials science, chemistry, and physics, as well as biomaterials, particularly with regard to their interactions with the biological environment. Knowledge of the structure and properties of engineering materials and the basic relationships between their composition, structure, and properties. Knowledge of fundamental concepts in medical (mechanical-medical) engineering. Ability to perform basic laboratory work, process measurement results, and use basic methods of data analysis.		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Final test	60.0%	50.0%
	Scientific Literature Assignment I	75.0%	25.0%
	Scientific Literature Assignment II	75.0%	25.0%
Recommended reading	Basic literature	1. Park J. <i>Bioceramics: Properties, Characterizations, and Applications</i>. Springer-Verlag, New York, 2008. 2. Farid S.B.H. <i>Bioceramics: For Materials Science and Engineering</i>. Woodhead Publishing, Sawston, United Kingdom, 2019. 3. Baino F., Novajra G., Vitale-Brovarone C. <i>Bioceramics and scaffolds: A winning combination for tissue engineering</i>. Frontiers in Bioengineering and Biotechnology, 2015, 3, 202. 4. Kokubo T. (ed.) <i>Bioceramics and Their Clinical Applications</i>. Woodhead Publishing, Cambridge, 2008. 5. Wagner W.R., Sakiyama-Elbert S.E., Zhang G., Yaszemski M.J. (eds.) <i>Biomaterials Science: An Introduction to Materials in Medicine</i>. 4th ed., Academic Press, London, 2020.	
	Supplementary literature	1. Eliaz N., Metoki N. <i>Calcium Phosphate Bioceramics: A Review of Their History, Structure, Properties, Coating Technologies and Biomedical Applications</i>. Materials, 2017, 10, 334. 2. Ostrowski N., Roy A., Kumta P.N. <i>Magnesium Phosphate Cement Systems for Hard Tissue Applications: A Review</i>. ACS Biomaterials Science & Engineering, 2016, 2(7), 1067–1083. 3. Cannio M., Bellucci D., Roether J.A., Boccaccini D.N., Cannillo V. <i>Bioactive Glass Applications: A Literature Review of Human Clinical Trials</i>. Materials, 2021, 14, 5440. 4. Ellakwa D.E., Abu-Khadra A.S., Ellakwa T.E. <i>Insight into bioactive glass and bio-ceramics uses: unveiling recent advances for biomedical application</i>. Discover Materials, 2025, 5, 78. 5. Jesiotkiewicz R., Wekwejt M., Ossowska A. <i>Emerging trends in 3D printing of self-setting pastes with a focus on magnesium phosphate cements: From development to biomedical potential – a comprehensive review</i>. Ceramics International, 2026, 52(11).	
	eResources addresses		

Example issues/ example questions/ tasks being completed	Example questions – final test: 1. Explain the relationship between the composition, structure, and microstructure of a ceramic material and its properties and potential applications in medical engineering. 2. Compare bioinert, bioactive, and resorbable ceramics in terms of their properties, behavior in the biological environment, and medical applications. 3. Characterize a selected group of bioceramics (e.g., oxide ceramics, calcium phosphates, or bioactive glasses) in terms of composition, properties, fabrication methods, and applications. 4. Explain the mechanisms of bioactivity, degradation, and resorption of bioceramics and discuss their importance in the design of materials for bone tissue regeneration. 5. Characterize ceramic bone cements, considering their setting mechanisms, functional properties, modification strategies, and potential medical applications. Example assignments – scientific literature work: - Scientific Literature Assignment I: critical analysis of an assigned scientific publication on bioceramics based on a set of problem-oriented questions, including identification of the research objective and hypothesis, evaluation of the applied methods, analysis and interpretation of results, assessment of the validity of the authors' conclusions, and identification of study limitations. - Scientific Literature Assignment II: analysis of a publication presenting a specific clinical problem and development of a proposed material-based solution, including selection of the type and composition of the bioceramic, its fabrication and processing methods, desired properties, and, where appropriate, modification or functionalization strategy. Example topics covered during laboratory classes: 1. Fabrication and processing of selected ceramic materials used in medical engineering. 2. Modification and functionalization of bioceramics and evaluation of the influence of material and processing parameters on their properties. 3. Characterization of the physicochemical properties and behavior of ceramic materials under conditions simulating the biological environment. 4. Characterization of the microstructure and mechanical properties of ceramic materials. 5. Analysis and interpretation of experimental results in the context of potential medical applications.
Practical activities within the subject	Not applicable

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