GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	DESIGN OF POLYMER MATERIALS, PG_00064407						
Field of study	Chemistry						
Date of commencement of studies	October 2026		Academic year of realisation of subject	2028/2029			
Education level	first-cycle studies		Subject group	Optional subject group 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	3		Language of instruction	Polish			
Semester of study	5		ECTS credits	4.0			
Learning profile	general academic profile		Assessment form	exam			
Conducting unit	Department of Polymer Technology -> Faculty of Chemistry -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Michał Strankowski				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	15.0	0.0	0.0	45
	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	45		5.0		50.0	100
Subject objectives	The aim of the course is to prepare participants for designing polymer products by utilizing knowledge of polymer materials, processing technologies, and computer-aided design (CAD) tools, as well as fostering a sense of responsibility for engineering decisions made in the context of quality, economics, and sustainable development.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_K02] is aware of the importance of non-technical aspects and consequences of engineering activities, including their impact on the environment, and of the related responsibility for the decisions to be taken	is aware of and ready to take into account the environmental and social impacts of project decisions.	[SK3] Assessment of ability to organize work [SK5] Assessment of ability to solve problems that arise in practice
[K6_U07] is able to undertake accurate and precise analytical measurements, to synthesise simple and large-molecular chemical compounds, to purify and analyse their composition and to determine their structure using classical and instrumental methods	Able to analyze and interpret data from instrumental material testing (e.g., DSC, TGA, DMA, rheometry) and utilize material databases (e.g., Ansys GRANTA EduPack) and engineering software (CAE - Moldflow) to determine processing parameters and optimize the design of polymer products.	[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information [SU4] Assessment of ability to use methods and tools
[K6_W04] identifies the conditions of chemical processes occurring in the analysed systems through the appropriate selection of methods to solve them, by taking into account the interdependence of the structure and properties of key materials in sustainable development technologies	Understands and identifies relationships between the chemical structure and thermal, mechanical, and rheological properties of polymers; is able to select appropriate polymer materials and additives tailored to processing technologies and application requirements, taking into account the principles of sustainable development and eco-design.	[SW1] Assessment of factual knowledge [SW2] Assessment of knowledge contained in presentation
[K6_U09] is able to recognise hazards, counteract them and work with chemical reagents and basic technical apparatus in accordance with health and safety principles and the concept of sustainability	Identifies technological and environmental hazards associated with polymer processing (including thermal degradation, emissions, and production waste); is able to conduct a Life Cycle Assessment (LCA) of a polymer product and propose environmentally safe material and structural solutions.	[SU2] Assessment of ability to analyse information [SU5] Assessment of ability to present the results of task

Subject contents

Course content – lecture

- Design methods for polymer products.
- Material selection.
- Processing of polymer materials.
- Additives for plastics.
- Polymer composites.
- Design for manufacturing (injection molding, extrusion, 3D printing).
- CAD/CAE simulations (Autodesk Moldflow, Moldex 3D).
- Economic and environmental analysis.
- Sustainable design (LCA analysis).

Course content – laboratory

1. Advanced design and characterization of polymer materials (Ansys GRANTA EduPack)

- Selection of polymers and plastic additives based on application requirements.
- Impact of structural modifications on performance properties.

2. Thermal analysis in material design

- Utilization of DSC, TGA, DMA methods, and rheometry to optimize mixture composition and evaluate the thermal stability of products (NETZSCH Proteus software).

3. Processing technologies and Computer-Aided Engineering (CAE)

- Analysis of processing methods (injection molding, extrusion) in terms of polymer rheology.
- Computer simulations: Use of Autodesk Moldflow software to optimize part geometry and feed systems, as well as to minimize residual stresses and warpage.

4. Economics, ecology, and sustainability in polymer engineering

- Life Cycle Assessment (LCA): Evaluating the carbon and environmental footprint of polymer products, from raw material extraction to disposal (SimaPro).
- Production cost management: Economic process analysis, raw material selection, and optimization of production.

Prerequisites and co-requisites

Fundamental knowledge regarding types and properties of polymers, as well as the application potential of plastics.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Lecture: lecture-based tests	60.0%	50.0%
Laboratory: project	60.0%	50.0%

Recommended reading

Basic literature

1. Osswald T. A., Turng L. S., Gramann P. J., International Plastics Handbook: The Resource for Plastics Engineers, 4th Edition, Hanser Publishers, Munich 2006.
2. Ashby M. F., Materials Selection in Mechanical Design, 5th Edition, Butterworth-Heinemann, Oxford 2017.
3. Rosato D. V., Designing with Plastics, 2nd Edition, Hanser Publishers, Munich 2006.
4. Autodesk, Autodesk Moldflow Adviser: Help and Documentation, Autodesk Inc., wersja aktualna dostępna online pod adresem: help.autodesk.com

	Supplementary literature	1. Gerdeen J. C., Rorrer R. A. L., Engineering Design with Polymers and Composites, 2nd Edition, CRC Press, Boca Raton 2011. 2. Fernandes C., Faroughi S. A., Ferrás L. L., Afonso A. M. (red.), Advanced Polymer Simulation and Processing, MDPI, Basel 2022. 3. Gibson I., Rosen D. W., Stucker B., Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Springer, New York 2015. 4. Ashby M. F., Materials and the Environment: Eco-informed Material Choice, 3rd Edition, Butterworth-Heinemann, Oxford 2022.
	eResources addresses	
Example issues/ example questions/ tasks being completed	• Based on property analysis (e.g., using software such as GRANTA EduPack), select an appropriate group of polymers for a product requiring high stiffness at 100°C and chemical resistance. Justify your choice by referring to the chemical structure of the polymer chain. • How do parameters determined by DSC analysis (glass transition temperature Tg, melting temperature Tm) influence the selection of injection molding parameters in Moldflow software? • Explain the phenomenon of thermomechanical degradation of a polymer in an injection molding plasticizing unit. Which simulation parameters in CAE software allow for the detection of the risk of this phenomenon occurring? • During injection molding simulation (Moldflow), the "sink marks" phenomenon was observed on the finished part. What changes in the part geometry or process parameters (mold temperature, packing time) should be implemented to eliminate this defect?	
Practical activites within the subject	Not applicable	

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