GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Inspired by nature in engineering, PG_00072667		
Field of study	Chemical Technology, Chemistry, Biotechnology, Engineering and Technologies of Energy Carriers, Corrosion , Green Technologies, InfoBioChem		
Date of commencement of studies	February 2026	Academic year of realisation of subject	2026/2027
Education level	second-cycle studies	Subject group	
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Energy Conversion and Storage -> Faculty of Chemistry -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Katarzyna Januszewicz	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	0.0	0.0	30.0	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	2.0	18.0	65

Subject objectives

Introducing students to the concept of **bionics**, i.e. drawing inspiration from nature in the development of inventions and innovative solutions. The course explores the structure, mechanisms of movement, and functioning of plants, animals, and humans that have inspired technological inventions and practical biotechnical solutions. Its objective is to familiarize students with the process of creating innovative solutions based on the observation, analysis, and understanding of the structure and operating principles of living organisms. As part of the course, students will independently develop a project using the **Design Thinking** methodology and available **AI tools** to visualize and present their concepts.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U03] designs innovative technological solutions for obtaining useful goods based on the state of the knowledge in accordance with the latest scientific literature	is able to develop a concept for an innovative solution inspired by nature, using the Design Thinking method, analysis of biological solutions, and tools supporting the design and visualization of concepts.	[SU1] Assessment of task fulfilment [SU5] Assessment of ability to present the results of task
[K7_W06] integrates knowledge from different disciplines, principles of intellectual property protection and patent law, relevant for appropriate interpretation and application in scientific, sustainable economic activities	knows the principles of intellectual property protection and patent law in the process of creating inventions and indicates the importance of an interdisciplinary approach and solutions inspired by nature for the sustainable development of technology.	[SW3] Assessment of knowledge contained in written work and projects
[K7_W101] is able to make an in-depth identification of key objects and phenomena related to the field of study, as well as theories that describe them and applicable analytical and design methods	knows the basic assumptions of biomimetics and characterizes the biological mechanisms and structures that inspire technical solutions, including those in the areas of biomaterials, bioprosthetics, biooptics, biodynamics and biohydraulics.	[SW3] Assessment of knowledge contained in written work and projects

Subject contents	Course content – lecture **LECTURE** 1. **Biomimetics.** An interdisciplinary field that uses knowledge of the structure and functioning of living organisms to develop technological devices based on biological mechanisms, principles, and relationships. 2. **Structural Biomimetics.** The use of nature-inspired concepts in the design of engineering and architectural structures (e.g., a tube inspired by the structure of a plant stem). 3. **Biomaterials.** Materials developed through the analysis of solutions found in nature. Aircraft skin structures and spider silk as inspirations for innovative materials. 4. **Bioinformatics and Biocybernetics.** Development of devices inspired by the movements of animals such as cats, flamingos, and cows. Butterfly-inspired nanosensors. Walking robots modeled on animal locomotion. 5. **Bioprosthetics.** Examples of solutions with case study analysis. Materials and designs used in prosthetic devices (e.g., foot and hip prostheses). 6. **Bio-optics.** Examples of solutions with case study analysis. Discussion of biological aspects, including structure and function, and the application of this knowledge in specific technological solutions and inventions. The chameleon as an inspiration for camouflage technologies. 7. **Biodynamics.** Examples of solutions with case study analysis. Discussion of biological structures and functions and their application in technological solutions and inventions. Rehabilitation-support actuators as an example. 8. **Biohydraulics.** The phenomenon of cavitation illustrated by the example of the pistol shrimp (*Alpheus* shrimp). 9. **Opportunities and Prospects for Future Inventors.** Perspectives and possibilities available to students interested in innovation and invention. 10. **Application of the Design Thinking Methodology.** Using Design Thinking in creative problem-solving and idea generation. Collaborative use of tools for creative problem-solving. 11. **Intellectual Property Protection.** Interesting case studies related to intellectual property rights and key considerations for protecting innovative ideas. Course content – seminar **Seminar** As part of the seminar, each student independently develops a concept for an innovative invention inspired by nature (**biomimetics**) using the **Design Thinking** methodology. The project is an individual conceptual assignment that fosters creativity, problem-solving skills, and the integration of biological knowledge with technological solutions. 1. Identifies a problem or need. 2. Searches for inspiration in nature. 3. Develops a concept for an invention. 4. Creates a visualization. 5. Presents the project during class.
Prerequisites and co-requisites	
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
Task with the presentation (sem)	60.0%	70.0%
TEST(lecture)	60.0%	30.0%

<table>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>1. Johan Gielis: A generic geometric transformation that unifies a wide range of natural an abstract shapes. 2003. American Journal of Botany 90(3): 333338.

2. Bioinformatics. W: Robert Nisbet, John Elder IV, Gary Miner: Handbook of Statistical Analysis and Data Mining Applications. Academic Press, 2009, s. 321334. ISBN 978-0-08-091203-5.

3. Paul G. Higgs Teresa K. Attwood. Bioinformatyka i ewolucja molekularna.

4. Eisner T., Aneshansley D.J.Spray aiming in the bombardier beetle: Photographic evidence , Proc. Natl. Acad. Sci. USA, 1999, Vol. 96, pp. 97059709,

5. Kasprzak M. (2013) Wybrane algorytmy i modele grafowe w bioinformatyce wydawnictwo: Politechnika Poznańska ISBN 978-83-7775-233-3

6. M.Kossobudzka, Żywa latarka, Wiedza i Życie, 2004,6, 32-33

7. M.Fischetti, Błysk w oku laserowa korekcja wad wzroku, Świat Nauki, 2004, 6, 82-84</td></tr>
<tr><td>Supplementary literature</td><td>7. M.Fischetti, Błysk w oku laserowa korekcja wad wzroku, Świat Nauki, 2004, 6, 82-84

8. Ślesak, S. Karpiński. Biologiczne bazy danych i ich zastosowanie w funkcjonalnej analizie porównawczej organizmów wybrane zagadnienia. Biotechnologia, s. 3952, 2010.

9. Vincent, J. F. V.; Bogatyreva, O. A.; Bogatyrev, N. R.; Bowyer, A. & Pahl, A.-K. (2006). "Biomimeticsits practice and theory". Journal of the Royal Society Interface. 3 (9): 471482. doi:10.1098/rsif.2006.0127. PMC 1664643. PMID 16849244.

10. Nanosensors inspired by butterfly wings (Wired UK) Archived 17 October 2010 at the Wayback Machine. Wired.co.uk. Retrieved on 23 April 201

11. Clark, O. G.; Kok, R.; Lacroix, R. (1999). "Mind and autonomy in engineered biosystems" (PDF). Engineering Applications of Artificial Intelligence.12 (3): 389399. CiteSeerX 10.1.1.54.635. doi:10.1016/S0952-1976(99)00010-X. Archived from the original (PDF) on 18 August 2011

12. Design inspired by nature Archived 21 September 2009 at the Wayback Machine, ESA</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="2">Topics covered during the course

• Fundamentals of biomimetics
• Analysis of biological structures
• Nature-inspired design
• Materials of the future
• Biomimetic robotics
• Intellectual property protection

Define biomimetics and provide three examples of its applications. What is the lotus effect?</td></tr>
<tr><td>Practical activites within the subject</td><td colspan="2">Not applicable</td></tr>
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