GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Bioreology in mechanical and medical engineering, PG_00039383		
Field of study	Medical and Mechanical Engineering, Mechanical and Medical Engineering		
Date of commencement of studies	October 2020	Academic year of realisation of subject	2022/2023
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	3.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Energy and Industrial Apparatus -> Faculty of Mechanical Engineering and Ship Technology		
Name and surname of lecturer (lecturers)	Subject supervisor		
	Teachers		

Lesson types and methods of instruction

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

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	5.0	40.0	75

Subject objectives

Provide general knowledge on bioflows

Learning outcomes

Course outcome	Subject outcome	Method of verification
K6_U10	The student assesses the structure of the human body and the functioning of its essential organs at a basic level and is able to use elementary medical knowledge in mechanical and medical engineering to the extent necessary for the IMM field of study	[SU4] Assessment of ability to use methods and tools
K6_W08	The student has a basic knowledge of thermodynamics and fluid mechanics, including bioreology	[SW1] Assessment of factual knowledge
K6_U05	The student is able to use analytical, simulation and computer methods to formulate and solve engineering tasks in the field of mechanical and medical engineering	[SU3] Assessment of ability to use knowledge gained from the subject

Subject contents

LECTURES General form of conservation equation. Constitutive equation for newtonian fluids (air) and non-newtonian (blood). Special form of conservation equations. Boundary and compatibility conditions. Blood vessels. Murrays laws. Characteristics of blood. Selected analytical solutions for tube flows. Electrical-mechanical analogy for blood flow. Introduction to turbulence in respiratory system. Flows with heat transfer. Human thermal balance. LABORATORY Learning of the basic features of the software for numerical simulation of flows. Comparison of analytical and numerical solutions for selected equations of blood models. Reconstruction of example bifurcation geometry on the basis of MRI data. Numerical simulation of blood flow through reconstructed geometry. Numerical simulation of air flow through chosen geometry.

Prerequisites and co-requisites

Fluid Mechanics. Mathematics.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
test	50.0%	100.0%

Recommended reading	Basic literature	Tesch K., "Mechanika Płynów", Wyd. PG, 2008, 2013 Tesch K., "Wybrane Zagadnienia Modelowania Przepływów Krwi...", Wyd. PG, 2012 Bębenek B., "Przepływy w układzie krwionośnym" Wyd. PK, 1999 Cieślicki K., "Hydrodynamiczne uwarunkowania krążenia mózgowego", Wyd. EXIT, 2001
	Supplementary literature	Puzyrewski R., Sawicki J., "Podstawy Mechaniki Płynów i Hydrauliki", PWN, 1998
	eResources addresses	Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed	1. What is the closed system of equations that describes blood flow as a Newtonian fluid. What are the names of all equations and symbols? 2. What is the closed system of equations that describes blood flow as a non-Newtonian fluid. What are the names of all equations and symbols? 3. What is the difference between the Newtonian and non-Newtonian model of fluid? 4. What is the general classification of non-Newtonian fluids? 5. Describe the Ostwald-de Waele model. What are the names and meaning of all symbols? 6. Describe the Herschel-Bulkley model. What are the names and meaning of all symbols? 7. Describe the Casson model. What are the names and meaning of all symbols? 8. Describe any rate type fluid. What are the names and meaning of all symbols? 9. What are the blood features. Is it a Newtonian fluid? Why? 10. Describe Poiseuille's law. What are the names of all symbols? Where does it come from? 11. Is the velocity profile in an circular cross section the same for a Newtonian and non-Newtonian fluid? Why? 12. What does Womersley's solution/equation describe? 13. What is the mechanical-electrical analogy? What are the relationships among mechanical and electrical quantities/functions? 14. Draw electrical circuit describing an elastic artery with leakage. What is the system of equation for this circuit? What are the names and meaning of all symbols? 15. Draw electrical circuit describing an rigid artery without leakage. What is the system of equation for this circuit? What are the names and meaning of all symbols? 16. Derive Murray's law. What is the interpretation of this law? 17. How to estimate the total number of bifurcations and arteries by means of Murray's law? 18. What are the configurations/structures of arteries? For which structure is Murray's law valid?	
Work placement	Not applicable	