GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Biofluids, PG_00057493		
Field of study	Mechanical and Medical Engineering		
Date of commencement of studies	February 2023	Academic year of realisation of subject	2023/2024
Education level	second-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	2	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Energy and Industrial Apparatus -> Faculty of Mechanical Engineering and Ship Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. inż. Krzysztof Tesch	
	Teachers	prof. dr hab. inż. Krzysztof Tesch	

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	3.0	17.0	50

Subject objectives

Provide general knowledge on bioflows

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W03] He/she knows methods, techniques and tools applied to solve engineering problems in the scope of the field of study of mechanical-medical engineering	The student knows methods, techniques and tools used to solve engineering tasks in the field of mechanical-medical engineering	[SW1] Assessment of factual knowledge
[K7_W04] He/she has in-depth knowledge related to the construction and utilization of machines used mechanical-medical engineering	The student has in-depth knowledge of selected problems in the field of mechanical engineering and operation of machines useful in mechanical-medical engineering	[SW1] Assessment of factual knowledge
[K7_U05] He/she can use measurement technique and methods to assess errors of measurement. He/she can plan and conduct research (also numerical ones) and interprets obtained results and draw conclusions	The student is able to use measurement apparatus and methods of measurement error estimation, plan and conduct experiments (including computer simulations), critically interpret the obtained results and draw conclusions	[SU4] Assessment of ability to use methods and tools

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. Murray"s laws. Fractal dimension of vessel structure. 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.

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: Bioprzepływy, W/L, IMM, sem. 2, zimowy 23/24 (PG_00057493) - Moodle ID: 32378 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=32378

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