

。 GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Biofluids, PG_00065014							
Field of study	Mechanical and Medical Engineering							
Date of commencement of studies	February 2025		Academic year of realisation of subject			2025/2026		
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 brak		
Semester of study	2		ECTS credits			2.0		
Learning profile	general academic profile		Assessment form			assessment		
Conducting unit	Department of Energy	Apparatus -> Faculty of Mechanical			Engineering and Ship Technology			
Name and surname	Subject supervisor		prof. dr hab. inż. Krzysztof Tesch					
of lecturer (lecturers)	Teachers							
Lesson types and methods	Lesson type	Lecture	Tutorial	Laboratory	Projec	t	Seminar	SUM
of instruction	Number of study hours	15.0	0.0	15.0	0.0		0.0	30
	E-learning hours inclu	ided: 0.0						
Learning activity and number of study hours	Learning activity	Participation in classes includ plan	n didactic ed in study	Participation in consultation hours		Self-study		SUM
	Number of study hours	umber of study 30 burs		6.0		14.0 50		
Subject objectives	Provide general knowledge on bioflows							
Learning outcomes	Course out	come	Subject outcome				Method of verification	
	[K7_W12] identifies and interprets the main developmental trends and significant new achievements in the field of engineering and technical sciences and disciplines relevant to the course of study		demonstrates the ability to identify and interpret major development trends related to bio-flows			[SW1] Assessment of factual knowledge		
	[K7_W03] has structured and well- founded knowledge covering issues in the field of medical engineering allowing to design medical devices, rehabilitation systems and to formulate research procedures		demonstrates knowledge covering medical engineering problems to design flow medical devices and test procedures			[SW1] Assessment of factual knowledge		
	[K7_U01] uses acquired analytical, simulation and experimental methods as well as mathematical models to solve engineering problems in the field of medical engineering		demonstrates the ability to use analytical and simulation methods to solve engineering tasks in the field of biofluids			[SU1] Assessment of task fulfilment		
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. Comparis 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.						Comparison example istructed	

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/	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?
tasks being completed	
	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

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