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 2026	Academic year of realisation of subject	2026/2027
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 -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. inż. Krzysztof Tesch	
	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	6.0	14.0	50

Subject objectives

Provide general knowledge on bioflows

Learning outcomes

Course outcome	Subject outcome	Method of verification
[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
[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_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

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.

<table>
<tr><td>Prerequisites and co-requisites</td><td colspan="3">Fluid Mechanics. Mathematics.</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="3"><table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>test</td><td>50.0%</td><td>100.0%</td></tr></table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td colspan="2">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</td></tr>
<tr><td>Supplementary literature</td><td colspan="2">Puzyrewski R., Sawicki J., "Podstawy Mechaniki Płynów i Hydrauliki", PWN, 1998</td></tr>
<tr><td>eResources addresses</td><td colspan="2"></td></tr>
</table>

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

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