

1.	Nazwa kierunku	biofizyka
2.	Wydział	Wydział Nauk Ścisłych i Technicznych
3.	Cykl rozpoczęcia	2022/2023 (semestr zimowy), 2023/2024 (semestr zimowy), 2024/2025 (semestr zimowy), 2025/2026 (semestr zimowy)
4.	Poziom kształcenia	studia drugiego stopnia
5.	Profil kształcenia	ogólnoakademicki
6.	Forma prowadzenia studiów	stacjonarna

Moduł kształcenia: Rheology

Kod modułu: W4-2BF-MB-21-10

1. Liczba punktów ECTS: 6

2. Zakładane efekty uczenia się modułu			
kod	opis	efekty uczenia się kierunku	stopień realizacji (skala 1-5)
MB_10_1	the student is aware of the importance of rheology in scientific research, industrial applications, and life including daily activities	KBF_W02 KBF_W04	4 5
MB_10_2	the student knows the main rheological behaviors of the materials and can recognize the rheological behaviour of different material	KBF_W10	5
MB_10_3	the student can apply the main rheological models	KBF_K02 KBF_U07 KBF_W04	4 4 4
MB_10_4	the student knows the experimental methods of rheological survey and main instrumentation	KBF_U07 KBF_W10	4 4
MB_10_5	the student knows the mathematical tensor treatment of rheology	KBF_U02	4

3. Opis modułu

Opis 1) The viscosity of liquids: introduction to rheology 2) Flow and deformation: introduction; shear rate and shear stress; dimensions and units 3) The newtonian liquid: viscosity; variation of viscosity with temperature; effects of pressure; limit of newtonian behaviour 4) Some equations for the flow of newtonian liquid: flow in rotational viscometer; flow in straight circular pipes; spheres falling in newtonian liquids; other important flows 5) Viscometry: some important things about using viscometers; viscometer design. 6) Shear—thinning liquid: qualitative features of flow curves; mathematical description of flow curves: models

	<p>7) Equations for the flow of non – newtonian fluids: some selected examples</p> <p>8) Yield stress fluids: history of the yield stress and yield stress values; flow equations with yield stress</p> <p>9) The flow of “solids”: non-linear “viscosity” of solids</p> <p>10) Linear viscoelasticity and time effects: introduction; mechanical analogues of viscoelastic behaviour; measuring linear viscoelasticity : creep and oscillatory tests, response of model materials and real systems; relationship between oscillatory and steady-state viscoelastic parameters; stress relaxation testing and start-up experiments.</p> <p>11) Non- linear viscoelasticity: everyday elastic liquids; some visible viscoelastic manifestations; proper description of viscoelastic forces and their measurements; some viscoelastic formulas</p> <p>15) The flow of suspensions: viscosity of dispersions and emulsions; effects of the shape and size of the particles; overview of particle interactions; viscosity of flocculated systems; thixotropy; shear thickening</p> <p>16) Polymer rheology: different kinds of polymer chains; polymer solutions; polymer melts</p> <p>17) Rheology of surfactant systems: surfactant phases; rheology of surfactant systems</p> <p>18) Rheology of food products</p> <p>19) Extensional flow: the extensional flow; the Trouton ratio; examples of extensional viscosity curves; some applications</p> <p>20) Recall on scalars, vectors, tensors and their algebra.</p> <p>21) The stress tensor. Construction, property.</p> <p>22) Stress ellipsoid. The case of pressure. Deformation tensor.</p> <p>23) Generalized Hooke’s law. Matrix of modules and compliance, its properties. Recalls: differential operators on scalars / vectors / tensors, useful theorems.</p> <p>24) Conservation of the moment and the mass. Newtonian constitutive equations. Navier Stokes equation. Problems on the flow of incompressible Newtonian fluids: entrainment, f. of poiseuille, f. torsional</p> <p>25) Material functions and experimental response to steady state flow in simple shear geometry and in extensional geometry.</p> <p>26) Viscoelasticity and constitutive equations</p> <p>27) Non-linear viscoelasticity. Cauchy and Finger Tensors.</p> <p>28) Introduction to more advanced constitutive equations. Models: Integral Lodge, Maxwell Upper / Lower Convected, Cauchy-Maxwell, Rubberlike Liquid Lodge. Quasi-linear models (fluid A and B), non-linear differentials (Oldroyd 8 const.)</p> <p>29) Other constitutive approaches: molecular approach for polymeric systems. Outline: Configuration distribution function, temporary network model, reptation theory</p>
Wymagania wstępne	

4. Sposoby weryfikacji efektów uczenia się modułu			
kod	nazwa (typ)	opis	efekty uczenia się modułu
MB_10_w_1	egzamin	The modality of verification of the students’ knowledge and skills foresees the continuous interaction with the teacher during the lessons as well as a final oral exam and a presentation of a seminar on a topic previously agreed with the teacher	MB_10_1, MB_10_2, MB_10_3, MB_10_4, MB_10_5

5. Rodzaje prowadzonych zajęć						
kod	rodzaj prowadzonych zajęć			praca własna studenta		sposoby weryfikacji efektów uczenia się
	nazwa	opis (z uwzględnieniem metod dydaktycznych)	liczba godzin	opis	liczba godzin	
MB_10_fs_1	wykład	Detailed discussion by the lecturer of the issues listed in the table "module description" using the table and/or multimedia	48	Supplementary reading, working with the textbook	102	MB_10_w_1

		presentations				
--	--	---------------	--	--	--	--