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: Transport Phenomena in Materials

Kod modułu: W4-2BF-MB-22-35

1. Liczba punktów ECTS: 6

2. Zakładane efekty uczenia się modułu

kod	opis	efekty uczenia się kierunku	stopień realizacji (skala 1-5)
MB_35_1	the student will have a deep knowledge of the fundamentals to transport phenomena (species, heat, and momentum) according to a unified chemical engineering perspective	KBF_W04	4
MB_35_2	the student will be able to use quantitative balances (steady-state and dynamic) and to set up simple models, with or without analytical solution	KBF_W01 KBF_W10	4 4
MB_35_3	the student will have a general understanding enabling her/him to apply the theory to more advanced applications	KBF_W07	4
MB_35_4	the student will have got some practical experience on numerical simulation of transport phenomena with commercial codes	KBF_U08 KBF_W03	4 4

3. Opis modułu

Opis	INTRODUCTION. Local equilibrium, definition of convective and diffusive fluxes, materials transport properties, dimensionless numbers (Reynolds, Prandtl, Schmidt, Peclet, etc), origin of diffusive equations & random walk. MICROSCOPIC GOVERNING EQUATIONS. Derivation of microscopic balance equations (general, mass, species, internal energy, momentum), Eulerian and Lagrangian approaches, tensor notation and operators. STATIONARY HEAT CONDUCTION. Governing equation and boundary conditions, Newton law of cooling, Biot and Nusselt numbers, unidirectional heat conduction (linear, cylindrical and spherical coordinates), effective thermal conductive of composite materials, heat conduction with heat source. TIME-DEPENDENT HEAT CONDUCTION. Step response in a semi-infinite slab, self-similar solutions, response to heat pulse. FUNDAMENTALS OF MATERIAL TRANSPORT. Species fluxes and velocities, convection vs diffusion, mass vs molar basis, constitutive equations of diffusion (Fick law), balance equations and boundary conditions. STATIONARY MATERIAL TRANSPORT. Diffusion in a stagnant film, effective mass transport coefficient, Sherwood number, simplifications in the dilute limit, diffusion with heterogeneous reaction, diffusion with homogeneous reaction, Thiele modulus and effectiveness factor, scaling of regimes (kinetic,

	internal and external). TIME-DEPENDENT MATERIAL TRANSPORT. Unidirectional diffusion in semi-infinite slab with Robin-type boundary condition (Crank's solution). MOMENTUM TRANSPORT. Laminar and turbulent flows, velocity profiles in a pipe, non-Newtonian fluids, flow in porous media, Knudsen effects. TUTORIALS. Use of Microsoft Excel and codes in Comsol Multiphysics: basic use of the codes, isotope exchange, baking of a ceramic brick with phase transformation. SEMINARS. Transport phenomena in lithium-ion batteries.
Wymagania wstępne	

4. Sposoby weryfikacji efektów uczenia się modułu

kod	nazwa (typ)	opis	efekty uczenia się modułu
MB_35_w_1	egzamin	The global assessment of the learning outcomes is made with an oral exam (1h on average). The exam consists of 2-3 practical exercises to be implemented and solved by the candidate, covering the key subjects of the class (transport of species and heat, steady-state and transient solutions). Based on the exercises, the general knowledge of the meaning of dimensionless quantities, asymptotic behaviors, and correlations among different fields, will be assessed. The correct implementation of the practical exercises is a necessary criterion to succeed in the exam.	MB_35_1, MB_35_2, MB_35_3, MB_35_4

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_35_fs_1	wykład	detailed discussion by the lecturer of the issues listed in the table "module description" using the table and/or multimedia presentations	48	supplementary reading, working with the textbook	102	MB_35_w_1