PART A: COURSE PROGRAMME

1.	**Field of study**	**Biophysics**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne
7.	ISCED code	0533 (Physics)
8.	Connection between the field of study and university development strategy, including the university mission	A field of study in line with the development strategy of the Institute of Physics and the mission of the University.
9.	Number of semesters	4
10.	Degree	magister (Master's Degree)
11.	Specializations	Bio and Pharmaceutical Materials Science
12.	The semester from which the specializations starts	1
13.	Percentage share of scientific or artistic disciplines in education (along with the indication of the leading discipline)	• *[leading discipline]* physical sciences (natural sciences): 100%
14.	Percentage of the ECTS credits for each of the scientific or artistic disciplines to which the learning outcomes are related to the total number of ECTS credits (along with the indication of the leading discipline)	Bio and Pharmaceutical Materials Science: • *[leading discipline]* physical sciences (natural sciences): 100%
15.	Number of ECTS credits required to achieve the qualification equivalent to the level of study	120
16.	Percentage of the ECTS credits for optional modules in relation to the total number of ECTS credits	69%
17.	Total number of ECTS credits that a student must obtain in the modules taught	120
18.	Number of ECTS credits that a student must obtain in modules assigned to disciplines within the humanities or social sciences (not	5

	less than 5 ECTS) - in the case of fields of study assigned to disciplines within the fields other than, respectively, humanities or social sciences	
19.	Graduation requirements for a particular specialization	The condition of graduation is: -passing all modules specified in the study plan of the biophysics major with the specialization "Bio & Pharmaceutical material science", and passing the required examinations, writing and defending the master's thesis in front of the examination committee, -obtaining the number of ECTS points required by the study plan.
20.	Organization of the process of obtaining a degree	§1 The diploma procedure has been specified at the University level in the Study Regulations and in the Ordinance No. 16 of the Rector of the University of Silesia in Katowice of 28 January 2015 on the procedure for submitting and archiving written diploma theses, as amended. §2 1. The student enrolls in a selected MA seminar, on the date set by the Dean. 2. The student chooses the topic of his master's thesis from the topics given by the Coordinator of a given field of study, simultaneously choosing the Promoter who proposed the topic. 3. The supervisor clarifies the subject of the master's thesis with the student, taking into account the conditions set out in §30, section 5 of the Study Regulations. 4. The student submits the diploma dissertation, archives its electronic version and submits a printed copy of his dissertation in the manner announced in the Ordinance of the Rector of the University of Silesia in Katowice of January 28, 2015 on the introduction of the procedure for submitting and archiving written diploma theses in accordance with, respectively, §2 clause 1, 2, 3, §3 section 1, 2, 3, 4, 5 and §6 sec. 1, 2. §3 Reviews are made available to the graduate student in the APD system no later than 3 days before the scheduled date of the master's examination. § 4 1. The master's examination consists of two parts: (a) defense of the thesis, (b) answers to questions. 2. The defense of the master's thesis begins with the master's dissertation. Then the graduate student responds to the comments on the thesis contained in the reviews; then members of the commission formulate additional questions and comments about the work. The graduate student's answers end the defense of the thesis. 3. In the second part of the examination, the graduate student receives examination questions. The questions concern subjects in the field of biophysics (depending on the specialization: molecular biophysics, molecular spectroscopy, basics of drug action, optometry, science of biological and pharmaceutical materials). The scope of the exam in a given subject corresponds to the curriculum of the relevant lectures included in the Course Card. 4. At the end of the exam: a) Members of the commission evaluate the course of the diploma examination

		b) The committee determines partial marks for answers to particular examination questions. c) The examination committee determines the final grade for the thesis and the final grade for the diploma according to the rules adopted in the Study Regulations at the University of Silesia. 5. Immediately after determining the grades, the commission announces them to the graduate student.
21.	Internships (hours and conditions) in the case of practical programmes and in general university programme - if such requires internship	Research/industrial internship as an introduction to research projects. The internship should last up to 2 months, and take place in one of the EU countries in an academic or industry laboratory, large scale research facility, or computer center After completion of the internship, the students will have hands-on, operative knowledge of a research project carried out either at a university, research institute or facility, or private company. They will actively participate in a line of research or development of a product, and become acquainted with the work environment which is the target of the Erasmus Mundus program. A supervisor from Institute/Company + Tutor from UPC.
22.	Total number of ECTS credits that a student must obtain in internships	5
23.	Number of ECTS credits - higher than 50% of the total number of credits - that a student must obtain: • in general university programmes within a module connected with research carried out in the scientific or artistic disciplines to develop his/her knowledge and research skills; • in practical programmes within a module to develop practical skills	111
24.	General description of the programme	During the first term in the University of Pisa, all students will have to complete a set of common courses devoted to a broad spectrum of materials science topics. During the second term, all students will move to Barcelona. The second term actually marks the first differentiation from teaching general knowledge in the materials science fields towards more specialized courses. It will offer the possibility to students to discover new concepts and approaches topics in a very flexible way based on a selection of optional courses. During the third term, students engaged in the “Track 1: soft-matter and biopharmaceuticals” track will move to Katowice to develop their skills on soft-matter (polymers, colloids, gels) as well as biological materials (peptides, proteins, biomaterials) of therapeutical interest and their specificities. In the meantime, students of the “Track 2: condensed-matter and pharmaceuticals” track will go to Lille.The “soft-matter and biopharmaceuticals track” (track 1) (Pisa-Barcelona-Katowice) will provide a training focusing on understanding at the molecular level of the physicochemical and biological properties of small and macromolecules, lipid membrane systems and macromolecular drugs. Biopharmaceuticals are among the most sophisticated medicines and are becoming increasingly prominent in the pharmaceutical industry. Some companies are already spending 40% or more of their R&D budget on biopharmaceuticals and they are expected to dominate product use and sales of the future. However, compared to conventional chemical drugs, therapeutic proteins suffer from intrinsic instability. Changes due to chemical or physical instability can alter protein folding and the protein 3-dimensional structure. It is a major problem because denatured or aggregated protein species will not only be therapeutically inactive, but also may cause unpredictable side effects, such as immunogenicity or toxicity. A strong awareness to attempt for highly stable biopharmaceutical products has thus emerged. Because of their highly limited stability in liquid form, many of these protein-based therapeutics would be unusable within a few days. Solid dosage forms are thus usually preferred. Industries are particularly highly demanding of training with a high fundamental knowledge in biophysics science to face many challenges of protein-based therapeutics because of their intrinsic physical and chemical instability and specific mode of formulation in the solid forms using different techniques of drying (freeze drying, spray drying, supercritical fluid drying). This problematic includes very important fundamental knowledge of materials science such as

		freezing, thawing, interfacial stress, interaction with specific solvents (water, sugars), mechanism of stabilization (glassy state, water replacement, interfacial adsorption) and know-how of very specific experimental techniques (microcalorimetry, Infra-Red, Raman scattering, Scanning electron micrographs).
25.	General description of the specialization	The European Master programme "BIOPHAM (BIO&PHArmaceutical Materials science)" is a two-year (120 ECTS) programme entirely taught in English and jointly operated by the University of Lille (France), the University of Pisa (Italy), the University of Silesia in Katowice (Poland) and the Polytechnic University of Catalunya (Spain). BIOPHAM answers to an international demand for qualified graduates with theoretical and applied high-level training in materials science and physics & chemistry of materials and their applications to pharmaceuticals and biopharmaceuticals. During the third term, students engaged in the “Track 1: soft-matter and biopharmaceuticals” track will move to Katowice to develop their skills on soft-matter (polymers, colloids, gels) as well as biological materials (peptides, proteins, biomaterials) of therapeutical interest and their specificities. students will get the opportunity to specialize either on numerical techniques applied to drugs (atomistic modelling, mathematical diffusion models for controlled drug delivery) or on dedicated advanced characterization experimental techniques. The fourth and last term covers the Master thesis of the students. The location where the student will perform her/his thesis is a free choice and can be performed in a research laboratory of a partner University, in an associated academic/industry partner organization or in any other company offering oriented topic for the Master thesis. The students will be strongly encouraged to take advantage of the large network of associated academic and industrial organizations and external associated universities. In any case, an agreement will be signed between the student, the company/laboratory/organization where the work placement takes place and the host University chosen by the student for the fourth term. All defences will be made public and followed by all students (compulsory) thanks to video-conference systems.

PART B: LEARNING OUTCOMES

1.	**Field of study**	**Biophysics**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Code of the learning outcome of the programme	**Learning outcomes** The graduate:	Codes of the second-order PRK characteristics to which the learning outcome of the programme is related
KNOWLEDGE		
KBF_W01	understands complex physical and natural phenomena and processes; can relate and explain these phenomena	2018_P7S_WG
KBF_W02	has an in-depth knowledge of the sciences such as biomathematics, biophysics, biochemistry and bioinformatics	2018_P7S_WG
KBF_W03	can apply modelling methods to biophysics and biochemistry issues	2018_P7S_WG
KBF_W04	is proficient in the use of scientific apparatus for studying physical and biological phenomena; understands the theoretical basis of the functioning of research apparatus	2018_P7S_WG
KBF_W05	has knowledge of nanobiotechnology, of obtaining and applying nanocarriers, biosensors, nanoparticles in medicine and health care	2018_P7S_WG
KBF_W06	has knowledge in the field of optics and ophthalmology, has learned the construction of physical equipment and its application in diagnosis and therapy in ophthalmology	2018_P7S_WG
KBF_W07	knows and understands the basic physical phenomena occurring at the molecular level, methods for their description and the use of physical research to explain them	2018_P7S_WG
KBF_W08	knows the basic software used in molecular modelling	2018_P7S_WG
KBF_W09	knows the basics of drug action, their chemical affinity, knows how to design their chemical properties	2018_P7S_WG
KBF_W10	has a basic knowledge of experimental methods used in molecular biophysics	2018_P7S_WG
KBF_W11	knows the basics of occupational health and safety at the level that allows independent work in the laboratory	2018_P7S_WG
KBF_W12	has an in-depth knowledge of selected scientific methods and is familiar with issues characteristic of the discipline of science not related to the programme	2018_P7S_WG
KBF_W13	has knowledge of intellectual property and copyright protection	2018_P7S_WK
SKILLS		
KBF_U01	is able to clearly present correct biophysical reasoning, collect and generalise facts in speech and writing	2018_P7S_UK
KBF_U02	is able to apply a mathematical apparatus to solve complex problems in physics and biophysics	2018_P7S_UW
KBF_U03	is able to explain the processes occurring in the living matter based on the laws of physics and chemistry	2018_P7S_UW
KBF_U04	can perform various types of physical measurements and experiments related to the phenomena occurring in nature	2018_P7S_UW
KBF_U05	is able to perform statistical analysis and interpretation of measurement results	2018_P7S_UW
KBF_U06	can use selected software packages for the analysis of molecular structure, proteins, drugs, etc.	2018_P7S_UW

KBF_U07	is able to select and apply appropriate scientific apparatus and perform a series of measurements of the properties of biological systems	2018_P7S_UW
KBF_U08	can describe basic micro- and macroscopic properties of the living matter based on the knowledge gained	2018_P7S_UK
KBF_U09	is able to prepare a study containing a description, analysis, discussion of errors and conclusions on experimental results obtained	2018_P7S_UW
KBF_U10	is able to work individually and in a team; is able to estimate the time required to conduct out the commissioned task	2018_P7S_UO, 2018_P7S_UU, 2018_P7S_UW
KBF_U11	can obtain information from literature, databases and other sources; can integrate and interpret information obtained, draw conclusions and formulate and justify opinions	2018_P7S_UW
KBF_U12	has a sufficient command of English (B2+ level) to comprehend the specialist literature and manuals for IT devices and tools	2018_P7S_UK
KBF_U13	is able to clearly present the problem/point of view to the specialist and the layman	2018_P7S_UK
KBF_U14	can prepare a typical written paper on specific biophysical issues using advanced theoretical models	2018_P7S_UK
KBF_U15	has the ability to prepare and deliver an oral presentation in their native and English languages, using modern multimedia techniques	2018_P7S_UK
KBF_U16	has the ability to self-learn, e.g. to improve professional competence	2018_P7S_UU
KBF_U17	has an in-depth ability to pose and analyse problems based on the acquired content from the discipline of science not related to the programme	2018_P7S_UW
KBF_U18	communicates in a foreign language using advanced language communication competences and has the ability to comprehensively read complex scientific texts and an in-depth ability to prepare various written works (including research) and oral presentations on specific issues in a given programme in a foreign language	2018_P7S_UK
SOCIAL COMPETENCES		
KBF_K01	knows the limitations of their own knowledge and understands the need for further education	2018_P7S_KK
KBF_K02	is able to precisely formulate questions to deepen their own understanding of a given topic or to find the missing elements of reasoning	2018_P7S_KK
KBF_K03	is able to work in a group with different roles; understands the division of tasks and the individual's need to fulfil a given task	2018_P7S_KO, 2018_P7S_UO
KBF_K04	understands the need to improve professional and personal competences	2018_P7S_KK
KBF_K05	understands and appreciates the importance of intellectual honesty in their own and others' actions; acts ethically	2018_P7S_KR
KBF_K06	understands social aspects of applying the acquired knowledge and skills and the related responsibility	2018_P7S_KR
KBF_K07	is able to listen to a different opinion and professionally discuss the issue in question	2018_P7S_KK
KBF_K08	can think and act in terms of entrepreneurship (costs, economic effects, profit and loss account, profitability)	2018_P7S_KO
KBF_K09	is able to correctly identify priorities for the implementation of the tasks specified by themselves or others	2018_P7S_KK
KBF_K10	understands the need for an interdisciplinary approach to solving problems, integrating knowledge from different disciplines and practising self-education to deepen the knowledge acquired	2018_P7S_KK

PART C: COURSE STRUCTURE

1.	**Field of study**	**Biophysics**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne
7.	Academic year for which the revised course structure applies	—

Specialization: Bio and Pharmaceutical Materials Science

Basic requirements

No.	Module	Lang.	E/C	form of teaching: Total	L	O	Total ECTS	year 1 / semester 1: L	O	E	year 1 / semester 2: L	O	E	year 2 / semester 3: L	O	E	year 2 / semester 4: L	O	E
1	Disordered and Off-Equilibrium Systems	EN	E	48	48		6	48		6									
2	Mechanical Behaviour of Materials	EN	E	48	48		6	48		6									
3	Optional Courses: Common Basis *[see description below]	*	*	46	46		6	46		6									
4	Quantum Matter Physics	EN	E	48	48		6	48		6									
5	Solid State Physics	EN	E	48	48		6	48		6									
6	Large Facilities: Synchrotron and Neutron Sources	EN	E	45	45		5				45		5						
7	Materials Science of Drugs	EN	Z	36	30	6	4				30	6	4						
8	Optional Courses: Pre-Orientation *[see description below]	*	*	72	50	22	8				50	22	8						
9	Soft Materials (Molecular and Soft Condensed Matter)	EN	E	36	36		4				36		4						
10	Application of Vibrational Spectroscopy in Therapeutic Substance Studies	EN	E	45	15	30	4							15	30	4			
11	Molecular Biophysics	EN	E	45	15	30	5							15	30	5			
12	Optional Courses: Specialization *[see description below]	*	*	120	60	60	12							60	60	12			
13	Master's Seminar, Master's Laboratory, Preparation of a Master Thesis	EN	Z	210		210	30											210	30
	TOTAL Basic requirements:			**847**	**489**	**358**	**102**	**238**	**0**	**30**	**161**	**28**	**21**	**90**	**120**	**21**	**0**	**210**	**30**

Internships and Field Work

No.	Module	Lang.	E/C	form of teaching: Total	L	O	Total ECTS	year 1 / semester 1: L	O	E	year 1 / semester 2: L	O	E	year 2 / semester 3: L	O	E	year 2 / semester 4: L	O	E
1	Short Internship	EN	Z	45		45	5					45	5						
	TOTAL Internships and Field Work:			**45**	**0**	**45**	**5**	**0**	**0**	**0**	**0**	**45**	**5**	**0**	**0**	**0**	**0**	**0**	**0**

Others requirements

No.	Module	Lang.	E/C	form of teaching: Total	L	O	Total ECTS	year 1 / semester 1: L	O	E	year 1 / semester 2: L	O	E	year 2 / semester 3: L	O	E	year 2 / semester 4: L	O	E
1	Language Course	EN	Z	36		36	4					36	4						
2	Introduction to Entrepreneurship	EN	Z	30	30		1							30		1			
3	Language Course: Scientific English	EN	Z	45		45	4								45	4			

Others requirements				form of teaching				year 1						year 2					
								semester 1			semester 2			semester 3			semester 4		
No.	Module	Lang.	E/C	Total	L	O	Total ECTS	L	O	E	L	O	E	L	O	E	L	O	E
4	Protection of Intellectual Property, Health and Safety, Ergonomics	EN	Z	15	15		1							15		1			
5	Subject in the Field of Humanities	EN	Z	30	30		3							30		3			
	TOTAL Others requirements:			**156**	**75**	**81**	**13**	**0**	**0**	**0**	**0**	**36**	**4**	**75**	**45**	**9**	**0**	**0**	**0**
	TOTAL:			**1048**	**564**	**484**	**120**	**238**		**30**	**270**		**30**	**330**		**30**	**210**		**30**
TOTAL								**1048**											

Studia kończą się nadaniem tytułu zawodowego magistra na kierunku Biophysics w specjalności Bio and Pharmaceutical Materials Science.

* Groups of modules

Optional Courses: Common Basis

Description:

Students choose specific courses over the available optional courses offered (6 ECTS credits are required). The proposed modules include several courses on various topics. Their goal is to homogenize and strengthen student's backgrounds to the level required for the implementation of the further study program.

Modules:	Lang.	E/C	L	O	ECTS
Biofluids and Materials Interactions	EN	E	24		3
Computational Materials Science	EN	E	48		6
Green Chemistry for Materials and Processes	EN	E	48		6
Introduction to Optical Spectroscopy	EN	E	36		6
Polymer Science and Engineering	EN	E	48		6
Rheology	EN	E	48		6
Surface Science	EN	E	18	6	3

Optional Courses: Pre-Orientation

Description:

Students choose 2 specific courses over the available optional courses offered (4 ECTS points each). The selection of the module should be adapted to the planned field of further student's specialization.

Modules:	Lang.	E/C	L	O	ECTS
Biophysical and Materials Science Characterization	EN	E	30	6	4
Complexity in Biophysics	EN	E	36		4
Machine Learning with Neural Networks	EN	C	26	10	4
Stochastic Methods for Optimization/Simulation	EN	C	24	12	4

Optional Courses: Specialization

Description:

Depending on the preferred specialization, students choose one of the two groups of modules containing a set of specialized lectures guaranteeing 12 ECTS credits. Students interested in modeling and simulations choose Group A (MB-22: Fundamentals of molecular modeling, MB-23: Computer modeling, MB-24: Specialized lecture). Students interested in advanced experimental techniques choose the group of modules B (MB-25: Specialized laboratory, MB-26: Drug chemistry and technology of drug forms, MB-27: Pharmacology and pharmacognosy, MB-28: Selected issues from biomaterials toxicology.)

Modules:	Lang.	E/C	L	O	ECTS
Computer Modeling	EN	C		30	4
Drug Chemistry and Technology of Drug Forms	EN	C		45	3
Fundamentals of Molecular Modeling	EN	E	30	30	5
Pharmacology and Pharmacognosy	EN	E	30	30	5

Selected Issues from Biomaterials Toxicology	EN	E	30	15	2
Specialized Laboratory	EN	C		30	2
Specialized Lecture: Dielectric Spectroscopy in the Study of Dynamics of Biological Systems	EN	E	30		3

Legend

Each semester consists of 15 weeks
E/C - examination/course work
E - ECTS
L - lecture, O - all forms of teaching excluding lecture (practical classes, laboratory classes, discussion classes, seminar, proseminar, language classes, field practice, workshop, internship, tutoring)

PART D: MODULES DESCRIPTION

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Application of Vibrational Spectroscopy in Therapeutic Substance Studies

Module code: W4-2BF-MB-21-21

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_21_1	The student knows the laws of physical chemistry underlying vibration spectroscopy methods	KBF_K02 KBF_U04 KBF_W01 KBF_W02 KBF_W04 KBF_W07 KBF_W11	3 3 3 3 3 3 3
MB_21_2	The student gathered extensive information on the usefulness of vibration spectroscopy in the analysis of pharmaceutical materials	KBF_U07 KBF_W04 KBF_W10	4 4 4
MB_21_3	The student knows how to perform basic measurements using IR and Raman spectrometers	KBF_K02 KBF_U04 KBF_W01 KBF_W02 KBF_W04 KBF_W07 KBF_W11	4 4 4 4 4 4 4
MB_21_4	The student can analyse the results of measurements obtained from these two techniques	KBF_K09	4

		KBF_U04	4
		KBF_U07	4
		KBF_W01	4
		KBF_W02	4
		KBF_W04	4
		KBF_W11	4

3. Module description	
Description	The entire course consists of lectures and laboratory exercises that introduce students to the theory and practice of the application of two complementary research techniques: infrared absorption (IR) spectroscopy and Raman scattering (RS). This will give them the knowledge to solve many important problems in pharmacy: 1) drug identity, 2) test purity, 3) crystal structures of drugs, 4) characteristics of polymorphism, 5) tautomerization, 6) interactions between active drugs and excipients. In the first part of the lecture, students will be introduced to the basic principles of vibration spectroscopy, in the second part the possibilities of using spectroscopic methods in pharmacy will be presented in detail. During the laboratory work, they learn the practical aspects of various vibration spectroscopy measuring techniques.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_21_w_1	exam	test on issues discussed during the lecture	MB_21_1, MB_21_2
MB_21_w_2	credit	evaluation of the report containing the analysis of measurement results	MB_21_3, MB_21_4

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_21_fs_1	lecture	Detailed discussion by the lecturer of the issues listed in the table "module description" using the table and/or multimedia presentations	15	Work with lecture notes and given bibliography	20	MB_21_w_1
MB_21_fs_2	laboratory classes	Performance of exercises on professional research equipment	30	Preparation of the final report	30	MB_21_w_2

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Biofluids and Materials Interactions

Module code: W4-2BF-MB-21-08

1. Number of the ECTS credits: 3

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_08_1	know the biofluid mechanics	KBF_K01 KBF_U08 KBF_W01 KBF_W02	4 4 4 4
MB_08_2	know the basics of biofluids in the human body	KBF_K01 KBF_U08 KBF_W01 KBF_W02	4 4 4 4
MB_08_3	know the interactions of fluids with gas and sound waves	KBF_K01 KBF_U08 KBF_W01 KBF_W02	4 4 4 4

3. Module description

Description	Introduction to biofluid mechanics: definitions of fluid, fluid hydrostatics, and fluid dynamics; pressure and shear stress; fluid properties (density, viscosity); types of fluids (Newtonian, non-Newtonian); types of fluid flow (laminar, turbulent). Fluids in the human body, Blood-material interactions: Blood fluid dynamics; the influence of materials surface. Fluid materials interacting with gas and sound waves. Metal corrosion in biofluids.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
MB_08_w_1	exam	Oral exam	MB_08_1, MB_08_2, MB_08_3

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
MB_08_fs_1	lecture	Detailed discussion by the lecturer of the issues listed in the table "module description" using the table and/or multimedia presentations	24	Supplementary reading, working with the textbook	51	MB_08_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Biophysical and Materials Science Characterization

Module code: W4-2BF-MB-21-14

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_14_1	students will be able to understand and describe the fundamental properties of aqueous solutions and complex materials	KBF_U03 KBF_U08 KBF_W02 KBF_W07	4 4 4 4
MB_14_2	students will be able to describe the application of experimental physicochemical methods to the solid and liquid states and choose the appropriate experimental techniques that serve a specific purpose	KBF_U01 KBF_U09 KBF_W02 KBF_W10	3 3 4 4

3. Module description

Description	The course aims to provide an introduction to chemical physics, especially on liquid solutions (both electrolyte and nonelectrolyte), solid solutions, and homogeneous and hybrid materials, and on the relevant characterization techniques. Course syllabus: (1) Introduction to inorganic chemical physics of electrolyte & nonelectrolyte solutions Types of solutions. Thermodynamics of solutions. Properties of water: The hydrogen bond, solubility of molecules in water, polar and non-polar solvents. Electrical permeability of water. Dissociation: acids and bases, protonation. Properties of solutions: functional groups, hydrophilic and hydrophobic interactions; solubility; diffusion. Colligative properties: boiling-point elevation, freezing point depression, osmotic pressure. Surface tension, capillarity. Water phase diagram and anomalies; aqueous electrolytes; non-electrolyte solutions. Electrostatics of salty solutions: biopolymers (polyelectrolytes) and biomembranes in water; Poisson-Boltzmann equation, Debye-Hückel model, electric double layers, ion, and proton conduction; transport properties. (2) Introduction to materials science properties Cohesive interactions; structural and mechanical properties of homogeneous solids; organic molecular solids; non-miscible systems: morphology and properties of phase-separated materials (3) Laboratory techniques

	- Elemental analysis: photoelectron & mass spectroscopy (XPS, UPS, Auger, secondary ion mass spectroscopy) - Chemical analysis: optical and vibrational spectroscopy (UV-vis, IR, Raman), nuclear magnetic resonance (NMR) - Morphological analysis: contact angle, powder X-ray diffraction (XRD), tomography (microCT), NMR-imaging, electron microscopy (SEM, TEM, energy loss/secondary electron spectroscopy) - Phase-change analysis - Mechanical, electrical, and optical characterization - A pharmaceutical application: optical measurement of the dissolution kinetics and solubility of a drug (4) Applications to pharmaceutics, drug formulation, & biophysical pharmacology: - Experimental techniques for electrolyte and non-electrolyte solutions - Small Molecules (drugs): HPLC, Chromatography, Mass spectroscopy, ICP-MS - Characterization of Nanoparticles: Molecular sizes (Dynamics light scattering, DLS), Surface charge (zeta potential, with conductivity measures) - Characterization of Biomolecules: chromatography, gel electrophoresis, Western Blot. Proteomics
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_14_w_1	credit	the basis for obtaining credit will be the grades from homework and laboratory reports	MB_14_1, MB_14_2
MB_14_w_2	exam	oral/written exam	MB_14_1, MB_14_2

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_14_fs_1	lecture	Detailed discussion by the lecturer of the issues listed in the table "module description" using the table and/or multimedia presentations	30	Supplementary reading, working with the textbook, doing homework	44	MB_14_w_2
MB_14_fs_2	laboratory classes	Performance of exercises on the subject consistent with the issues listed in the table "module description"	6	Acquiring knowledge in the scope of the exercise, preparation of the final report on a given exercise	20	MB_14_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Complexity in Biophysics

Module code: W4-2BF-MB-21-16

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_16_1	students will have a basic knowledge of some biological phenomena (from the molecular or cellular level to the macroscopic level), and understand what a complex system is and how to characterize it	KBF_U03 KBF_U08 KBF_W02 KBF_W07	4 4 4 4
MB_16_2	students will be able to employ numerical techniques as well as a software specific to the course	KBF_U02 KBF_U06 KBF_W08	3 4 4
MB_16_3	students will be able to employ theoretical/practical knowledge to solve problems of biological interest and present the results in a broader context, using the appropriate terminology	KBF_K02 KBF_U08 KBF_U13	4 4 3

3. Module description

Description	Course syllabus: (1) Biological networks (examples in system biology: metabolic networks, interactome, regulatory and signalling networks; biological neural networks; networks in ecology and epidemiology (2) Complex spatio-temporal dynamics in biology (oscilations, excitability, bistability; sinchronization in biological systems: neural networks; spatio-temporal chaos: cardiac fibrillation (3) Analysis of complex biosignals (deterministic and stochastic signals; statistical properties; non-lineal time-series analysis of series temporalis) (4) Self-organization in biological systems (morphogenesis; self-assembly: protein folding, membrane formation); growth processes: chemotaxis, tumour growth) (5) Collective motion and active matter (flocking, swarming and herd; cell migration)

Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
MB_16_w_1	exam	The final mark for this course will be as follows mark = W*0.5 + O*0.5, where W is the total mark of written examinations, which will include a written exam, applied activities, case studies or problem resolution, and O is the total mark of oral examination, consisting of an oral exam or oral presentation	MB_16_1, MB_16_2, MB_16_3

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
MB_16_fs_1	lecture	Detailed discussion by the lecturer of the issues listed in the table "module description" using the table and/or multimedia presentations	36	Supplementary reading, working with the textbook	64	MB_16_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Computational Materials Science

Module code: W4-2BF-MB-21-34

1. Number of the ECTS credits: 6

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_34_1	the student can comprehend molecular modeling techniques currently used in the field of life and material sciences	KBF_W02	4
MB_34_2	The student develops competencies on some of the most common computational methodologies used in molecular sciences	KBF_W03 KBF_W08	4 4
MB_34_3	the student develop computational skills through tutorials and exercises	KBF_K04	4

3. Module description

Description	Intermolecular Forces: Hydrogen bonding, Electrostatic interactions, London forces. Molecular clusters, Supramolecular assemblies. Thermodynamics: Variational formulation. Free energy of a reaction, Equilibrium constants. Statistical Mechanics: Gibbs ensemble, Mechanical system, Generalized coordinates, Lagrangian formalism. Hamiltonian formalism, Hamilton's equation, Phase space. Properties of Hamiltonian systems, Conservation laws, Canonical transformation, Poisson brackets, Liouville's operator, Equation of motion of dynamical variables. Liouville's equation and theorem, Probability density, Microcanonical ensemble, Canonical ensemble. Molecular dynamics: Definition, Foundations of molecular simulations, Limits and approximations. Overview of the basic ingredients (Energy potential, Force fields, Numerical integrators). Energy potential, Force fields, Numerical integrators. Force field terms (bonding, bending, torsion, non-covalent interactions). Molecular Dynamics: Coordinate and Velocity initialization, Integrators. Numerical integrators (velocity Verlet, Leapfrog), Statistical mechanical ensemble, Thermal and pressure coupling. Enhanced Sampling Methods. Simulation of the Kv ion channel. Simulation of a lipid bilayer. Fundamentals of enhanced sampling techniques. Implicit solvent and continuum electrostatic modeling. From collisional theory to stochastic dynamical systems. Stochastic differential equations and Statistical Mechanics. Structural properties: distribution function, radial distribution functions. Monte Carlo methods: Numerical Integration, Importance sampling. Free Energy methods. Free Energy Methods: Thermodynamic Integration, Free energy perturbation, Umbrella Sampling Free Energy Methods: Metadynamics, Jarzinski method, Adiabatic free energy. The course aims to provide an overview of the theories and methodologies currently used in various fields of computational molecular sciences, ranging from biomedical sciences to material sciences. A special focus will be devoted to those models and algorithms related to molecular simulation techniques, including enhanced sampling and free energy methods. Such models will be illustrated along with relevant examples taken from recent literature and concerning different molecular modeling applications.

Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
MB_34_w_1	exam	Oral Exam. In addition to questions related to the basic knowledge of the course, students will be asked to present a scientific problem of their interest suitable to be treated with molecular modeling methodologies.	MB_34_1, MB_34_2, MB_34_3

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
MB_34_fs_1	lecture	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_34_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Computer Modeling

Module code: W4-2BF-MB-21-23

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_23_1	Student has knowledge of advanced modeling methods in physics, chemistry and biology	KBF_K04 KBF_W03 KBF_W08	4 4 4
MB_23_2	Student knows the basic mathematical relations used in molecular modeling	KBF_K02 KBF_U02 KBF_U06 KBF_W08	4 4 4 4
MB_23_3	Student knows how to apply the mathematical modeling mechanism to solve complex problems in physics and biophysics	KBF_K02 KBF_U02 KBF_U06 KBF_W08	3 3 3 3
MB_23_4	Student can use selected software packages for the analysis of molecular structure, proteins, drugs, etc.	KBF_K02 KBF_U02 KBF_U06 KBF_W08	3 3 3 3

3. Module description

Description	During the course, students in practice become familiar with: 1. Deterministic modeling based on numerical solving for ordinary differential equations - examples and applications in biophysics: - transmission of nerve impulses, - tumor growth, - molecular motors,

	2. Amino acid and protein databases. 3. Modeling of molecules and their systems using density functional methods (DFT); geometry parameters, charge distribution characteristics and molecular spectra of organic molecules (e.g. amino acids). 4. Modeling of organic molecules and their systems using molecular dynamics methods.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_23_w_1	credit	average of marks for self-made projects	MB_23_1, MB_23_2, MB_23_3, MB_23_4

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_23_fs_1	laboratory classes	Solving specific problems of computer modeling. Both group and individual work	30	Group work on project tasks, independent work, preparation of the presentation of the results	45	MB_23_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Disordered and Off-Equilibrium Systems

Module code: W4-2BF-MB-21-03

1. Number of the ECTS credits: 6

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_03_1	Students will be able to understand and analyze scientific reports concerning experimental, theoretical, and computational studies concerning the physics of disordered and off-equilibrium systems	KBF_K02 KBF_U11 KBF_W01 KBF_W03 KBF_W07 KBF_W10	4 4 4 4 4 4

3. Module description

Description	1. From order to disorder Non-periodical long-range positional order: quasi-crystals Disorder in long-range positional atomic systems (cellular disorder): Substitutional disorder: interstitial and substitutional impurities, vacancies; Orientational disorder: plastic crystals (e.g. fullerene) Disorder in atomic systems without long-range positional order (topological disorder): Base elements in real crystals: Dislocations and Burger’s vector, Interfacial defects. Liquid state and amorphous state: N-bodies distribution functions, particular case: pair distribution; static structure factor; Hard sphere atomic liquids: Percus-Yevick theory. Disorder in polymeric systems: Conformations of polymeric linear chain: analogy with a random walk. Chain rigidity: Kuhn’s segment. Size distribution of the linear polymeric chain. Free energy of polymeric chain, entropic elasticity. The pair distribution function of polymeric chain: self-similarity 2. From equilibrium to out of equilibrium Supercooled metastable states and glass transition in liquids: Van Hove function and its momenta; Collective and microscopic dynamics: cage effect and vibrational properties, local and structural relaxation, relaxation time distribution, diffusion, visco-elasticity; Simple models of glass transition: Free volume, Configurational entropy. Elements of non-equilibrium thermodynamics: Zero Principle: fictive temperature in glasses, fluctuation-dissipation theorem violation; Second Principle: Jarzynski’s equality and Crooks fluctuation theorem: experimental tests in nanosystems.

	Polymeric chain Dynamics: Short-chain: Rouse model; Long chain: entanglement effect; Edwards tube model; De Gennes reptation motion: scale arguments. Non-equilibrium states in the active matter: Molecular Motors; Bacteria, Swimmers, swarms: emergent collective motions and glass transition. 3. Experimental techniques: structure and dynamics of disordered systems Scattering from disordered systems: generalities: Scattering cross-sections, coherent and incoherent scattering; Static and dynamic structure factor, elastic and inelastic scattering; Spatial, temporal and spatio-temporal correlation function. Photon Scattering (X-rays and light): Sources of coherent radiation (synchrotron), spectrometers and detectors; Structure of disordered systems: X-ray diffraction at a wide and small angle; Dynamics in disordered systems: Brillouin and Raman scattering, inelastic X-ray scattering, photocorrelation spectroscopy. Neutron scattering: Neutron sources and detectors: typical experimental layout; Structure of disordered systems: neutron diffraction at a wide and small angle, comparison with X-ray; inelastic neutron scattering and spectroscopy: TAS, TOF, Backscattering, Spin-Echo.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_03_w_1	exam	oral exam	MB_03_1

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_03_fs_1	lecture	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_03_w_1

1.	**Field of study**	**Biophysics**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Drug Chemistry and Technology of Drug Forms

Module code: W4-2BF-MB-21-26

1. Number of the ECTS credits: 3

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_26_1	Student learned the methods of obtaining biologically active substances	KBF_K04 KBF_U04 KBF_U07 KBF_U09 KBF_W01 KBF_W04 KBF_W05 KBF_W09	4 4 4 4 4 4 4 4
MB_26_2	Student knows the basics of drug synthesis technology	KBF_K04 KBF_U04 KBF_W02	4 4 4
MB_26_3	Student learned the techniques of molecular design of drug-like compounds	KBF_K02 KBF_U04 KBF_U07 KBF_U09 KBF_W01 KBF_W04 KBF_W05 KBF_W09	3 3 3 3 3 3 3 3
MB_26_4	Student plans and carries out syntheses of selected organic compounds using laboratory equipment, in accordance with	KBF_K09	3

	applicable health and safety regulations and the principles of safe waste disposal	KBF_W01 KBF_W04 KBF_W05 KBF_W09	3 3 3 3
MB_26_5	Student knows the classification of drugs and their effects on living organisms	KBF_K06 KBF_U04 KBF_U07 KBF_U09 KBF_W01 KBF_W04 KBF_W05 KBF_W09	3 3 3 3 3 3 3 3
MB_26_6	Student is able to apply selected spectroscopic methods and interpret a wide range of simple molecular methods in order to apply their chemical structure	KBF_K02 KBF_U04 KBF_U07 KBF_U09 KBF_W01 KBF_W04 KBF_W05 KBF_W09	4 4 4 4 4 4 4 4

3. Module description	
Description	During the course, students in practice become familiar with: 1. Molecular modeling of therapeutic compounds. 2. Preparation of selected therapeutic compounds. 3. Characterization of new drugs by NMR, MS, XRD methods. 4. In vitro biological activity studies.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_26_w_1	credit	average of marks for self-made projects + report	MB_26_1, MB_26_2, MB_26_3, MB_26_4, MB_26_5, MB_26_6

5. Forms of teaching						
code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_26_fs_1	laboratory classes	Self-performance of exercises on professional research equipment	45	Theoretical preparation in the scope of exercise. Preparation of a report on the given exercise	45	MB_26_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Fundamentals of Molecular Modeling

Module code: W4-2BF-MB-21-22

1. Number of the ECTS credits: 5

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_22_1	Has basic knowledge of molecular dynamics simulation and Monte Carlo method	KBF_W08	5
MB_22_2	Student knows the basics of molecular dynamics	KBF_W08	5
MB_22_3	Student can identify the advantages and limitations of known computer simulation methods	KBF_W08	5
MB_22_4	Student can choose the proper model of the interaction, statistical set and parameters of classical simulations appropriate for the analyzed system	KBF_U02	4
MB_22_5	He can use the available programs with open access to model simple molecules and simulate the dynamics of the system of atoms and molecules	KBF_U06	4

3. Module description

Description	During the lecture, the student becomes acquainted with the following issues: Molecular mechanics: -Description of binding and non-binding interactions. -Force fields: MMFF94, GAFF and GROMACS. -Optimization methods: simple gradient method, fastest gradient and conjugate gradients, Metropolis algorithm. Classic computer simulations: -Models of molecules and potentials of intermolecular interactions. Deterministic computer simulation methods - isolated molecular systems and extended systems (periodic boundary conditions, nearest image convention, spherical truncation, shifted potential), equations of motion, methods of solving difference equations, dynamics with constraints, long-range interactions, molecular dynamics for a microcanonical ensemble, canonical and isobaric-isothermal; mean values and fluctuations, thermodynamic quantities, temporal correlation functions, correlation times and transport coefficients, structural properties (binary decomposition function, static structure factor), long-range potential energy and pressure corrections. -Stochastic computer simulation methods - Monte Carlo method (Metropolis method, simulations for the canonical ensemble). During the laboratory classes free software such as GROMACS, Avogadro, VMD, NAMD, will be used to: -Constructing a given molecule and determining its most probable conformation.

	-Conducting a molecular dynamics simulation of a system of atoms. -Conducting molecular dynamics simulations of a system of simple molecules
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_22_w_1	exam	written exam/oral exam	MB_22_1, MB_22_2, MB_22_3, MB_22_4, MB_22_5
MB_22_w_2	credit	Two written tests. Constructing the starting configuration of a given molecule and optimizing its structure. Preparation of a system of atoms/molecules for a given density and thermodynamic conditions and starting a molecular dynamics simulation of such a system. The credit grade will be the arithmetic mean of the test marks on a scale of 2-5.	MB_22_1, MB_22_2, MB_22_3, MB_22_4, MB_22_5

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_22_fs_1	lecture	Detailed discussion by the lecturer of the issues listed in the table "module description" using the table and / or multimedia presentations	30	Work with the textbook; supplementary reading	60	MB_22_w_1
MB_22_fs_2	laboratory classes	Getting to know the available software, constructing molecules, selecting the force field and determining the equilibrium configuration. Designing a system of molecules using the implemented force fields and simulating the molecular dynamics of this system	30	Acquiring knowledge from lectures	45	MB_22_w_2

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Green Chemistry for Materials and Processes

Module code: W4-2BF-MB-21-06

1. Number of the ECTS credits: 6

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_06_1	the students will have the knowledge and skills useful in designing the construction of products, materials, and plants with minimal impact on human health and the environment	KBF_K06 KBF_U11 KBF_W02	5 3 4

3. Module description

Description	The concepts that will be presented are the emerging ones of the Green Chemistry: atomic efficiency, heterogeneous catalysis and biocatalysis, replacement of solvents and toxic compounds, reaction and process intensification, conversion of biomass into valuable chemicals/materials, waste recycling, design and production of green products as bioplastics. Examples of industrial processes where this sustainability approach is adopted will be shown as the extraction of active biomolecules and biopolymers from biomass with green solvents (supercritical fluids, ionic/eutectic liquids) and enzymatic technologies, modification of natural fibers with enzymes, and green technologies (steam explosion, supercritical carbon dioxide, microwaves, etc).
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_06_w_1	exam	Oral exam Requirement for examination: Knowledge on the tools and methodologies for the assessment of chemical, toxicological and environmental risk, life cycle analysis of products and processes, environmental indicators, green design of chemicals, polymers, and materials.	MB_06_1

5. Forms of teaching						
code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_06_fs_1	lecture	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_06_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Introduction to Entrepreneurship

Module code: W4-2BF-MB-21-32

1. Number of the ECTS credits: 1

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_32_1	Student has basic knowledge of creating and developing forms of individual entrepreneurship	KBF_U11 KBF_U17 KBF_W12	4 4 4
MB_32_2	Student knows and understands the basic concepts and principles of the protection of intellectual property and copyright	KBF_U11 KBF_W13	4 4
MB_32_3	Student can work individually and in a team; can estimate the time needed to complete the commissioned task	KBF_K07 KBF_K09 KBF_U10	5 5 5
MB_32_4	Student knows and understands the legal, economic and ethical aspects of scientific activity	KBF_K08 KBF_K10 KBF_W12	4 4 4
MB_32_5	Student knows how to work in a team taking different roles in it; understands the division of tasks and the need for the unit to fulfill the entrusted task	KBF_K03 KBF_K07 KBF_K09	5 5 5
MB_32_6	Student can think and act in terms of entrepreneurship (costs, economic effects, profit and loss, profitability)	KBF_K08 KBF_K10 KBF_U11 KBF_U17 KBF_W12	4 4 4 4 4

3. Module description

Description	Economic development, money and development. Entrepreneurship, features of an enterprising person. Social and economic importance of Entrepreneurship. Courage of vision and risk of action. Is it worth getting involved in ventures? A scientist as an entrepreneur. Innovation and innovation. The mental revolution of the transition from scientist to entrepreneur. How do scientists and entrepreneurs solve the problem? Place of science and scientist in entrepreneurship. "Doing" science in an entrepreneurial environment. Protection of intellectual property. Is the protection of intellectual property necessary and does it serve economic development? How to start creating a new company? Planning the creation of a new company. Stages of the company's life, the specificity of the innovative company "Death Valley". Project management. Competition and sector analysis. SWOT, PEST for selected sectors. Strategy, marketing and positioning of the company on the market. Enterprise Finance for Dummies. Break-even point.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_32_w_1	credit	Final test on issues discussed during the lecture.	MB_32_1, MB_32_2, MB_32_3, MB_32_4, MB_32_5, MB_32_6

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_32_fs_1	lecture	Providing the content of the lecture verbally with the use of content visualization. Focusing on a conceptually difficult material and indication of sources. Illustration of content using examples	30	Getting acquainted with the subject of the lecture, using textbooks, scripts, websites, etc.	30	MB_32_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Introduction to Optical Spectroscopy

Module code: W4-2BF-MB-21-07

1. Number of the ECTS credits: 6

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_07_1	students will gain the ability to analyze problems of optics involving nanomaterials, both for the analysis at the local scale and for the exploitation of their specific properties in devices and approaches	KBF_W02 KBF_W05 KBF_W07 KBF_W10	4 4 4 4
MB_07_2	students will develop cross-disciplinary abilities directly connected with other scientific areas	KBF_K10 KBF_W02	4 4

3. Module description

Description	Basics of radiation/matter interaction and understanding of emission/absorption spectra of substances in the range near- UV - IR, up to the THz range. Technical and conceptual tools for emission, absorption, Raman spectroscopy. Energy levels of the main physical systems: electronic levels in atoms and molecules, rotational and vibrational levels of molecules, Lorentz-Drude model, electronic levels of impurities (transition metals and rare earth) in crystals, electronic and phononic bands in crystals. Group theory applied to the main energy level systems mentioned above.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_07_w_1	exam	Oral final exam, partly fulfilled through a short presentation on a topic chosen in agreement with the lecturers	MB_07_1, MB_07_2

5. Forms of teaching						
code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_07_fs_1	lecture	Detailed discussion by the lecturer of the issues listed in the table "module description" using the table and/or multimedia presentations	36	Supplementary reading, working with the textbook	104	MB_07_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Language Course

Module code: W4-2BF-MB-21-19

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_19_1	Understands the importance of oral communication and texts of varying complexity, including understanding discussions, topics general and specialist in the field of the subject	KBF_U14	5
MB_19_2	Formulates clear and transparent oral and written statements, using the rules of organization of statements and appropriate registry	KBF_U14 KBF_U15	5 5
MB_19_3	Communicates with the use of various channels and communication techniques in various fields of science and disciplines research appropriate for a given field of study	KBF_U01 KBF_U17	3 3
MB_19_4	It searches for, selects, analyzes, evaluates, and classifies information using various sources and methods	KBF_U13	5
MB_19_5	Understands the need for further education, performs self-assessment, can supplement and improve the acquired knowledge and skills; can work in a team, communicate with the environment in the workplace and outside it	KBF_K01 KBF_K02 KBF_K04 KBF_U18	2 2 2 2

3. Module description

Description	ROSETTA STONE LANGUAGE COURSE. One level (A1, A2, B1, B2, C1) of a foreign language in a form of online written and oral exercises. To be chosen in a list of courses such as English C1 level or a basic level in Spanish, French, Italian, Polish, or another foreign language course.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
MB_19_w_1	credit	checking the language skills acquired during the course and self-study based on the results of online tests	MB_19_1, MB_19_2, MB_19_3, MB_19_4, MB_19_5

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
MB_19_fs_1	discussion classes	One level (A1, A2, B1, B2, C1) of a foreign language in a form of online written and oral exercises	36	Assimilation and consolidation of acquired language skills. Work with a textbook, dictionary, doing exercises, supplementary literature. Preparation of various oral and written forms (for example presentation, essay, letter, etc.)	64	MB_19_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Language Course: Scientific English

Module code: W4-2BF-MB-21-29

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_29_1	Understands the importance of oral communication and texts of varying complexity, including understanding discussions, topics general and specialist in the field of the subject	KBF_U14	5
MB_29_2	Formulates clear and transparent oral and written statements, using the rules of organization of statements and appropriate registry	KBF_U14 KBF_U15	5 5
MB_29_3	Communicates with the use of various channels and communication techniques in various fields of science and disciplines research appropriate for a given field of study	KBF_U01 KBF_U17	3 3
MB_29_4	It searches for, selects, analyzes, evaluates, and classifies information using various sources and methods	KBF_U13	5
MB_29_5	Understands the need for further education, performs self-assessment, can supplement and improve the acquired knowledge and skills; can work in a team, communicate with the environment in the workplace and outside it	KBF_K01 KBF_K02 KBF_K04 KBF_U18	3 3 3 3

3. Module description

Description	- Discussion on the methods of financing scientific research. - Comparing research and development activities. - Describing the activities and coordination of research teams. - Reporting factors of logical inference. - Discussion about students' research needed for the thesis.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
MB_29_w_1	credit	Average of partial grades from the whole semester, activity during classes, frequency	MB_29_1, MB_29_2, MB_29_3, MB_29_4, MB_29_5

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
MB_29_fs_1	discussion classes	The course is conducted using a communicative teaching method, with elements of discussion, with written or oral feedback, with the participation of work own student. Exercises are conducted using the method activating (including design, webquest, casestuda, presentation) with application of ICT.	45	Work with a textbook, dictionary, exercises, supplementary literature, Internet sources. Assimilation and consolidation of knowledge and skills acquired during the classes. Preparation of oral and written forms (on example letter, email, announcement, presentation).	30	MB_29_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Large Facilities: Synchrotron and Neutron Sources

Module code: W4-2BF-MB-21-11

1. Number of the ECTS credits: 5

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_11_1	students will be able to explain the basic functioning of a synchrotron radiation source and a spallation source, as well as the different properties that synchrotron light or neutrons can possess and how they can be tuned	KBF_W02	4
MB_11_2	students will be able to describe how synchrotron light and neutrons can be used to investigate the condensed matter, how collected data should be analyzed, and what information can be extracted from the data	KBF_U09 KBF_W04 KBF_W10	4 4 5
MB_11_3	students will be able to identify the advantages of using a large facility to perform experiments, and the most suitable technique to tackle a given experimental problem	KBF_K06 KBF_U11 KBF_U13	3 3 3

3. Module description

Description	The purpose of this unit is to learn the basics of facilities such as synchrotrons and spallation sources, and the kind of characterization techniques that they allow. Program: (1) Particle accelerators, synchrotron radiation, and neutron sources. (Basics of particle accelerators: general introduction, types of accelerators, methods of acceleration; circular accelerators, magnetic systems; main accelerator systems: RF, diagnostics; Beam characteristics. Generation of e.m. radiation: Bremsstrahlung, synchrotron radiation, characteristics and generation, insertion devices; beamlines and experiments: the Alba synchrotron; ion accelerators; spallation sources. (2) Data analysis and elementary scattering theory (Frequentist data analysis; data and errors: a statistical view; classical fitting methods; statistical distributions; hypothesis testing; Bayesian data analysis: Bayesian statistics and probability distribution functions; Bayes theorem, measurement, fitting functions; Markov Chain Montecarlo method; Model selection in Bayesian statistics; basics of X-ray and neutron scattering (Bragg Law; the phase problem; reflectometry and small-angle scattering; diffraction of liquids and amorphous materials; inelastic scattering: coherent and incoherent scattering, Van –Hoff functions. (3) Some synchrotron and Neutron applications (XRD and powder diffraction; EXAFS – XANES; hard X-ray synchrotron imaging Techniques; Neutron

	applications: inelastic neutrons scattering methods: Time of flight, Spin Echo, Backscattering; magnetism using neutrons; imaging using neutrons; specialized seminars by ALBA staff; practices at ALBA in the accelerators group: magnetic measurements, RF measurements, vacuum system
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_11_w_1	exam	The evaluation will consist of a mark for small homework projects and exercises of each module (25%), and one for the final project (75%). The latter will consist of two marks, one for the written report and one for the oral presentation.	MB_11_1, MB_11_2, MB_11_3

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_11_fs_1	lecture	Detailed discussion by the lecturer of the issues listed in the table "module description" using the table and/or multimedia presentations	45	Supplementary reading, working with the textbook, doing homework projects and exercises. Final project preparation	80	MB_11_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Machine Learning with Neural Networks

Module code: W4-2BF-MB-21-17

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_17_1	students will be able to state the fundamental problem and complexity of Machine Learning, and acquire a global view of the different Machine Learning techniques	KBF_K10 KBF_U02 KBF_U11 KBF_U14 KBF_W02	3 3 4 5 4
MB_17_2	students will be able to understand and explain classical models of Neural Networks such as the Hopfield networks, Boltzmann Machines, Single- and Multi-layer Perceptrons, and Convolutional networks	KBF_K10 KBF_U02 KBF_U11 KBF_U14 KBF_W02	3 3 4 5 4
MB_17_3	students will be able to implement the standard training techniques in these models, and put them in relation with the issue of the Deep Learning and its solution techniques	KBF_K10 KBF_U02 KBF_U11 KBF_U14 KBF_W02	3 3 4 5 4

3. Module description

Description	Course syllabus: (1) Introduction to Machine Learning (fundamental problem and its inherent complexity; general approaches for its solution) (2) Classic Neural Networks models (Hopfield model; recurrent Boltzmann Machines (BM) and Restricted Boltzmann Machines (RBM); learning with BM

	y RBM: gradient descent, Contrastive Divergence and its variants; single-layer perceptrons (SLP): lineal and logistic regression, Rosenblat perceptron; multi-layer perceptrons (MLP): learning with MLP, back-propagation; Convolutional Neural Networks (CNN): model, link to MLP, and learning) (3) Deep Learning: link with classical models and modern learning techniques.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_17_w_1	credit	The final mark for this course is computed as 0.2*M_1 + 0.2*M_2 + 0.6*M_3, where M_n is the grade of each practical homework. For the latter, the students will be provided with a code structure, and they will have to implement specific functions and run virtual experiments in which different machine learning strategies will be employed	MB_17_1, MB_17_2, MB_17_3

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_17_fs_1	lecture	Detailed discussion by the lecturer of the issues listed in the table "module description" using the table and/or multimedia presentations	26	Supplementary reading, working with the textbook	44	MB_17_w_1
MB_17_fs_2	laboratory classes	Computer sessions	10		20	MB_17_w_1

1.	**Field of study**	**Biophysics**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Master's Seminar, Master's Laboratory, Preparation of a Master Thesis

Module code: W4-2BF-MB-21-33

1. Number of the ECTS credits: 30

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_33_1	has the ability to use knowledge in the field of biophysics and related sciences in practice	KBF_U01 KBF_U02 KBF_W02 KBF_W04 KBF_W05 KBF_W06 KBF_W07	4 4 4 4 4 4 4
MB_33_2	knows the basic principles of occupational health and safety to be able to independently perform measurements	KBF_K08 KBF_W11	3 3
MB_33_3	can choose the appropriate measurement method to implement the assumptions of the thesis	KBF_U07 KBF_W04 KBF_W07 KBF_W10	4 4 4 4
MB_33_4	based on the acquired knowledge and performed measurements, the student can describe the results of the research	KBF_K05 KBF_U07 KBF_U08 KBF_W02 KBF_W04	3 3 3 3 3
MB_33_5	can independently analyze the results of measurements taking into account the methodology, analysis, and discussion of the obtained data	KBF_U05 KBF_U08	4 4

		KBF_U09 KBF_U15 KBF_W02 KBF_W03 KBF_W07 KBF_W08 KBF_W13	4 4 4 4 4 4 4
MB_33_6	broadens her/his knowledge based on English-language scientific literature, can integrate the obtained information, and draw conclusions	KBF_U12 KBF_U13 KBF_U16 KBF_U18 KBF_W13	3 3 3 4 4
MB_33_7	can work in a team in the planning and implementation of research tasks	KBF_K04 KBF_U10 KBF_U11	4 4 4
MB_33_8	can listen to another opinion and substantively discuss a given topic	KBF_K03 KBF_K06 KBF_K07 KBF_K09 KBF_U14	3 3 3 3 3

3. Module description	
Description	Depending on the subject of the master's thesis, the student: - develops knowledge in the selected fields of biophysics - performs measurements using advanced equipment suitable for conducting a specific type of research or use advanced computer programs in the case of theoretical projects - gains unique practical skills related to the subject of the Master's thesis. During the master seminar, students present the results of the research and their analysis. Such a presentation aims to develop the ability to discuss and formulate judgments in a given field of science. The student will improve the skills of effective presentation and communication in the selected field of biophysical research. The student chooses the place where the thesis will be realized. This could be a university, research laboratory, company, or any institution with a profile compatible with the subject of the Master thesis. The student chooses the topic of the master thesis and the supervisor.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
MB_33_w_1	credit for the master's thesis	Assessment of the performance of measurements under the supervisor's care, development of measurement results, and their discussion	MB_33_1, MB_33_2, MB_33_3, MB_33_4, MB_33_5, MB_33_6, MB_33_7, MB_33_8
MB_33_w_2	thesis review	Assessment of the value of the literature part and student's contribution to the subject matter. The supervisor additionally assesses the degree of involvement of the master's student during the work and the possibility of using the results in the publication.	MB_33_1, MB_33_2, MB_33_3, MB_33_4, MB_33_5, MB_33_6, MB_33_7, MB_33_8
MB_33_w_3	master exam	Assessment of knowledge of physical sciences at the second level of education and knowledge in a field of biophysics. Assessment of the presentation and defense of the thesis	MB_33_1, MB_33_2, MB_33_3, MB_33_4, MB_33_5
MB_33_w_4	activity	Student's suggestions aimed at improving the performance of measurements, discussions on the methods of analyzing the results, and their interpretation	MB_33_1, MB_33_2, MB_33_3, MB_33_4, MB_33_5

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
MB_33_fs_1	laboratory classes	Become familiar with measuring equipment, pay attention to the reliability of the measurements, the selection of the proper method of data analysis, statistical analysis of measurement results, a description of the physical and biophysical phenomena using the selected models, a summary of the results, and conclusions, intensified consultation	180	Additional hours of student's self-work related to the processing of the obtained results	400	MB_33_w_1, MB_33_w_2, MB_33_w_3, MB_33_w_4
MB_33_fs_2	seminar	Preparation of the thesis: Master's thesis submission with a description of the conducted research including the purpose of the work, methodology, description, and discussion of the obtained results and their importance in the light of similar research	30	Preparation and writing a thesis taking into account the supervisor's comments	140	MB_33_w_1, MB_33_w_2, MB_33_w_3, MB_33_w_4

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Materials Science of Drugs

Module code: W4-2BF-MB-21-13

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_13_1	students will be able to discuss the equilibrium conditions for a phase or phase coexistence, draw multiphase and/or binary phase diagrams, and distinguish between different equilibrium, metastable, and unstable states, and their relevance for drug formulations	KBF_K06 KBF_U01 KBF_U02 KBF_U11 KBF_W02	3 4 4 3 4

3. Module description

Description	The purpose of this unit is to provide an overview of the thermodynamics of phase equilibrium and phase transitions, with application to the polymorphism of drugs, and to introduce binary phase diagrams and the non-equilibrium glass state, with applications in the field of amorphous drugs. Course syllabus: (1) Basic concepts of crystallography: translational order, unit cell, Bravais lattices. Point groups, space groups, crystal systems. Crystallographic planes, reciprocal lattice, Miller indices. From crystal system to molecular structure and geometry: crystals with a base and molecular crystals. Calculation and modeling of diffraction patterns from atomic and structure scattering factors. Solid-state polymorphism of drugs and other organic molecules. (2) Phase Equilibrium and phase transitions (Thermodynamic Potentials for hydrostatic pvT systems; Maxwell relations; TdS equations; General conditions for equilibrium; Fluctuations; Le Châtelier principle) (3) Phase transitions and topological pressure-temperature phase diagram (Equilibrium conditions for hydrostatic pvT systems; First-order phase transitions: Clausius-Clapeyron equation. Stability and metastability domains; High-order phase transitions. Group-subgroup phase transitions. Second-harmonic generation; Critical and triple points; Topological P-T phase diagram. (4) Landau's theory for phase transitions. Ferroelastic phase transitions. Long-range anisotropic interactions. Self-accommodation. Structural phase transitions. Mechanistic and kinetic classification of phase transitions. (5) Phases out of equilibrium (Glass state and glass transition; dynamics and structural relationships in the glass state; pressure dependence of the glass transition temperature; non-equilibrium phases and mesophases of drugs) (6) Binary systems (thermodynamics of mixing, thermodynamic potential; types of binary phase diagrams: eutectic, metatectic, and peritectic; solubility

	and miscibility; metastable and unstable states; nucleation vs spinoidal decomposition. The course will include laboratory sessions.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_13_w_1	credit	the basis for obtaining credit will be the grades from homework and laboratory reports	MB_13_1

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_13_fs_1	lecture	Detailed discussion by the lecturer of the issues listed in the table "module description" using the table and/or multimedia presentations	30	Supplementary reading, working with the textbook, doing homework	45	MB_13_w_1
MB_13_fs_2	laboratory classes	Performance of exercises on the subject consistent with the issues listed in the table "module description"	6	Acquiring knowledge in the scope of the exercise, preparation of the final report on a given exercise	19	MB_13_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Mechanical Behaviour of Materials

Module code: W4-2BF-MB-21-04

1. Number of the ECTS credits: 6

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_04_1	the students will be able to understand the mechanism of plastic deformation and the origin of materials strength	KBF_W01 KBF_W02	4 4
MB_04_2	the students will be able to suggest ways by which engineering materials may be intrinsically strengthened	KBF_U01	4
MB_04_3	the students will be able to derive ductile-brittle transition temperature and select materials accordingly	KBF_U01 KBF_U07	4 3
MB_04_4	the students will be able to understand the high-temperature mechanical behavior of materials and be able to select the materials for high-temperature applications	KBF_U01 KBF_W02	4 4
MB_04_5	the students will be able to design and select engineering components based on the principles of fracture mechanics and fatigue	KBF_U01 KBF_W01 KBF_W02 KBF_W04	4 4 4 4
MB_04_6	the students will be able to improve materials resistance to fracture and fatigue performance	KBF_U01	4

3. Module description

Description	1. Introduction to deformation behavior: Concept of stresses and strains, engineering stresses and strains, Different types of loading and temperature encountered in applications. 2. Tensile Test - stress-strain response for metal, ceramic, and polymer, elastic region, yield point, plastic deformation, necking, and fracture. 3. Bonding and Material Behaviour, theoretical estimates of yield strength in metals and ceramics. 4. Elasticity (the state of stress and strain, stress and strain tensor, tensor transformation, principal stress and strain, elastic stress-strain relation, anisotropy, elastic behavior of metals, ceramics, and polymers).

	5. Viscoelasticity (Molecular foundations of polymer viscoelasticity. Rouse-Bueche theory, Boltzmann superposition principle, mechanical models, distribution of relaxation and retardation times, interrelationships between mechanical spectra, the glass transition, secondary relaxations, dielectric relaxations. 6. Plasticity (Hydrostatic and Deviatoric stress, Octahedral stress, yield criteria, and yield surface, texture and distortion of yield surface, Limitation of engineering strain at large deformation, true stress and true strain, effective stress, effective strain, flow rules, strain hardening, Ramberg-Osgood equation, stress-strain relation in plasticity, plastic deformation of metals and polymers). 7. Microscopic view of plastic deformation: crystals and defects, classification of defects, thermodynamics of defects, the geometry of dislocations, slip and glide, dislocation generation - Frank Read and grain boundary sources, stress and strain field around dislocations, force on dislocation - self-stress, dislocation interactions, partial dislocations, twinning, dislocation movement and strain rate, deformation behavior of single crystal, critical resolved shear stress (CRSS), deformation of poly-crystals, Hall-Petch and other hardening mechanisms, grain size effect - source limited plasticity, Hall-Petch breakdown, dislocations in ceramics and glasses. Effects of microstructure on the mechanics of polymeric media: deformation modes, yield, rubber toughening, alloys and blends. 8. Fracture mechanics (energetics of fracture growth, plasticity at the fracture tip, measurement of fracture toughness, -Linear fracture mechanics -KIC. Elasto-plastic fracture mechanics - JIC, Measurement and ASTM standards, Design based on fracture mechanics, the effect of environment, effect of microstructure on KIC and JIC. Application of fracture mechanics in the design of metals, ceramics, polymers and composites, damage tolerance design, elements of fractography) 9. Fatigue (S-N curves, low- and high-cycle fatigue, laboratory testing in fatigue, residual stress, surface and environmental effects, fatigue of cracked components, designing out fatigue failure, Life cycle prediction, Fatigue in metals, ceramics, polymers, and composites. 10. Creep. Creep in crystalline materials (stress-strain-time relationship, creep testing, different stages of creep, creep mechanisms and creep mechanism maps, diffusion, creep and stress rupture, creep under multi-axial loading, microstructural aspects of creep and design of creep resistant alloys, high-temperature deformation of ceramics and polymers.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_04_w_1	exam	oral exam Requirement for examination: Knowledge of the mechanical behavior of a wide variety of materials ranging from conventional metals and alloys, ceramics and polymers to hybrid materials and biomaterials, at different length and time scales, from the continuum description of properties to the atomistic and molecular mechanisms that confer those properties to all materials. Knowledge of the micro-mechanics of deformation of metals, ceramics, polymers, and composites. Knowledge of the fundamentals of elasticity and viscoelasticity, plasticity, imperfections/defects in crystals, deformation and strain-hardening, fracture, strengthening of alloys, martensitic transformations	MB_04_1, MB_04_2, MB_04_3, MB_04_4, MB_04_5, MB_04_6

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_04_fs_1	lecture	Detailed discussion by the lecturer of the	48	Supplementary reading, working with the	102	MB_04_w_1

		issues listed in the table "module description" using the table and/or multimedia presentations		textbook		

1.	**Field of study**	**Biophysics**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Molecular Biophysics

Module code: W4-2BF-MB-21-20

1. Number of the ECTS credits: 5

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_20_1	The student understands the physical basis of known research techniques used in molecular biophysics	KBF_K07 KBF_U03 KBF_W01 KBF_W02	4 4 4 4
MB_20_2	The student can characterize and develop the results of research obtained for biological systems	KBF_K05 KBF_W02 KBF_W03	3 3 3
MB_20_3	The student knows the principles of operation, capabilities and specificity of high-class research equipment	KBF_K03 KBF_U03 KBF_W02 KBF_W04 KBF_W08	3 3 3 3 3
MB_20_4	The student knows how to use mathematical and statistical methods of developing experimental results	KBF_K09 KBF_W02 KBF_W04	3 3 3
MB_20_5	Student through acquired knowledge from physics and biology knows how to propose a method of research of various biological systems, thanks to which he becomes a natural partner of biologists and doctors	KBF_K03 KBF_U07 KBF_U08 KBF_W02 KBF_W03	3 3 3 3 3

3. Module description

Description	By participating in the classes, the student will deepen their knowledge in the field of biophysics by performing research on various biological objects, from single molecules, through subcellular complexes and structures, to the structures of living matter using methodology and physics methods. It will be an opportunity to understand the basics of many advanced research techniques and take part in experiments performed using them. Familiarize yourself with, among others with the following research methods: 1) Spectroscopy and fluorescence microscopy used to observe the structure and follow cell life processes. 2) Multidimensional nuclear magnetic resonance (NMR) in imaging of tissue structure and observation of cellular changes. 3) Atomic force microscopy (AFM) in the study of individual molecules, forces of interaction between them and the structure of molecular and cellular systems as well as characteristics of their mechanical (viscoelastic) properties. 4) Microscale Raman spectroscopy - Raman mapping and surface enhanced Raman spectroscopy (SERS). 5) Electron cryomicroscopy of single molecules and molecular systems. 6) Mass spectrometry in the study of the atomic and molecular composition of substances and tissues (ToF-SIMS). 7) Analytical centrifugation. 8) Theoretical methods for modeling the structure, spectra and properties of molecules and their systems - the use of molecular dynamics and ab-initio modeling methods.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_20_w_1	exam	Written exam/oral exam. The scope of the exam will be announced 3 weeks before the end of the semester	MB_20_1, MB_20_2, MB_20_3, MB_20_4, MB_20_5
MB_20_w_2	credit	Passing the preliminary test before each new exercise, performing the exercise, preparing a report	MB_20_1, MB_20_2, MB_20_3, MB_20_4, MB_20_5

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_20_fs_1	lecture	Detailed discussion by the lecturer of the issues listed in the table "module description" using the table and/or multimedia presentations	15	Supplementary reading, working with the textbook, trying to find answers to simple problem questions asked during the lecture	20	MB_20_w_1
MB_20_fs_2	laboratory classes	Performance of exercises on professional research equipment	30	Acquiring knowledge in the scope of the exercise. Preparation of the final report on a given exercise	45	MB_20_w_2

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Pharmacology and Pharmacognosy

Module code: W4-2BF-MB-21-27

1. Number of the ECTS credits: 5

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_27_1	Student knows the basic concepts of pharmacy and pharmacognosy	KBF_K04 KBF_U03 KBF_W01 KBF_W02 KBF_W09	4 4 4 4 4
MB_27_2	Student learned the properties of active substances, their action in the body, side effects	KBF_K06 KBF_U03 KBF_W01 KBF_W02 KBF_W09	3 3 3 3 3
MB_27_3	Understands the basics of drug action mechanisms	KBF_K02 KBF_U03 KBF_W01 KBF_W02 KBF_W09	3 3 3 3 3
MB_27_4	Student learned about the chemical conditions of the use of active substances and the biochemical reactions at the cell level	KBF_K02 KBF_U03 KBF_W01 KBF_W02 KBF_W09	3 3 3 3 3

MB_27_5	Student knows and understands the use of prodrugs generated by genetic engineering	KBF_K05 KBF_U03 KBF_W01 KBF_W02 KBF_W09	3 3 3 3 3
MB_27_6	Student knows how to use genomics technology in search of drugs	KBF_K05 KBF_U03 KBF_W01 KBF_W02 KBF_W09	3 3 3 3 3
MB_27_7	Student has the basic ability to work in a synthesis laboratory	KBF_K03 KBF_U03 KBF_W01 KBF_W02 KBF_W09	3 3 3 3 3

3. Module description	
Description	The content of the lecture includes: 1. Subject and basic concepts of pharmacology, pharmacy and pharmacognosy. 2. Drug nomenclature. Drug forms. 3. Drug properties and types of actions in the body. Side effects. Drug toxicity. 4. Factors affecting drug performance. Drug absorption. Fundamentals of drug action mechanisms. Non-specific drugs. 5. Drug distribution, redistribution and biotransformation. Drug excretion. Drug transport. 6. Chemical stability of the drug. Structural determinants of chemical stability. Structural factors affecting durability. 7. Drug metabolite. First phase processes 8. Pharmacokinetics. The concept of a model compartment. 9. Cell structure and drugs. Drugs in the organism. Basic information about the cell and cellular mechanisms of drug action. 10. Hydrophobicity vs hydrophilicity. Ionization of the drug. Lipinski rule and pharmacokinetics. 11. ADMET and pharmacokinetics. Pharmacokinetics and drug design. 12. Solubility and transport through membranes. The effect of acyl and alkyl substituents and their substitution on drug polarity. 13. Introduction of genes to cells. Antisense therapy. Prodrugs generated by genetic engineering. 14. Pharmacogenetics (pharmacogenomics). Genomics technology in the search for drugs. Laboratory - selected issues: 1) Oxidation reactions. Aromatic hydroxylation. Epoxidation of alkenes. 2) Oxidation of aliphatic and alicyclic carbon atoms. Oxidation of moieties containing a carbon-nitrogen connection. 3) Oxidation of the carbon-oxygen bond. 4) Reduction reactions. Reduction of the carbonyl group. Reduction of the nitro group. Azo group reduction. Reduction of tertiary amine oxides. Reductive halogen removal. 5) Hydrolysis reactions. 6) Second phase processes - coupling reactions. Coupling with glucuronic acid. Coupling with sulfuric acid. Coupling with amino acids. Coupling with glutathione. Coupling with water. Coupling with acetic acid.

Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
MB_27_w_1	credit	Positive assessment of the test allowing to perform a given exercise	MB_27_1, MB_27_2, MB_27_3, MB_27_4, MB_27_5, MB_27_6, MB_27_7
MB_27_w_2	written test/ oral examination	Written / oral exam from the material presented during the lecture	MB_27_1, MB_27_2, MB_27_3, MB_27_4, MB_27_5, MB_27_6, MB_27_7

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
MB_27_fs_1	laboratory classes	Self-performance of exercises, ability to prepare reports, ability to describe the results obtained	30	Preparation of a report on the given exercise	30	MB_27_w_1
MB_27_fs_2	lecture	The lecture is conducted with the use of multimedia resources, with the use of own presentations and materials from the e-learning platform	30	Supplementing the knowledge obtained during the lectures with additional literature. Using lectures posted on the e-learning platform	30	MB_27_w_2

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Polymer Science and Engineering

Module code: W4-2BF-MB-21-05

1. Number of the ECTS credits: 6

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_05_1	the student will be aware of the specific characteristics of the materials included in the class of polymers, particularly with respect to structure and properties	KBF_K01 KBF_W02	3 4
MB_05_2	the student will acquire knowledge of both mechanisms for synthesizing polymeric materials and relevant industrial production and processing technologies	KBF_W02	4
MB_05_3	the student will acquire basic knowledge of the principal experimental techniques for characterizing the physical-chemical properties of polymeric materials	KBF_W04 KBF_W10	4 4

3. Module description

Description	Introduction to the course. Subject, tentative program, goals. Introductory survey on the universe of polymers, classification in plastics and elastomers, recyclable and not recyclable polymers. Historical milestones of polymer science and engineering. Basic review of general concepts in polymer science. Molecular structure, homo- and copolymers, the functionality of a monomer, possible skeletal configurations: linear, branched, and crosslinked polymers. Classification of polymers as thermoplastics, elastomers, and thermosets. Semi-crystalline and amorphous thermoplastics. Melting and glass transition. Survey on the typical values of properties (mechanical, electrical, density, thermal stability) of most employed thermoplastics, thermosets, and elastomers. Deformation mechanisms acting in polymers at the microscopic scale and factors that influence the mechanical response. Viscoelasticity of polymers. Molecular weight, molar masses, and degree of polymerization. Generalities of step-growth polymerization. Linear step polycondensation and polyaddition reactions.

	Control of degree of polymerization in step-growth reactions: Carothers theory and statistical analysis. Kinetics of step polymerization and methods for controlling reactions. Network step polyaddition. Gelation: significance, problems in the quantitative definition of the gel-point, consequences at microscopic and macroscopic scales. Carothers theory and Flory's theory of gelation. Brief mention of dendrimers and hyperbranched polymers. Generalities of chain-growth polymerizations. Stages of a linear chain-growth polyaddition. Production of free radicals activators by thermolysis, photolysis, and redox reactions. Propagation stage. Termination by combination and disproportionation. Termination by intra- and inter-molecular chain transfer. Kinetics of linear chain polyadditions and steady-state conditions. Degree of polymerization. Diffusion constraints and diffusion-controlled reactions. Autoacceleration. Effects of chain transfer. Molar mass distribution. Effects of temperature. Ceiling temperature. Industrial methods for polymerization: bulk, solution, suspension, and emulsion processes. Network radical polymerization by crosslinking monomers. Network radical polymerization of unsaturated (pre-)polymers. Thermodynamics of ideal solutions. Liquid lattice, Gibbs free-energy for mixing, configurational entropy. The Flory-Huggins theory and its limitations. Chemical potential. Dilute polymer solutions. The cohesive density approach for predictions of polymer solubility. Chain dimensions: the freely-jointed chain model, bond angle constraints and short-range steric restrictions, stiffness of a polymer chain. Long-range steric interactions and chains with excluded volume. Expansion parameters for the end-to-end distance and for the gyration radius of a polymer molecule coil. Frictional properties of polymers in solutions. Free-draining and non-draining regimes. Hydrodynamic volume and intrinsic viscosity of a polymer in solution in the non-draining limit: the Flory-Fox and the Mark-Houwink-Sakurada equations. Diffusion process in the non-draining limit. The behavior of polyelectrolytes in solution. Characterization of polymers at a molecular level. Techniques for measuring the number average molar mass based on colligative effects. Membrane osmometry. Vapour pressure osmometry. Ebulliometry and cryoscopy. End-group analysis. Scattering methods for characterization of polymers: static light scattering by liquids and solutions of small molecules and scattering by large molecules in solution. Effect of molar mass dispersity. The Zimm- the plot method for analysis of data. Dynamic light scattering. Photon correlation spectroscopy. Small-angle X-ray and neutron scattering. Purposes, limits, and methods for SAXS and SANS analysis. Measurement of frictional properties of polymers in solutions. Dilute solution viscometry. The intrinsic viscosity, the Huggins equation for the reduced viscosity, and the Kraemer equation for the inherent viscosity. Determination of average molar mass and expansion parameter for polymer molecules in solutions. Use of capillary viscometers for measuring the relative viscosity of a polymer in solution. Differential viscometer. Molar mass distribution. Fractionation of dilute Polymer Solutions by Phase-Separation. Gel permeation chromatography: separation by size exclusion, GPC calibration, and data analysis, universal calibration for GPC. Porous gels and eluants for GPC. Instrumentation and procedures for GPC. Mass spectroscopy (MS). Mass spectra of polymers. ESI and MALDI methods for soft ionization. Time-of-flight (ToF) mass spectroscopy. Analysis of MALDI-TOF mass spectra of polymers. Use of MALDI MS for examining the chemical structure of polymers. Spectroscopic methods for characterization of chemical composition and molecular microstructure of polymers. The principles of spectroscopy and the Lambert-Beer law. Principles of UV-vis spectroscopy, applications in polymer science, essential apparatus, and experimental procedures. Principles of IR spectroscopy, applications in polymer science, apparatus and experimental procedures, interpretation of IR spectra. Principles of Raman spectroscopy, applications in polymer science, interpretation of Raman spectra. Brief mention of Raman microscopy.

	Principles of NMR spectroscopy, interpretation of NMR spectra, absorption splitting by J-coupling. Applications of NMR spectroscopy in polymer science. The amorphous state of polymers. The glass transition and its characteristics. Free volume theories. Factors controlling Tg. Macromolecular dynamics in the amorphous state. The Rouse-Bueche theory. The de Gennes reptation theory. Different paths to a glass transition: cooling, compression, polymerization. The crystalline state in polymers. Evidence and characteristics of polymer crystal structures. Crystals structures for most common polymers. Characteristics of crystals obtained from either dilute solutions, melt cooling, or solid-state polymerization. Polymer single crystals. Lamellae and spherulites. Semi-crystalline polymers and determination of the degree of crystallinity. Crystal thickness. Oriented crystals and polymer fibers. Defects in polymer crystals. Kinetics and thermodynamics of crystallization. Melting of crystalline polymers. Equilibrium melting temperature. Factors that influence melting of polymers. Effects on the melting temperature of crystal thickness, chemical structure, molar mass, branching, copolymerization, annealing. Relationship between Tm and Tg. Differential scanning calorimetry (DSC): traditional power-compensation and heat-flux apparatuses, experimental procedures, and calibration. Qualitative and quantitative interpretation of DSC thermograms. Modulated-temperature DSC (MTDSC), separation of reversing and non-reversing thermal events. Crystal perfection before melting. The elasticity of rubbers. Molecular structural requirements for a polymer to show elastomeric properties. Elastomers as entropic springs. Natural rubber. Vulcanization. Mechanical behavior of elastomers. Thermodynamics of elastomer deformation. The thermoelastic inversion effects. Statistical theory of elastomer deformation. Effects of entanglements, loops, and chain end. Stress-strain behavior of rubbers. Strain-induced crystallization. Electrical properties of polymers. Survey on the variety of possible electrical properties within the class of polymeric materials. A brief review of the classical and the band models for current transport in conductors and semiconductors. Inherently conducting polymers. Conjugated polymers and their molecular structure. The case of polyacetylene: structure, explanation of its conductivity, doping, polarons, and solitons. Ionic conduction in polymers: electrophoresis of ionic species from ionomers or from impurities. Electrical properties of insulating matrix/conducting fillers composites. Percolative behavior of the electrical conductivity. Factors influencing the critical value of the filler volume fraction. Polymers as insulators: the dielectric breakdown phenomenon and the dielectric strength of polymers. Polymer dielectrics: the different mechanisms of electric polarization occurring in polymers, behavior under time-varying electric fields, the complex dielectric permittivity, and the dielectric spectrum. Dielectric relaxation processes and models for their description. Dielectric spectroscopy methods for measuring and analyzing the complex permittivity spectrum. A dielectric spectrum of a glass former: recognizable patterns in the behavior of dielectric constant and loss factor; multiple relaxations, dielectric parameters, ionic conduction. Discussion about the influence of temperature on the spectra and the dielectric parameters of a supercooled glass former. Evolution of the dielectric spectra and of the dielectric parameters in time-varying systems: the case of polymerization reactions. Dielectric analysis of chemically, thermally and mechanically induced glass transition: differences, analogies, and attempts for a unified description of the glass transition. Microwave heating. Processing of polymers. Principles of the techniques for the processing of polymers.

	low properties of polymer melts: bulk deformation, elongational flow (tension stiffening and tension thinning), shear flow (shear thinning). Melt flow index. Apparent viscosity as a function of temperature and molar mass. Viscoelasticity of molten polymers and swell ratio. Cooling and solidification of polymer melts. Extrusion. Injection moulding. Thermoforming. Blow moulding. Compression moulding. Transfer moulding.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_05_w_1	exam	The final exam is composed of a final oral examination which has a duration averaging between 40 and 60 minutes. During the oral exam, the student can be also required to solve open questions/exercises/problems. The student will be assessed on his/her demonstrated ability to discuss the course contents with critical awareness and with the property of an expression by starting from problems/exercises/questions proposed by the exam commission. The oral test is not passed if the candidate demonstrates to not be able to express him/herself in a clean and proper language and if the candidate does not correctly answer at least those questions concerning the very basic parts of the course. Knowledge of the micro-mechanics of deformation of metals, ceramics, polymers, and composites. Knowledge of the fundamentals of elasticity and viscoelasticity, plasticity, imperfections/defects in crystals, deformation and strain-hardening, fracture, strengthening of alloys, martensitic transformations	MB_05_1, MB_05_2, MB_05_3

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_05_fs_1	lecture	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_05_w_1

1.	**Field of study**	**Biophysics**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Protection of Intellectual Property, Health and Safety, Ergonomics

Module code: W4-2BF-MB-21-30

1. Number of the ECTS credits: 1

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_30_1	Student knows and understands the basic legal, economic and ethical aspects of scientific activity	KBF_K06 KBF_K10 KBF_U17 KBF_W13	4 4 4 4
MB_30_2	Student knows and understands the basic concepts and principles of the protection of intellectual property and copyright	KBF_K06 KBF_K10 KBF_U17 KBF_W13	4 4 4 4
MB_30_3	Student can obtain information from literature, databases and other sources	KBF_K06 KBF_K10 KBF_U11 KBF_U17 KBF_W13	5 5 5 5 5
MB_30_4	Student is able to integrate the obtained information and interpret it, draw conclusions, and formulate and justify opinions understands the need to improve professional and personal competences	KBF_K06 KBF_K10 KBF_U11 KBF_U17 KBF_W13	5 5 5 5 5
MB_30_5	Student understands and appreciates the importance of intellectual honesty in the actions of oneself and others	KBF_K06 KBF_K10	4 4

		KBF_U17 KBF_W13	4 4
MB_30_6	Student acts ethically	KBF_K06 KBF_K10 KBF_U17 KBF_W13	4 4 4 4
MB_30_7	Student understands the social aspects of applying the acquired knowledge and skills and the related responsibility	KBF_K06 KBF_K10 KBF_U17 KBF_W13	4 4 4 4
MB_30_8	Student knows the basic principles of occupational health and safety	KBF_K06 KBF_K10 KBF_U17 KBF_W11	5 5 5 5

3. Module description	
Description	During the lecture, the student becomes acquainted with the following issues: - the concept of intellectual property; - goals and principles of copyright protection; - the concept of work and author; - the concept of an idea and its protection; - author's personal and property rights and their protection; - the concept of plagiarism and legal liability for infringement of copyright; - ethical ways of using someone else's creativity; - personal and public use permitted; - the concept of personal rights and their protection; - the concept of invention, industrial design, utility design, trademark and their protection
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_30_w_1	credit	Final test on issues discussed during the lecture.	MB_30_1, MB_30_2, MB_30_3, MB_30_4, MB_30_5, MB_30_6, MB_30_7, MB_30_8

5. Forms of teaching						
code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_30_fs_1	lecture	Providing the content of the lecture verbally with the use of content visualization. Focusing on a conceptually difficult material and indication of sources. Illustration of content using examples.	15	Getting acquainted with the subject of the lecture, using textbooks, scripts, websites, etc.	30	MB_30_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Quantum Matter Physics

Module code: W4-2BF-MB-21-01

1. Number of the ECTS credits: 6

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_01_1	Students will be familiar with the basic concepts and methods of nonrelativistic quantum mechanics which are at the base of the modern theory of atoms, molecules, and condensed matter systems	KBF_U02 KBF_W01	5 4
MB_01_2	He/she will also be able to peruse the literature on the quantum microscopic theory of matter that might be useful for his/her studies/research/work	KBF_U11	4

3. Module description

Description	Introduction to quantum mechanics: Waves and particles. Wave-particle duality and the uncertainty principle. Wave function. Schroedinger equation and stationary states. Expectation values. Atomic Physics: First atomic models and their shortcomings. Hydrogen atom: energy spectrum, angular momentum, and eigenfunctions. Electron spin. Pauli exclusion principle. Helium atom, singlet, and triplet states. Many-electron atoms, periodic system of elements. Atomic spectroscopy. Molecular physics: Adiabatic approximation. The ionized hydrogen molecule. The hydrogen molecule. Homonuclear and heteronuclear diatomic molecules.Polyatomic molecules. Molecular vibrations. Molecular Spectroscopy. Condensed matter physics: Structure of liquids, amorphous solids, and crystals. X-ray diffraction. Types of crystals: molecular, ionic, covalent, and metallic. Boltzmann distribution, equipartition of energy. Quantum statistics: bosons and fermions. Phonons and specific heat of solids. Free electron model of metals: electrical conductivity and specific heat.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
MB_01_w_1	exam	oral exam in conceptual and practical knowledge on quantum mechanics and its relation to the behavior of atoms, molecules, and solids	MB_01_1, MB_01_2

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
MB_01_fs_1	lecture	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_01_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Rheology

Module code: W4-2BF-MB-21-10

1. Number of the ECTS credits: 6

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 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. Module description

Description	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 7) Equations for the flow of non – newtonian fluids: some selected examples 8) Yield stress fluids: history of the yield stress and yield stress values; flow equations with yield stress 9) The flow of “solids”: non-linear “viscosity” of solids

	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. 11) Non- linear viscoelasticity: everyday elastic liquids; some visible viscoelastic manifestations; proper description of viscoelastic forces and their measurements; some viscoelastic formulas 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 16) Polymer rheology: different kinds of polymer chains; polymer solutions; polymer melts 17) Rheology of surfactant systems: surfactant phases; rheology of surfactant systems 18) Rheology of food products 19) Extensional flow: the extensional flow; the Trouton ratio; examples of extensional viscosity curves; some applications 20) Recall on scalars, vectors, tensors and their algebra. 21) The stress tensor. Construction, property. 22) Stress ellipsoid. The case of pressure. Deformation tensor. 23) Generalized Hooke's law. Matrix of modules and compliance, its properties. Recalls: differential operators on scalars / vectors / tensors, useful theorems. 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 25) Material functions and experimental response to steady state flow in simple shear geometry and in extensional geometry. 26) Viscoelasticity and constitutive equations 27) Non-linear viscoelasticity. Cauchy and Finger Tensors. 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.) 29) Other constitutive approaches: molecular approach for polymeric systems. Outline: Configuration distribution function, temporary network model, reptation theory
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_10_w_1	exam	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. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_10_fs_1	lecture	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_10_w_1

1.	**Field of study**	**Biophysics**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Selected Issues from Biomaterials Toxicology

Module code: W4-2BF-MB-21-28

1. Number of the ECTS credits: 2

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_28_1	Understands the relationship between material properties and basic laws of nature	KBF_W01 KBF_W02	4 4
MB_28_2	Acquired basic knowledge about theoretical specification of material properties (specific heat, susceptibility etc.)	KBF_W02	4
MB_28_3	Analyses of various type computational approximations	KBF_U02	4
MB_28_4	Acquired the knowledge about materials electron structure, magnetism, dielectric and other properties	KBF_W01 KBF_W02	4 4
MB_28_5	Acquired the skill to resolve theoretical problems from the field of material properties computation	KBF_U02 KBF_U09	4 4
MB_28_6	Acquired the skill to apply specified computational methods and approximations	KBF_U02 KBF_U05 KBF_U06	4 4 4
MB_28_7	Analyses of various type approaches to theoretical determination of material properties	KBF_K10 KBF_U02	4 4

3. Module description

Description	This course will provide students with the issues related to biomaterials toxicology, including terms and definitions such as: toxin (poison), toxicity, degrees of toxicity, types of intoxications, adsorption of toxic substances and biocorrosion. The module shall ensure that students are knowledgeable about toxic action mechanisms and dynamics, based on which students shall understand the importance of biomaterials toxicity and its adverse effects of impact on the organism. Program: laboratory

	1. Organization of classes. 2. Ways of distributing harmful compounds to the body. The effect of drugs on the presence of an implant in the body. The effect of alcohol on the presence of the implant in the body. 3. Effect of drugs on the presence of the implant in the body. Toxicity of metals found in titanium-containing biomaterials additives. Toxicity of metals present in 316L implant steel. 4. Diseases caused by the presence of metals in food. Toxicity of ceramic implants. Life expectancy of implants. 5. Toxicological assessment of cosmetic raw materials. Toxicity of plastics. Methods for determining metals in the material biological. 6. Methods of neutralizing poisons. Toxicity of metals and semimetals. 7. Toxicity of non-metals and their inorganic compounds. Toxicity of addictive substances (hallucinogens). 8. Written test / test. Program: lecture 1. Toxin (poison), toxicity, degrees of toxicity, types of poisoning. 2. Mechanisms of toxic action. 3. Adsorption of toxic substances. 4. Metabolic disorders caused by poisons. 5. Morphological disorders caused by poisons. 6. The carcinogenic response of a living organism to the implant. 7. Allergic reaction of the living organism to the implant. 8. Allergy mechanisms. 9. Allergies caused by implants. 10. Infection mechanisms caused by implanted materials. 11. Biocorrosion.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_28_w_1	exam	Verification of knowledge based on the content of the lectures, the indicated literature and the auditorium exercises	MB_28_1, MB_28_2, MB_28_3, MB_28_4
MB_28_w_2	credit	Verification of the knowledge acquired during the auditorium exercises	MB_28_5, MB_28_6, MB_28_7

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_28_fs_1	lecture	Detailed discussion by the lecturer of the issues listed in the table "module description". The lecture is conducted with the use of multimedia resources, based on a selected set of textbooks.	30	Work with the selected literature including the independent acquisition of knowledge in relation to the issues covered in the lectures.	10	MB_28_w_1
MB_28_fs_2	laboratory classes	Based on the discussion and problem solving with the use of multimedia.	15	Preparation for exercises through self study of the indicated issues.	5	MB_28_w_2

1.	**Field of study**	**Biophysics**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Short Internship

Module code: W4-2BF-MB-21-18

1. Number of the ECTS credits: 5

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_18_1	can use knowledge in the field of biophysics to implement the subject of internships	KBF_W04	4
MB_18_2	knows selected experimental methods enabling him to undergo an apprenticeship	KBF_W03 KBF_W10	4 4
MB_18_3	knows the methods and computer programs necessary to implement the subject of internships, can use them	KBF_W08	4
MB_18_4	knows the basics of occupational health and safety	KBF_W11	4
MB_18_5	can work in a group with different roles; understands the division of tasks and the individual's need to fulfill a given task	KBF_K03	4
MB_18_6	can work individually and in a team; can estimate the time required to conduct out the commissioned task	KBF_U10	4

3. Module description

Description	Research/industrial internship as an introduction to research projects. The internship should last up to 2 months, and take place in one of the EU countries in an academic or industry laboratory, large scale research facility, or computer center After completion of the internship, the students will have hands-on, operative knowledge of a research project carried out either at a university, research institute or facility, or private company. They will actively participate in a line of research or development of a product, and become acquainted with the work environment which is the target of the Erasmus Mundus program. A supervisor from Institute/Company + Tutor from UPC.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
MB_18_w_1	credit	the written report that will be evaluated by Tutor from UPC	MB_18_1, MB_18_2, MB_18_3, MB_18_4, MB_18_5, MB_18_6

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
MB_18_fs_1	internship	The internship is aimed at deepening the knowledge and gaining unique practical skills by working in an academic or industrial laboratory, a large research facility, or a computer center in one of the EU countries	45	Additional reading of specialist literature and scientific articles related to the subject of the internship. Preparation of the final report	80	MB_18_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Soft Materials (Molecular and Soft Condensed Matter)

Module code: W4-2BF-MB-21-12

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_12_1	students will be able to describe the phases of single-component molecular systems, and the main experimental techniques available to study molecular dynamics and phase transitions	KBF_W02 KBF_W07 KBF_W10	4 4 4
MB_12_2	students will be able to discuss the (dynamic) disorder present in a phase and its impact on rheological/mechanical properties and on vitrification	KBF_U01 KBF_U11 KBF_W02	4 4 4
MB_12_3	students will be able to describe the main theories that describe the properties of glasses, liquid crystals, linear polymers and polymer networks, as well as their main technological applications	KBF_U02 KBF_W02	3 4

3. Module description

Description	This unit introduces the physics of molecular and macromolecular condensed phases such as liquids, glasses, liquid crystals, plastic and orientationally disordered crystals, polymers and polymer gels. Course syllabus: (1) Basics of molecular condensed matter: introduction (polymorphism, glasses, complex fluids: mesophases & polymers); classification and mechanism of phase transitions (first order, continuous, glassy; nucleation and growth); van der Waals theory; microscopic constituents, effective interactions, disorder & dynamics; experimental tools & linear response theory; Boltzmann distribution and partition function (2) Single component systems: structural glasses, primary and secondary relaxations, aged and stable glasses; orientationally disordered solids and plastic crystals; amorphous and semicrystalline linear polymers; rotational isomeric state model; ideal chains and entanglement, normal and segmental relaxations; viscoelasticity; polymers networks, gelation and rubber elasticity; conjugated and conductive polymers; thermotropic liquid crystals and liquid crystal polymers) (3) Introduction to binary systems and binary equilibrium and non-equilibrium phase diagrams: heterointeractions; glass-forming mixtures; binary plastic

	crystals; polymer blends, solutions, and dispersions; block copolymers; polymer gels and hydrogels, swelling; superhydrophobic, superhydrophilic/ olephobic, superamphiphilic, and self-healing polymer coatings. Self-assembly in condensed matter: biopolymers, helix-coil & coil-globule transitions; surfactant-water systems, biomembranes, lyotropic liquid crystals, emulsions; semiflexible polymers & cytoskeleton; colloidal systems (glasses, crystals, nematics, gels); Applications to drug encapsulation, controlled drug release, and drug delivery.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_12_w_1	exam	Oral and written presentation of case study (60%), written midterm exam (40%)	MB_12_1, MB_12_2, MB_12_3

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_12_fs_1	lecture	Detailed discussion by the lecturer of the issues listed in the table "module description" using the table and/or multimedia presentations	36	Supplementary reading, working with the textbook	64	MB_12_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Solid State Physics

Module code: W4-2BF-MB-21-02

1. Number of the ECTS credits: 6

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_02_1	Students will be able to interpret the main experimental phenomenology of condensed matter - will obtain a sound knowledge of structural, electronic, optical, and vibrational properties of solids	KBF_K01	4
		KBF_K10	4
		KBF_U11	4
		KBF_U13	4
		KBF_W01	4
		KBF_W02	4

3. Module description

Description	Electrons in a one-dimensional periodic potential. Electron tunneling through a periodic potential. Velocity, quasimomentum, and effective mass of an electron in a band. Geometric description of crystals: direct and reciprocal lattices. Von Laue and Bragg scattering. The Drude electron gas. The theory of Sommerfeld. Energy and density of states of a two-and three-dimensional electron gas in a magnetic field. De Haas van Alphen effect. Landau diamagnetism and Pauli paramagnetism. Theory of harmonic crystal. Phonons. Optical properties of semiconductors and insulators. Charge transport in intrinsic and doped semiconductors. Fermi level in intrinsic semiconductors. Law of mass action. Donor and acceptor levels. Fermi level in doped semiconductors.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_02_w_1	exam	oral exam	MB_02_1

5. Forms of teaching						
code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_02_fs_1	lecture	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_02_w_1

1.	**Field of study**	**Biophysics**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Specialized Laboratory

Module code: W4-2BF-MB-21-25

1. Number of the ECTS credits: 2

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_25_1	Student got acquainted with work in biological and biochemical laboratories	KBF_K04 KBF_U01 KBF_W01 KBF_W02 KBF_W04 KBF_W10	4 4 4 4 4 4
MB_25_2	Student became acquainted with the most modern scientific equipment for physical research on biological systems	KBF_K02 KBF_U01 KBF_W01 KBF_W02 KBF_W04 KBF_W10 KBF_W11	4 4 4 4 4 4 4
MB_25_3	Student can present the results in the form of projects and scientific publications	KBF_K09 KBF_U09 KBF_U12 KBF_U14	4 4 4 4
MB_25_4	Student learned the English terminology used in biophysics	KBF_K01 KBF_U13	5 5
MB_25_5	Student learned to work in a team	KBF_K03	4

		KBF_U10 KBF_U11	4 4

3. Module description	
Description	During the course, students will have the opportunity to familiarize themselves with modern scientific equipment and the possibilities of testing drugs and biological materials as well as the visual system. Students can choose to work in the following research laboratories: 1. biophysical and biochemical laboratories - cell culture and research, 2. laboratory of optics and optical spectroscopy methods, 3. ESCA, ToF-SIMS laboratory, 4. spectacle optics laboratory, 5. X-ray spectroscopy laboratory.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_25_w_1	credit	Before starting the exercise, the student takes an introductory test, showing his preparation for work. Student prepares a report on the exercises	MB_25_1, MB_25_2, MB_25_3, MB_25_4, MB_25_5

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_25_fs_1	laboratory classes	Credit for individual laboratories on the basis of the presented final report	30	Development of measurement results, preparing a report	45	MB_25_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Specialized Lecture: Dielectric Spectroscopy in the Study of Dynamics of Biological Systems

Module code: W4-2BF-MB-21-24

1. Number of the ECTS credits: 3

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_24_1	Student knows elementary theory of interaction of electric field with dielectric materials	KBF_W01 KBF_W07	4 4
MB_24_2	Student knowns the basics of broadband dielectric spectroscopy measurements, how to apply it for the study of biological systems and how to analyse obtained dielectric measurements	KBF_K04 KBF_U02 KBF_U08 KBF_W02 KBF_W04	4 4 4 4 4
MB_24_3	Student knows theory of suspensions of particles in homogeneous fields	KBF_W01 KBF_W02	4 4
MB_24_4	Student has knowledge of the applications of the phenomenon of dielectrophoresis for the study of small biological organisms	KBF_U04 KBF_W10	4 4

3. Module description

Description	The content of the lecture includes: 1. Dielectric in a constant field (macroscopic and microscopic dielectric parameters, mechanisms of dielectric polarization, local field models and records of phase transformations in dielectric measurements). 2. Dielectric in an alternating field (the phenomenon of dielectric relaxation: dipole and electrical conductivity). 3. Theoretical foundations of the phenomenon of polarization of heterogeneous media (two-, three- and multiphase systems, membranes). 4. The phenomenon of dielectrophoresis. 5. Dielectric properties of selected biological materials (cells, tissues, proteins, blood, biopolymers)
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
MB_24_w_1	exam	Written test/oral exam	MB_24_1, MB_24_2, MB_24_3, MB_24_4

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
MB_24_fs_1	lecture	Detailed discussion by the lecturer of the issues listed in the table "module description" using the table and/or multimedia presentations	30	Supplementary reading, working with the textbook, trying to find answers to simple problem and questions asked during the lecture	20	MB_24_w_1

1.	**Field of study**	**Biophysics**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Stochastic Methods for Optimization/Simulation

Module code: W4-2BF-MB-21-15

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_15_1	students will be able to devise efficient sampling methods for sampling any multi-dimensional probability distribution	KBF_K02 KBF_U01 KBF_U02 KBF_U14 KBF_W03 KBF_W08	3 4 5 5 4 4
MB_15_2	students will be able to use of stochastic methods for the optimization of complex problems with arbitrary model functions	KBF_K02 KBF_U01 KBF_U02 KBF_U14 KBF_W03 KBF_W08	3 4 5 5 4 4
MB_15_3	students will be able to perform Monte Carlo simulations of both classical and quantum systems	KBF_K02 KBF_U01 KBF_U02 KBF_U14 KBF_W03 KBF_W08	3 4 5 5 4 4

3. Module description	
Description	This course will give students an operative knowledge of computational simulation and optimization techniques based on stochastic methods. Course syllabus: (1) Monte-Carlo Integration. Sampling techniques and variance reduction. (2) Stochastic optimization: simulated annealing and genetic algorithms. (3) Dynamic Monte Carlo: random walks and the diffusion equation. (4) Classical Monte Carlo simulations: from simple to molecular systems and biomolecules. (5) Application of Monte Carlo methods to quantum systems.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_15_w_1	credit	the final mark for this course is computed as 0.4 a + 0.4 b + 0.2 c, where a is the mean grade of each practical homework, b is the grade of the final project and c is the rating of written questions concerning the final project	MB_15_1, MB_15_2, MB_15_3

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_15_fs_1	lecture	Detailed discussion by the lecturer of the issues listed in the table "module description" using the table and/or multimedia presentations	24	Supplementary reading, working with the textbook, doing homework	44	MB_15_w_1
MB_15_fs_2	laboratory classes	Performance of exercises on the subject consistent with the issues listed in the table "module description"	12	Acquiring knowledge in the scope of the exercise, preparation of the final report on a given exercise	20	MB_15_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Subject in the Field of Humanities

Module code: W4-2BF-MB-21-31

1. Number of the ECTS credits: 3

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_31_1	Student has a general knowledge of selected scientific methods and knows issues specific to the discipline of science not related to the field of study	KBF_W12	5
MB_31_2	Posiada pogłębioną umiejętność stawiania i analizowania problemów na podstawie pozyskanych treści z zakresu dyscypliny nauki niezwiązanej z kierunkiem studiów	KBF_U17	5
MB_31_3	Student understands the need for an interdisciplinary approach to solving problems, integrating knowledge from various disciplines and practicing self-education aimed at deepening the acquired knowledge	KBF_K10	5

3. Module description

Description	The aim of the module is to expand the student's knowledge and social skills with content outside the field of study.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_31_w_1	credit	Final test on issues discussed during the lecture	MB_31_1, MB_31_2, MB_31_3

5. Forms of teaching						
code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_31_fs_1	lecture	Providing the content of the lecture verbally with the use of content visualization. Focusing on a conceptually difficult material and indication of sources. Illustration of content using examples	30	Getting acquainted with the subject of the lecture, using textbooks, scripts, websites, etc.	30	MB_31_w_1

1.	Field of study	Biophysics
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	studia drugiego stopnia
5.	Degree profile	general academic
6.	Mode of study	stacjonarne

Module: Surface Science

Module code: W4-2BF-MB-21-09

1. Number of the ECTS credits: 3

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_09_1	the student can be introduced to the physics of surfaces and interfaces, focusing on basic concepts rather than specific details	KBF_W01 KBF_W07	4 3
MB_09_2	the student is able to know the physical phenomena underlying some of the most important techniques and methods for surface analysis	KBF_W01 KBF_W10	4 4

3. Module description

Description

PART I: Phenomenology of surfaces and interfaces
Introduction to the course. Introduction to surfaces and interfaces. Surface/volume ratio. Microscopic interpretation of intermolecular forces. Interaction energy between ions, frozen and mobile permanent dipoles. Keesom energy.
Interaction energy with induced dipoles: Debye induction energy, London dispersive energy. Frequency dependence of atomic polarizability. Ionization energy. Van der Waals energy.
Additivity of Van der Waals interaction. VdW forces between macroscopic bodies: adsorption, adhesion, cohesion. Hamaker constant. Liquid surfaces. Interfacial thickness. Surface free energy and surface energy. Surface tension. Thermodynamics of
interfaces in equilibrium: Gibbs theory. Definition of interface and Gibbs dividing plane. Interfacial excess.
Thermodynamic potentials at the interface. Thermodynamic definition of surface tension. Euler relation and Gibbs-Duhem relation. Surface tension and interfacial excess. Mixing entropy and mixing chemical potential. Surface activity: case of ionic, apolar, and amphiphilic solutes. Colloidal aggregates. Critical micellar concentration. Thermodynamics of colloidal aggregation.
Pressure difference across a curved surface: Young-Laplace equation. Vapor pressure at a curved surface: Kelvin equation.
Supersaturation pressure. Theory of homogeneous nucleation. Heterogeneous nucleation. Wetting. Wetting line and contact angle. Young equation. Cases of partial, complete, and no wetting. Capillarity phenomena. Thin film formation.
Dewetting. Pseudo partial wetting and wetting layer. Thin film deposition: dip coating and spin coating.
PART II: Surface characterization techniques
Scanning probe microscopy. Beam vs local probes. Atomic force microscope. Working principle: typical setup. Piezoelectric scanners and raster scan. Constant height mode and constant force mode. Interaction steepness and atomic resolution.

	Cantilever force sensors. Optical lever deflection detection method. Static mode of operation: contact mode. Jump-in-contact and jump-off-contact points. Lateral force and local friction coefficient measurement. Bidirectional optical lever. Dynamic modes of AFM. Problems arising in static mode: thermal noise. Response function of the cantilever as a simple harmonic oscillator. Tapping mode. Phase sensitive coherent detection and lock-in detection. Effect of conservative and dissipative interactions on resonance curve. Frequency-modulation mode. Piezoelectric resonant force sensors: quartz tuning fork. Combined scanning probes. Auxiliary distance control. Electrostatic Force Microscopy. Dependence of electric force on distance and electric properties of dielectrics. Voltage-modulated force detection. Dielectric constant, surface charge and contact potential measurement. Kelvin probe method. Kelvin probe force microscopy. Nanotribology. Friction at a contact point measured by AFM. Stick-slip model for dissipation by dynamical friction. Friction of atomic layers. Quartz crystal microbalance (QCM). Gravimetric and non-gravimetric QCM. Interfacial viscosity and slip time.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_09_w_1	exam	oral exam, or presentation, in seminar form, of a detailed study concerning one of the topics of the course	MB_09_1, MB_09_2

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_09_fs_1	lecture	Detailed discussion by the lecturer of the issues listed in the table "module description" using the table and/or multimedia presentations	18	Supplementary reading, working with the textbook	41	MB_09_w_1
MB_09_fs_2	laboratory classes	One visit to research laboratories where experiments of surface physics using scanning probe microscopy are performed	6	Supplementary reading, working with the textbook	10	MB_09_w_1