COURSE DESCRIPTION CARD - SYLLABUS

Course name
Bioelektronika Molekularna

Course

Field of study
Technical Physics

Year/Semester
3/5

Area of study (specialization)

Profile of study
general academic

Level of study
First-cycle studies

Course offered in
polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
20

Laboratory classes

Other (e.g. online)

Tutorials

Projects/seminars

Number of credit points

3

Lecturers

Responsible for the course/lecturer:
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Wydział Inżynierii Materiałowej i Fizyki Technicznej

ul. Piotrowo 3, 60-965 Poznań

Responsible for the course/lecturer:

Prerequisites

Fundamentals of molecular and experimental physics. The ability to solve elementary problems in physics based on the possessed knowledge, the ability to obtain information from the indicated sources. Understanding the need to expand your competences, readiness to cooperate as part of the team.

Course objective

1. To acquaint students with the basics and the latest achievements of a relatively new field of interdisciplinary research at the interface between physics, electronics, biology and chemistry

2. analysis of physical molecular processes taking place in living organisms, modeling these processes

3. indication of the possibility of using biomolecular materials in microelectronics and in the construction of physical sensors

4.short course - "from biophysics to construction of molecular motors" - developing students' skills to solve simple physical tasks and problems based on the acquired knowledge

5. shaping students' literacy skills

Course-related learning outcomes

Knowledge

1.to familiarize students with the basics and the latest achievements of a relatively new field of interdisciplinary research at the interface between physics, electronics, biology and chemistry

2. analysis of physical molecular processes taking place in living organisms, modeling these processes

3. indication of the possibility of using biomolecular materials in microelectronics and in the construction of physical sensors

4.short course - "from biophysics to construction of molecular motors" - developing students' skills to solve simple physical tasks and problems based on the acquired knowledge

5. shaping students' literacy skills

Skills

As a result of the course, the student should demonstrate skills in the following areas (the student will be able to):

1. is able to correctly use standard analytical tools, including numerical and computational tools, to solve detailed physical and technical problems; is able to critically evaluate the results of such an analysis [K1_U09]

2. is able to notice their social, economic and legal aspects when formulating and solving engineering tasks [K1_U23]

3. has the ability to self-educate [K1_U03]

Social competences

Social competences: as a result of the course, the student will acquire the following competences. Completing the course means that:

1. is aware of and understands the importance of non-technical aspects and effects of engineering activities, including its impact on the environment and the related responsibility for decisions made [K1_K06]

2. is aware of the social role of a technical university graduate, and especially understands the need to formulate and transfer information and opinions to the society on the achievements of technical physics and other aspects of engineering activities [K1_K09].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Effect	Form of evaluation	Evaluation criteria
W11, W12, W13	written / oral examination	50.1% -70.0% (3)
U09, U23, U03	written / oral examination	70.1% -90.0% (4)
	rating of answers to questions	from 90.1% (5)

K06, K09, - involvement in solving problems, independently looking for a solution based on the acquired knowledge, looking for additional sources of knowledge useful to solve the problem, the student is actively involved in the implementation of accounting exercises, looks for solutions in non-standard situations

Programme content

1. SCOPE OF MOLECULAR BIOELECTRONICS; overview of Bioelectronics issues, various aspects of Bioelectronics, challenges and limitations of Bioelectronics, intelligent molecular materials, R&D strategies in bioelectronics.

2. BIOMOLCULAR COMPONENTS OF LIVING ORGANISMS; definition of life, cell chemistry, biological membrane, molecules as basic units of life, polypeptides, proteins, protein functions, DNA structure, molecular functional units.

3. PARTICLES AND PHOTOPHYSICAL REACTIONS IN BIOLOGY; retinal, dyes, chlorophylls, carotenoids, phycobiliproteins, dye functions, excited states in biophysics, energy transfer, charge transfer.

4. STRUCTURE AND FUNCTIONS OF HIGHLY ORGANIZED MOLECULAR SYSTEMS AND THEIR MODELING; photosynthetic processes taking place in photosynthetic organisms, structure of photosynthetic organisms, functions of macromolecular biological systems, transfer of excitation energy in LH systems, charge transfer in CR, model of an artificial photosynthetic unit, energy transport in JFS, aggregation properties of dyes in model systems, mass and signal transport by biological membrane.

5. APPLICATION OF THE PHOTOSYNTHESIS PROCESS; energy conversion - the use of photosynthesis, generation of the photopotential in functional systems containing CR and chromatophore membranes, generation of the photopotential in systems containing photosynthetic pigments, generation of the photopotential in systems containing synthetic dyes, systems modeling selected functions of photosynthetic organisms, hydrogen production.

6. MACRO-MOLECULES, BIO-MOLECULES, SUPPLEMENTARY; importance of large molecules in physics, chemistry and biology, molecular recognition, inclusion compounds, corona compounds, supramolecular structures, energy transfer, photosensitization (sensitization).

7. NEURAL NETWORKS; linear and non-linear models of neural cells, dynamics of learning neural networks.

8. MOLECULAR ELECTRONICS; nanomaterials, polymers, molecular conductors, monomolecular conductors, molecular switches, molecular rectifiers, quantum dots, emission of fluorophores in the presence of colloidal metals, surface plasmons, molecular field transistors, molecular nanotransistors, molecules as energy conductors, molecular memory, biocomputer memory bacteriorodopsin-based data, computational electronics, molecular light-emitting photodiodes, organic light-emitting photodiodes (OLEDs), light-emitting organic nanodiode matrices, light-induced charge separation (molecular photodiodes), future - intelligent molecular materials.

9. BIO-SENSORS; electrochemical biosensors, biosensor structures, nanosensors, biomimetic and bio-inspiring systems, biopolymers, the use of conductive polymers for the production of biosensors, immobilization of biomolecules, LB layers, self-assembling monolayers (SAM), self-assembling molecular systems, resonance sensors, surface plasmon coatings as physical markers in immunobiological applications, optical biosensors, printed molecular polymers, mass biosensors on quartz crystals (QCM), RNA biosensor, elastic properties of biomolecules.

10. SURFACE PLASMA - biophysical applications.

11. STRUCTURES OF BIOMOLECULAR SILINICS; molecular Lego, the essence of nanotechnology (Ames Research Center), nanomotors, nanotubes, protein nanotubes, NAS research directions, nanoelectronics, molecular motors.

12. BIOMOLECULAR SENSORS IMITATING THE HUMAN SENSES; electronic tongue, electronic nose, electronic eye - molecular photoreceptor.

Teaching methods

Wykład: prezentacja multimedialna, prezentacja ilustrowana przykładami podawanymi na tablicy

Bibliography

Basic

1. Fizyka molekularna z elementami chemii kwantowej, H. Haken, H. K. Wolf, PWN, Warszawa 1998

2. Molecular Bioelectronics, C. Nicolini, World Scientific Singapore, New Jersey, London, Hong Kong, 1996

3. Bioelectronics, I. Willner and E. Katz Ed., Wiley-Vch Verlag GmbH & Co. KGaA, 2005.

4. Molecular electronics - Biosensors and Biocomputers, Felix T. Hong Ed, Plenum Press New York and London, 1989

Additional

1. Biosensors and Bioelectronics - czasopismo naukowe, Elsevier Science - wybrane artykuły

2. Świat Nauki - czasopismo popularno-naukowe - , WSzP SA - wybrane artykuły

Breakdown of average student's workload

	Hours	ECTS
Total workload	59	3,0
Classes requiring direct contact with the teacher	39	2,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	0	0,0

[1] delete or add other activities as appropriate