POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Basics of bionics and virtual engineering [S2IBio1E>PBiIW]

Course

Field of study
Biomedical Engineering

Year/Semester
1/1

Area of study (specialization)
–

Profile of study
general academic

Level of study
second-cycle

Course offered in
English

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
15

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

KNOWLEDGE: Knowledge of geometry modeling methods in CAD systems. Basic knowledge of the construction of computer systems. basic knowledge of structural analysis. SKILLS: Ability to use computer systems. Ability to use a basic CAD system. Ability to model geometry in the CAD system. Ability to use the finite element method in practice. SOCIAL COMPETENCES: Ability to work in a team. Understanding the need for learning and acquiring new knowledge.

Course objective

To acquaint students with the current trends in the application of modern engineering methods in the field of biomedical engineering. Transfer of knowledge about the basics of bionics. Transfer of knowledge about the methods and processes related to advanced virtual design with the use of CAD design systems with the use of knowledge about the structure and principles of functioning of living organisms. Developing practical skills in creating a virtual project. Indication of the role of structural optimization in the design process. Identification of the similarities between the methods of structural optimization and natural processes resulting in technical solutions known from living organisms. Identification of the similarity between the structural optimization in mechanical applications and the processes of functional adaptation of living structures on the example of the phenomenon of adaptive remodeling of trabecular bone. To acquaint students with solutions to complex technical problems in living organisms and indication of methods allowing for their adaptation in technology. Providing students with the competences and skills needed to work in any enterprise in a position requiring general engineering knowledge. Providing students with the opportunity to work in research centers and research and development departments of companies related to the production and service sector in the field of biomedical engineering

Course-related learning outcomes

Knowledge:
1. The student has basic knowledge of engineering design and engineering graphics, allowing to design objects and processes, systems in terms of systems, machine elements; formulate and analyze problems; look for the concept of solutions modeled on living organisms, apply engineering calculations, select and evaluate solution variants; apply modeling, optimization and search for new solutions according to the patterns of structure and functioning of living organisms.
2. The student has detailed knowledge covering the key issues in the field of tissue functioning and growth, communication between cells, the influence of external fields, in particular mechanical interactions and their role in self-organization and optimization of bone structures.
3. The student has a basic knowledge of the development trends of computer-aided engineering design, knows selected numerical methods of optimization, and the development trends of Cax systems.

Skills:
1. The student is able to obtain information from literature, databases and other properly selected sources; in particular, he can describe the issues of biochemistry and biophysics and combine them with technical issues and engineering design, can integrate the obtained information, interpret it, and find similarities of the developed methods in the field of engineering and the achievements of Nature.
2. The student is able to use information and communication techniques appropriate to the implementation of tasks typical for engineering activities.
3. The student is able to carry out computer simulations, interpret the obtained results and draw conclusions. He can use computer aided to solve technical tasks, in particular in the area of structural optimization.
4. Can solve technical problems based on the laws of mechanics; apply knowledge of electrical engineering and electronics to design and analyze electrical and electronic systems; perform strength analyzes of machine elements and mechanical systems and use numerical tools for the purposes of structural optimization, also with the use of biomimetic methods.

Social competences:
1. Can interact and work in a group, assuming different roles in it.
2. The student is able to set priorities for the implementation of the tasks set by himself or others, especially in the area of modeling changes in living organisms.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Oral and written exam. Individual assessment of completed laboratory exercies. The condition for receiving a positive evaluation is obtaining at least 50% of the possible points. This applies to all forms of classes.
Test for:
- level of knowledge,
- application of knowledge,

- potential problem-solving skills.

Programme content

Lecture topics:
1. Current trends in the application of modern engineering methods in the field of biomedical engineering.
2. Bionics - the essence of the concept, history of creation, examples of use in design.
3. Introduction to the problem of structural optimization.
4. The role of optimization in virtual design and the use of biomimetic methods.
5. Examples of bionic structures.
6. The relationship of bionics, virtual engineering and modern manufacturing methods.
7. Summary and software review.
Practical classes:
1. Use of geometric models as the basis of virtual engineering.
2. Methods of structural analyzes.
3. The essence of optimization of cross-section dimensions, shape and topology optimization.
4. Similarities and differences in the process of functional tissue adaptation and structural optimization.
5. The use of biomimetics in mechanical design.
6. Designing mechanisms based on the structure of living organisms.
7. Final test.

Course topics

none

Teaching methods

An interactive lecture using multimedia presentations.

Bibliography

Basic
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5. Huiskes R et al (2000) Effects of mechanical forces on maintenance and adaptation of form in trabecular bone. Nature 404:704–706, 2000
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Additional
. Michał Nowak, Optymalizacja strukturalna według wzorca biologicznego, Politechnika Poznańska, Rozprawy nr 402, Wydawnictwo Politechniki Poznańskiej, ISBN 83-7143-259-3, Poznań, 2006
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4. Ohlsen J., Herzog F., Raso S. et al., Function Integrated, Bionic Optimised Vehicle Lightweight Structure in Flexible Production. ATZ Worldw 117, pp. 34–39, https://doi.org/10.1007/s38311-015-0060-7, 2015.
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Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	47	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	28	1,00