COURSE DESCRIPTION CARD - SYLLABUS

Course name
Orthopedic and rehabilitation engineering [S2IBio1>IOiR]

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
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
0

Other
0

Tutorials
0

Projects/seminars
30

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

The student starting the course has a basic knowledge of subjects such as Fundamentals of Machine Design, Mechanics, Technical Drawing and Computer Graphics. The student should be able to use the MS Office suite, any CAD software, obtain information from indicated sources, and independently search for information sources. The student should be ready to cooperate as part of a team and be aware of the need for self-education.

Course objective

The aim of the course is to familiarize students with the subject of designing assistive technology devices. The course will also discuss the biomechanical models used for this purpose and the applicable legal standards.

Course-related learning outcomes

Knowledge:
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 solution concepts; apply engineering calculations, select and evaluate solution variants; use modeling,

optimization and knowledge bases in engineering design, computer-aided design process, technical drawing; read drawings and diagrams of machines, devices and technical systems; describe their structure and principles of operation.
Has basic knowledge of engineering design and engineering graphics, allowing to describe and apply the processes and systems of operation, reliability and safety, elements of technical diagnostics of machines related to the operational properties of materials; use the basics of computer-aided design of CAD in connection with computer-aided material design CAMS and technological CAM.
Has a basic knowledge of the development trends of computer-aided engineering design, thanks to which he can describe and present the methods of recording the structure, rules of mapping and dimensioning, projection, simplification in the notation of the geometric form and dimension system, read assembly drawings, finite element methods (FEM) and boundary (MEB), selected numerical optimization methods, the use of FEM and MEB in computer aided design, the use of computer graphics in the process of creating technical documentation, CAD / CAM systems.
He knows the basic methods of techniques and tools in the field of engineering biomechanics, thanks to which he can describe the structure and mechanical and physical properties of human osteoarticular structures, factors and parameters of body posture, the basis of the strength of tissue materials - biomechanical aspects of overloading tissue structures, structure and biomechanics of the spine; is able to present the stabilizers used in the treatment of spine diseases, selected issues of the anatomy and biomechanics of the hip joint, the structure and elements of the anatomy of the knee joint, studies of stresses and deformations in the knee and hip joints; has knowledge of hip and knee arthroplasty, external stabilization of long bones; can characterize the construction of external stabilizers, the construction of selected stabilizers, the structure and biomechanics of the temporomandibular joint, selected issues of tribology of joints, experimental methods of biomechanics [K_W26 (P6S_WG)].

Skills:
Can obtain information from literature, databases and other properly selected sources (also in English or another foreign language recognized as the language of international communication) from biomedical engineering; in particular, can describe the issues of biochemistry and biophysics and combine them with technical issues and engineering design, can integrate the obtained information, interpret it, as well as draw conclusions and formulate and justify opinions.
Can use information and communication techniques appropriate to the implementation of tasks typical for engineering activities.
Can formulate and solve engineering tasks to use analytical, simulation and experimental methods. Can formulate problems and use mathematical methods and the laws of physics in the analysis of technical issues; can explain the role of chemical changes in industrial processes.
Can evaluate the usefulness of routine methods and tools for solving a simple practical engineering task, characteristic for biomedical engineering, and can select and apply the appropriate method and tools.

Social competences:
Understands the need for lifelong learning; can inspire and organize the learning process of other people.
Is aware of the social role of a technical university graduate and understands the need to formulate and convey to the society, in particular through the mass media, information and opinions on the achievements of technology and other aspects of engineering activities; makes efforts to provide such information and opinions in a commonly understandable manner.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Lecture (exam): written completion of tasks and questions from the program content.
Project: A project task carried out in groups.
passing threshold: 60%

Programme content

Lecture 1 - Assistive Techniques - introduction The course will present the most commonly used assistive technology devices and outlined engineering issues related to their construction.
Lecture 2 - Basics of design and legal standards Design problem definition. Formulating a design task based on anthropometric data and applicable legal standards.

Lecture 3 - Wheelchair part. 1 Discussion of the problems of constructing wheelchairs. Models, materials, legal norms, types, the latest trends.
Lecture 4 - Wheelchair part. 2 Discussion of advanced solutions in wheelchairs. Electric drive, hybrid drive, functionality extension modules.
Lecture 5 - Technical aids in standing and learning to walk Discussion of the issues of constructing standing frames and handrails. Models, materials, legal norms, types, the latest trends.
Lecture 6 - Technical means of passive locomotion Discussion of the problems of constructing beds and stretchers. Models, materials, legal norms, types, the latest trends.
Lecture 7 - Prostheses of upper and lower limbs Discussion of the problems of constructing and manufacturing prostheses of upper and lower limbs. Materials, legal standards, manufacturing technique.
Lecture 8 - Modular structures in terms of designing assistive devices Principles of designing modular structures. Ways of using modular structures oriented to the needs of people with disabilities. The possibility of functional development of the structure through the use of various modules.
Projects:
Project 1 - Distribution of project tasks During the classes, students will be given design tasks, the subject of which will be the requirement to replace specific functions of the organism by a technical device.
Project 2 - Development of the functional structure of the designed device During the classes, students will formulate their design task and develop the functional structure of the designed technical device
Project 3 - Formulation of the morphological matrix On the basis of the developed functional structure, students will formulate a morphological matrix of possible technical solutions that perform particular functions.
Project 4 - Multi-criteria assessment During the classes, students will carry out a multi-criteria assessment of the concepts of structures they have developed collected in morphological matrices. During the course, they will develop evaluation criteria and assign them appropriate weights.
Project 5 - Preliminary construction concept, part 1 In class, students will use CAD software to create a conceptual model of their technical solution.
Project 6 - Preliminary construction concept, part 1 In class, students will use CAD software to create a conceptual model of their technical solution.
Project 7 - The use of anthropometric dimensions in the selection of design features During the classes, students will use anthropometric atlases to verify the concepts they have developed. The aim of the course is to use anthropometric dimensions in the process of selecting regulatory systems.
Project 8 - Consultation classes During the classes, students will present their solutions which will be discussed by the whole group. The aim of the course is to introduce feedback to the design process. This will allow the student carrying out the project to obtain the opinion of potential users and, on this basis, to modify his structure.

Course topics

The course explores a range of topics in the design and engineering of assistive devices. It begins with an introduction to the most commonly used assistive technology devices and an overview of the engineering challenges involved in their development. Following this, students are introduced to the basics of design, including defining project problems and formulating project tasks based on anthropometric data and relevant legal standards.

One key focus is on wheelchair design, covered over two sessions. The first session addresses basic considerations, such as models, materials, legal standards, and the latest trends, while the second session delves into advanced solutions, including electric and hybrid drives and modular systems that expand functionality. The course also examines technical aids for standing and walking support, such as standing aids and rails, discussing models, materials, types, and emerging innovations.

Further into the course, students study passive locomotion aids, such as beds and stretchers, considering the associated models, materials, standards, and modern trends in their design. Additionally, upper and lower limb prostheses are explored, focusing on materials, legal standards, and manufacturing techniques. Another critical area of study is modular design principles, examining how modular structures can be used to enhance assistive devices, adapt them to the needs of people with disabilities, and expand functional capabilities through interchangeable modules.

The practical project component of the course guides students through the entire design process. The

project work begins with task distribution, where students are assigned a design project focused on replacing specific bodily functions with technical devices. In the following sessions, students develop the functional structure of their device, formulate a morphological matrix of potential technical solutions, and conduct a multi-criteria assessment of their concepts, assigning criteria weights to evaluate different designs.

Using CAD software, students then proceed to create conceptual models of their designs. After refining their models, they apply anthropometric measurements from atlases to verify their concepts and tailor regulatory systems. Finally, in a consultation session, students present their projects to the group, allowing for feedback and iterative improvements based on user perspectives and peer insights, integrating this feedback into their designs for improved functionality and usability.

Teaching methods

Lecture: multimedia presentation, examples given on the blackboard
Project: consultation with students on the project task being carried out

Bibliography

Basic
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Pahl G., Beitz W. 1988. Engineering Design, Wyd. The Design Council, London
Pheasant S. 1986 Bodyspace: Anthropometry, Ergonomics and Design, Wyd. Teylor & Francis, London

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