COURSE DESCRIPTION CARD - SYLLABUS

Course name
Disabled people centered design [S1IBio1>PZnONR_1]

Course

Field of study
Biomedical Engineering

Year/Semester
3/6

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
15

Laboratory classes
0

Other
0

Tutorials
0

Projects/seminars
15

Number of credit points

2,00

Coordinators

dr hab. inż. Bartosz Wieczorek prof. PP
bartosz.wieczorek@put.poznan.pl

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 the student with various aspects of designing rehabilitation devices. During the course, the student will learn about various methods of design and creative solving of engineering problems. The aim of the classes will be to present the issues of designing devices that compensate for the user's disability.

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. - [K_W05 (P6S_WG)]. 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 - [K_W06 (P6S_WG)]. 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 [K_W20 (P6S_WG)]. 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 [K_U01 (P6S_UW)]. Can use information and communication techniques appropriate to the implementation of tasks typical for engineering activities [K_U07 (P6S_UW)]. 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 [K_U10 (P6S_UW)]. 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. [K_U18 (P6S_UW)].

Social competences:
Understands the need for lifelong learning; can inspire and organize the learning process of other people [K_K01 (P6S_KK)]. 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 [K_K07 (P6S_KK)].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: written completion of tasks and questions from the program content. Project: A project task carried out in groups
passing threshold: 60%

Programme content

Lecture:
Lecture 1 - Types of disability. The lecture will discuss the types of disabilities and their impact on the functioning of the user's somatic and receptor relations. The content of the course will outline the spectrum of technical solutions to compensate for individual disabilities.
Lecture 2 - The impact of disability on the biomechanics of the human body. The lecture will discuss the

basic aspects of the biomechanics of the human body, such as muscle activity and the kinematic chain.
Lecture 3 - The use of anthropometric data in design The lecture explains the basics of anthropometry, the percentile classification of dimensions and methods of measuring the human body. The lecture will present the methods of using anthropometric dimensions in designing types of mechanical structures. The basics of designing series of types will be discussed.
Lecture 4 - Formulating the design problem. During the lecture, students learn how to define a design problem and formulate a design task based on it. Methods of creating the functional structure of a technical device will be discussed.
Lecture 5 - Design methods used in the design of rehabilitation devices. During the lecture, students learn about innovative methods of solving design problems and ways of formulating morphological matrices as an element enabling the development of an innovative solution.
Lecture 6 - Multi-criteria assessment. The lecture will discuss the principles of performing multi-criteria assessment in the process of selecting a functionally optimal technical solution. Students will learn how to formulate evaluation criteria so that they comply with the principles of good construction and the principles of user-centered design.
Lecture 7 - Modular structures in terms of designing rehabilitation devices. The lecture will discuss the principles of designing modular structures. On the basis of this information, the ways of applying modular structures oriented to the needs of disabled people will be presented. Students will learn about the functional development of a structure through the use of various modules.
Lecture 8 - experimental methods used in the design process of rehabilitation devices The lecture will discuss selected laboratory tests as part of the entire design process. Students will learn how to use laboratory tests as a way to determine the user's needs or a way to verify the developed design solution.
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 addresses the design of assistive devices with a focus on various types of disabilities and their impact on users' somatic and sensory functions. The introductory module covers different forms of disability and presents a range of technical solutions aimed at compensating for specific limitations. This is followed by an exploration of the effects of disabilities on human biomechanics, including muscle activity and the kinematic chain, providing a foundational understanding of how physical limitations influence movement and support needs.

Subsequent lectures introduce students to anthropometry, covering the basics of body measurement techniques, percentile classification of body dimensions, and the application of anthropometric data in designing series of mechanical constructions. This anthropometric foundation aids students in creating functional designs tailored to user needs. Building on this, students learn to define a design problem and

structure it into a clear project task, including methods for developing a functional framework for a technical device.

The course further explores innovative design methods for rehabilitation devices, including the formulation of morphological matrices to support the development of creative and novel solutions. In addition, multi-criteria evaluation methods are discussed, where students learn to develop assessment criteria that are both functionally optimal and aligned with user-centered design principles.

In another section, students delve into the principles of modular design, particularly for assistive devices, gaining insight into how modular structures can address the needs of users with disabilities by enabling functional expansion through the addition of various modules. The course concludes with a focus on experimental methods in the design process, where students learn to leverage laboratory research both to assess user needs and to verify their design solutions.

The project work begins with the assignment of design tasks focused on compensating for specific bodily functions with technical devices. Students then define their project objectives and develop a functional structure for their device. They use this structure to formulate a morphological matrix, brainstorming multiple design variations to address the assigned project problem creatively.

In later stages, students conduct a multi-criteria evaluation of their concepts, defining criteria and assigning appropriate weights. Using CAD software, they proceed to develop conceptual models of their designs, refine these models, and perform anthropometric verification with measurement atlases to ensure proper alignment with user dimensions.

The course concludes with a feedback-driven consultation session, where students present their designs to the group, gather user feedback, and incorporate suggestions to enhance their projects. This feedback loop integrates user perspectives, enabling students to refine their designs for greater functionality and user satisfaction.

Teaching methods

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

Bibliography

Basic:
Bober T., Zawadzki J. - 2006: Biomechanika układu ruchu człowieka. Wydawnictwo BK, Wrocław
Branowski B. - 2001: Rozwój metodologii projektowania technicznego (Na przykładzie urządzeń technicznych dla osób niepełnosprawnych, Metody i techniki konstruowania, Wyd. Wrocławskiej Rady FSNT NOT, Wrocław
Branowski, B. K. (1999). Metody twórczego rozwiązywania problemów inżynierskich. Wydaw. Wielkopolska Korporacja Techniczna NOT.
Branowski B., Zabłocki M. - 2006: Kreacja i kontaminacja zasad konstrukcji w projektowaniu dla osób nepełnosprawnych, Ergonomia produktu. Ergonomiczne zasady projektowania produktów pod red. J. Jabłońskiego, Wyd. Politechniki Poznańskiej, Poznań
Nowak E. - 2000: Anthropometry for design, International Encyclopedia of Ergonomics and Human Factors, Tom 2 pod red. W. Karwowskiego, Wyd. Teylor & Francis, London
Pahl G., Beitz W. - 1984: Nauka konstruowania, Wyd. Naukowo-techniczne, Warszawa

Additional:
Cooley, M. (1999). Human-centered design. Information design, 59-81.
Cempel C. - 2013: Inżynieria kreatywności w projektowaniu innowacji, Wyd. Naukowe Instytutu Gendarz P. - 2012: Parametryczny zapis uporządkowanych rodzin konstrukcji maszyn, Wyd. Politechniki Śląskiej, GliwiceTechnologii Eksploatacji - PIB Politechniki Poznańskiej, Poznań.
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	50	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	20	1,00