# COURSE DESCRIPTION CARD - SYLLABUS

Course name

Bioengineering

## Course

| | |
|---|---|
| Field of study<br>Automatic Control and Robotics | Year/Semester<br>2/3 |
| Area of study (specialization)<br>Control and robotics systems | Profile of study<br>general academic |
| Level of study<br>Second-cycle studies | Course offered in<br>Polish |
| Form of study<br>full-time | Requirements<br>elective |

## Number of hours

| | | |
|---|---|---|
| Lecture<br>15 | Laboratory classes | Other (e.g. online) |
| Tutorials | Projects/seminars<br>30 | |

## Number of credit points

3

## Lecturers

Responsible for the course/lecturer:

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Responsible for the course/lecturer:

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## Prerequisites

The student starting this subject should have a basic knowledge of automation, kinematics and dynamics of manipulators and mechanics. Should also have basic knowledge of the basics of programming. Should have the ability to think logically, use information obtained from the library and the Internet, and solve simple programming tasks. He should also understand the need to broaden his competences and be ready to cooperate within a team. In addition, in the field of social competence, students must present attitudes such as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, and respect for other people.

## Course objective

Providing students with knowledge of biomechanics and rehabilitation engineering as well as basic knowledge of robotics in the field of modern constructions of robotic systems used in medicine, with particular emphasis on devices used for the rehabilitation and support of human motor functions. Developing students' skills to solve design problems related to biomedical engineering. Developing students' ability to work in interdisciplinary teams to solve simple research tasks on the border of technology and medicine.

## Course-related learning outcomes

### Knowledge

1. has knowledge of the use of advanced measuring systems used in medicine - [K2_W6]

2. has expanded knowledge of the use of robotics in medicine (rehabilitation, orthopedics, cardiac surgery) - [K2_W10]

3. has the knowledge necessary to understand the social aspects of engineering activities and the possibilities of their application in medicine - [K2_W14]

### Skills

1. is able to simulate and analyze the operation of complex biomechanical systems and to plan and carry out experimental verification; - [K2_U9]

2. is able to identify non-technical aspects when formulating and solving tasks involving the design of robotic rehabilitation systems - [K2_U14]

3. is able to assess the usefulness and possibility of using new achievements (technologies) in the field of rehabilitation robotics - [K2_U16]

4. is able to design and implement a complex control system for rehabilitation devices taking into account non-technical aspects; - [K2_U23]

### Social competences

1. is aware of the importance and understands the non-technical aspects and effects of engineering activities, including its impact on human beings and the related responsibility for decisions taken - [K2_K2]

2. is aware of the responsibility for own work and readiness to comply with the principles of teamwork and taking responsibility for jointly implemented tasks - [K2_K3]

3. is aware of the need for a professional approach to technical issues, meticulous familiarization with the documentation and environmental conditions in which the devices and their components can function - [K2_K4]

### Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Knowledge acquired as part of the lecture is verified by the test carried out during the last lecture. The test consists of 10 differently scored questions. Passing threshold: 50% of points. Final issues will be sent to students by email.

Skills acquired as part of the project classes are verified on the basis of the completed project implemented in a 2-person group. The effectiveness of applying the acquired knowledge when solving a given problem will be assessed.

### Programme content

Lecture program includes the following: evaluation of mechanical properties of soft tissue structures and bone. Diagnostic and bone examination methods. Modeling of biomechanical properties of tissues, conducting experimental and simulation studies. The use of tissue models in virtual surgery. Electromechanical diagnostic and therapy procedures in rehabilitation. Analysis and modeling of the human musculoskeletal system with particular emphasis on biomechanics of the hip and knee. Biotribology of human joints, methods of determining frictional resistance and wear of endoprostheses. Influence of biological and biomechanical factors on the course of bone regeneration in distraction osteogenesis. The design and use of external stabilizers on the example of the Ilizarov apparatus. Human gait analysis, muscle structure and role. Vision systems for gait analysis. Discussion of measuring systems used in medicine. Design and engineering analysis of orthopedic implants. Rehabilitation systems, discussion of isometric, isokinetic and isotonic tests. The use of robotic systems in rehabilitation as devices supporting disabled people and used in rehabilitation. Discussion of modern electric and / or pneumatic drives used in rehabilitation works. The use of gears containing flexible elements. Discussion of the structure and operation of artificial organs (e.g. artificial heart). Discussion of systems supporting imaging diagnostics. Safety procedures in rehabilitation works. Directions of robotics development in medicine, with particular emphasis on rehabilitation.

Design classes take place in the laboratory and consist of solving simple research tasks. Project tasks are carried out by teams of 2 students. Before carrying out research tasks, students must conduct an analysis of existing solutions and patents. The implemented projects cover the following issues:

1. Modeling and simulation of human joints, e.g. the knee.

2. Modeling of the human upper limb.

3. Use of acceleration and pressure sensors to analyze human gait.

4. Modeling tissue structures based on x-rays.

5. Assessment of human gait using artificial neural networks.

6. Designing simple rehabilitation manipulators in the CAD environment.

7. Modeling and simulation of kinematics and dynamics of sample simple rehabilitation robots.

8. The use of mobile devices in medicine (patient gait analysis).

## Teaching methods

Teaching methods:

1. lecture: multimedia presentation, illustrated with films presenting existing solutions

2. project classes: solving research tasks, presentation of research results, discussion, teamwork.

## Bibliography

Basic

1. M. Nałęcz, Biocybernetyka i Inżynieria biomedyczna 2000, Tom 5, Biomechanika i Inżynieria rehabilitacyjna, Akademicka Oficyna Wydawnicza EXIT, Warszawa 2004,

2. J. L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons, Ltd 2008,

3. M. Nałęcz, Biocybernetyka i Inzynieria biomedyczna 2000, Tom 3, Sztuczne Narządy, Akademicka Oficyna Wydawnicza EXIT, Warszawa 2004,

4. M. Nałęcz, Biocybernetyka i Inzynieria biomedyczna 2000, Tom 8, Obrazowanie biomedyczne, Akademicka Oficyna Wydawnicza EXIT, Warszawa 2004,

Additional

1. L. Podsędkowski, Roboty Medyczne: Budowa i zastosowanie, Wydawnictwa Naukowo-techniczne, Warszawa 2010

2. J. Troccaz, Medical Robotics, John Wiley & Sons, Ltd 2012

3. Medical Robotics Reports Journal , International Society for Medical Robotics (www.medicalroboticsreports.com)

## Breakdown of average student's workload

| | Hours | ECTS |
|---|---|---|
| Total workload | 75 | 3,0 |
| Classes requiring direct contact with the teacher | 45 | 2,0 |
| Student's own work (literature studies, preparation for tests, project preparation) [1] | 30 | 1,0 |

[1] delete or add other activities as appropriate