POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Biomechanical modelling of human movement [S2IBio1>BMRC]

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
30

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

dr hab. inż. Jacek Buśkiewicz
jacek.buskiewicz@put.poznan.pl

Lecturers

Prerequisites

Engineering knowledge of first cycle of study comprising mathematics, biomechanics and mechanics.

Course objective

Widening of knowledge of: dynamic modelling of biomechanical systems and devices for supporting human's organism. constructing of empirical models and performing numerical simulations in selected software aiding engineering calculations.

Course-related learning outcomes

Knowledge:
1. The student has knowledge of load models and structure of human's bone-muscle system.
2. Has knowledge of differential equations and numerical integration.
3. Knowledge of fundamental methods and computer techniques applied for solving complex biodynamical problems.
4. Knowledge of various mathematical models in various human activities.

Skills:

2. To work out a mathematical model for biodynamical system, formulate simplifications, perform numerical simulation and discuss model limitations.
3. To carry out numerical simulations to assess the strength of structures applied in rehabilitation and healing motion systems.

Social competences:
1. The student understands the need of life-long learning, of inspiring and organising other person's teaching process.
2. Is aware of importance of engineering knowledge and its importance for society and environment.
3. Understands the need for popularisation of knowledge of biomedical engineering.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: Five theoretical questions: criteria of assessment 3.0 (50%-70%), 4.0 (71%-90%), 5.0 (>90%).
Laboratory: Assessment of the ability to understand specialist literature in the field of biomechanical modeling and practical solution of a given problem based on prepared instructions. The pass will consist of a score from five short tests (for a total of 10 points) and a grade from the report along with the presentation of one of the selected topics covered during the classes (10 points). Grading scale: below 50% - 2.0, (50%; 60%> - 3.0, (60%; 70%> - 3.5, (70%; 80%> - 4.0, (80%; 90%> - 4.5, (90%; 100%> - 5.0.

Programme content

Lecture
Elements of analytical mechanics. Biomechanical modelling of selected human motor activities. Modelling of muscular forces. Problems of redundant control.
Laboratory
Working in a software designed to model the kinematics and dynamics of the human movement system - OpenSim. Topics covered during the laboratory will include: the use of motion analysis techniques in biomechanical modeling, the influence of the length of muscles and tendons on the muscle torque generated in the joint, predicting the effectiveness of surgical procedures performed by changing the length or transplanting a tendon, using methods of inverse kinematics and inverse dynamics in observing various movement patterns, estimating muscle forces using redundant control methods and analysis of the effectiveness of orthopedic equipment in injury prevention.

Course topics

Lecture
1. Analitycal statics.
2. Analitycal dynamics.
3. Mathematical modelling, biomechanical models.
4. Dynamical models for analysis of selected human activities. Determination of muscle and joint forces.
5. Modeling of muscle forces. Problems of redundant control.
6. Modelling aimed at assesing the effect of vibrations on human body.
Laboratory
Working in a software designed to model the kinematics and dynamics of the human movement system - OpenSim. Topics covered during the laboratory will include: the use of motion analysis techniques in biomechanical modeling, the influence of the length of muscles and tendons on the muscle torque generated in the joint, predicting the effectiveness of surgical procedures performed by changing the length or transplanting a tendon, using methods of inverse kinematics and inverse dynamics in observing various movement patterns, estimating muscle forces using redundant control methods and analysis of the effectiveness of orthopedic equipment in injury prevention.

Teaching methods

1. Lecture: the presentation ilustrated with examples and problems solutions written down on the blackboard.
2. Laboratory: implementation and solving tasks in the OpenSim software, report, presentation, discussion.

Bibliography

Basic:
1. Technical mechanics V. XII Biomechanics. Part 5 Problems of dynamics in biomechanics and modeling of human body (Mechanika Techniczna, t. XII Biomechanika, pod red. R. Będzińskiego, Część 5. Problemy dynamiki w biomechanice, Modelowanie ciała człowieka, Wojciech Blajer). IPPT PAN, Warszawa, 2011.
2.R. Będziński, Engineering biomechanics - selected problems (Biomechanika inżynierska - zagadnienia wybrane) Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 1997.
3. A. Morecki, J.Knapczyk, K. Kędzior, Teoria mechanizmów i manipulatorów, Dział 8 - wybrane zagadnienia biomechaniki ruchu człowieka, (Theory of mechanisms and manipulators. Section 8 - selected problems of human biomechanics) WNT, Warszawa, 2002.
4. T. K. Uchida, S. L. Delp, Biomechanics of Movement: The Science of Sports, Robotics and Rehabilitation, The MIT Press, 2020.

Additional:
1. J. Jóźwiak, J. Podgórski, Basics of statistics (Statystyka od podstaw), PWE Warszawa, 1994
2. R.S. Guter, A.R. Janpolski, Differential equations (Równania różniczkowe), PWN, Warszawa, 1989.
3. Praca zbiorowa pod redakcją D. Tejszerskiej, E. Świtońskiego, M. Gzika, Biomechanics of motion system (Biomechanika narządów ruchu), Wydawnictwo Naukowe Instytut Technologii Eksploatacji - PIB, Radom, 2011.

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	55	2,00