Co-funded by the
Erasmus+ Programme
of the European Union

EUROPEAN UNIVERSITY FOR CUSTOMISED EDUCATION

STUDY GUIDE

Processing and analysis of biomechanical signals

Organised by

Poznan University of Technology

1. IDENTIFYING DATA.	
· Course Name.	*Processing and analysis of biomechanical signals*
· Coordinating University.	*Poznan University of Technology*
· Partner Universities Involved.	-
· Course Field(s).	*mechanical engineering/biomedical engineering*
· Related Study Programme.	-
· ISCED Code.	*0588, 0188, 0788, 0719,*
· SDG.	*3 – good health and well-being, 4 – quality education, 8 – decent work and economic growth*
· Study Level.	*Master (M)*

· Number of ECTS credits allocated.	*3*
· Mode of Delivery.	Online live, Online self-study
· Language of Instruction.	*English*
· Course Dates.	*November, 12th – January, 29th*
· Schedule of the course.	*November, 12th – Lecture (1,5h)* *November, 26th – Lecture (1,5h)* *November, 27th – Projects (3h)* *December, 3rd – Lecture (1,5h)* *December, 4th – Projects (3h)* *December, 10th – Lecture (1,5h)* *December, 11th – Projects (3h)* *December, 17th – Lecture (1,5h)* *December, 18th – Projects (3h)* *January, 7th – Lecture (1,5h)* *January, 8th – Projects (3h)* *January, 15th – Projects (3h)* *January, 22nd – Projects (3h)* *January, 29th – Projects (1,5h)*
· Key Words.	*Biomechanics, motion capture, human movement*
· Catchy Phrase.	*Dive into biomechanics: Analyse human movement with cutting-edge tools and techniques.*

· Prerequisites and co-requisites.	*Knowledge located in the educational standards in the field of: a) anatomy and physiology of the human motion system b) basics of classical mechanics, biomechanics, mathematics, physics and*

	programming languages. Student can obtain information from various sources, also in English, work individually and in a team. Has the skills necessary to work in an industrial and medical environment. He has social competences, in particular he understands the need for lifelong learning, he can interact and work in a group.
· Number of EUNICE students that can attend the Course.	*20*
· Course inscription procedure(s).	*standard*

2. CONTACT DETAILS.	
· Department.	*Institute of Applied Mechanics, Faculty of Mechanical Engineering, Poznan University of Technology*
· Name of Lecturer.	*dr inż. Martyna Białecka*
· E-mail.	*martyna.bialecka@put.poznan.pl, martyna.sopa@put.poznan.pl*
· Other Lecturers.	*mgr inż. Martyna Sopa*

3. COURSE CONTENT.

Tutorials:

1. Types of human movement monitoring systems and the information they provide.
2. Review of ready-made applications for human movement analysis, indication of the advantages and disadvantages of their use.
3. Structure of data obtained from the BTS Smart optoelectronic motion capture system with the AMTI dynamometric platforms and the strain gauge mat.
4. Methods of processing data obtained from human movement monitoring systems, reviewing key concepts in mathematics, physics and mechanics.
5. Data representation and analysis.

Projects:

1. Discussion of the principles of conducting research using an optoelectronic system, dynamometric platforms and a strain gauge mat.
2. Presenting the validity of using measurement systems to monitor human movement.
3. Processing of biomechanical signals from various movement patterns in Matlab software.
4. Counting own and literature parameters to assess the quality of movement patterns in Matlab.
5. Report on the results obtained, justification of your position based on your own, reliable results.
6. Discussion on the effectiveness of the traffic assessment, comparison of the results with the literature, indication of changes that could be introduced during data acquisition and processing.

4. LEARNING OUTCOMES.

Knowledge

1. The student defines basic concepts related to the functional and structural characteristics of the musculoskeletal system in normal and clinical conditions.

2. The student characterizes methods for assessing the condition of the human musculoskeletal system to explain disorders of their structure and function.

3. The student has detailed knowledge of the analysis and assessment of human locomotion and orthopedic supplies.

4. The student appropriately uses signals collected from experience, processes them correctly, analyzes and reports the results obtained.

5. The student has knowledge about how to monitor human movement using modern equipment.

Skills

1. The student is able to use biomechanical experimental methods to formulate and solve selected problems in the field of clinical biomechanics.

2. The student is able to use engineering methods (Matlab software) to process and analyze data from various systems monitoring human movement.

Social competences

1. The student is able to cooperate and work in a group, taking on various roles in it.

2. The student is able to think and act creatively.

3. The student is able to present the results of his or her work in a transparent way.

5. OBJECTIVES.

1. Knowledge and understanding of issues related to biomechanical and pathobiomechanical processes occurring in the human body related to the functioning of the musculoskeletal system during its static and dynamic activities.

2. Students' knowledge and understanding of the structure of the musculoskeletal system, arthromechanics and arthropathomechanics from the kinesiological perspective, taking into account the basic issues of muscle mechanics.

3. Familiarizing students with the latest biomechanical measurement tracks enabling an objective assessment of the patients' movement system - also based on the Department's own research.

4. Learning the appropriate methods of processing biomechanical signals from modern movement monitoring systems and acquiring the ability to analyze these data using computational systems.

6. COURSE ORGANISATION.

UNITS	
1.	*Types of motion capture systems and other tools in movement analysis.*
2.	Is including engineers into observation of movement beneficial?
3.	How can we include engineering tools in movement observation: challenges and solutions.

4.	What types of data can we get, how to prepare those and where is the “mechanics” in “biomechanics”?
5.	Introduction to Matlab: useful tools and commands
6.	*What our customer expect from us: how to calculate useful parameters?*
7.	*Present you work to the customer: different languages of engineers and non-engineers.*

LEARNING RESOURCES AND TOOLS.

- *International Society of Biomechanics standards: https://isbweb.org/activities/standards*
- *Tools: Matlab*
- *Literature about biomechanics, eg. Biomechanics of Movement: The Science of Sports, Robotics, and Rehabilitation, Uchida Thomas K. ISBN: 9780262044202, Fundamentals of Biomechanics, Duane Knudson*

PLANNED LEARNING ACTIVITIES AND TEACHING METHODS.

1. Tutorials: multimedia presentation, tutorials and video-tutorials.
2. Projects: team work, discussions, making reports, presentation of putcomes

7. ASSESSMENT METHODS, CRITERIA AND PERIOD.

The students are assessed by outcomes of the project task, made in groups. The project is presented on the last meeting (January, 29th). The criteria are: clarity of communication, usefulness of the report, presentation aesthetics, mathematical and mechanical, mechanical and mathematical accuracy of calculations.

OBSERVATIONS.

8. BIBLIOGRAPHY AND TEACHING MATERIALS.

[1] Wu G, Siegler S, Allard P et al. ISB recommendation on definitions of joint coordinate system of various joints for the reporting of human joint motion—part I: ankle, hip, and spine, Journal of Biomechanics 35 (2002) 543–548
[2] Winter D. (1998) The Biomechanics and Motor Control of Human Gait: Normal, Elderly and Pathological. University of Waterloo.
Additional
[3] T. K. Uchida, S. L. Delp, Biomechanics of Movement. The Science of Sports, Robotics, and Rehabilitation, MIT Press, 2021
[4] D. Lafonda , M. Duarteb , F. Prince, Comparison of three methods to estimate the center of mass during balance assessment, Journal of Biomechanics 37 (2004) 1421–1426

[5] Ahsan M, Shanab AA, Nuhmani S. Plantar Pressure Distribution Among Diabetes and Healthy Participants: A Cross-sectional Study. Int J Prev Med. 2021 Jul 9;12:88

[6] De Blasiis P, Caravaggi P, Fullin A, Leardini A, Lucariello A, Perna A, Guerra G and De Luca A (2023), Postural stability and plantar pressure parameters in healthy subjects: variability, correlation analysis and differences under open and closed eye conditions. Front. Bioeng. Biotechnol. 11:1198120.

[7] J. K. Grabski, T. Walczak. M. Białecka, On Different Methods for Calculating the Flight Height in the Vertical Countermovement Jump Analysis, Biomechanics in Medicine and Biology. BIOMECHANICS 2018. Advances in Intelligent Systems and Computing, vol 831.

[8] A. Mrozek, M. Sopa, J. Myszkowski et. al. Assessment of the Functional Movement Screen Test With the Use of Motion Capture System by the Example of Trunk Stability Push-Up Exercise Among Adolescent Female Football Players, Vibrations in Physical Systems, vol. 30/2, 2020

[9] M. Sopa, T. Walczak, A. M. Pogorzała, Motion Capture System Study on Human Balance, Innovations in Biomedical Engineering 2023 pp 77–84

[10] J. Kaszyński, C. Baka, M. Białecka et al. Shoulder Range of Motion Measurement Using Inertial Measurement Unit–Concurrent Validity and Reliability, Sensors, iss. 17, vol. 23, 2023, pp 7499-1 - 7499-15