COURSE CONTENT

(1) GENERAL INFO

SCHOOL	ENGINEERING			
DEPARTMENT	BIOMEDICAL ENGINEERING			
MSc PROGRAM	BIOMEDICAL ENGINEERING AND TECHNOLOGY			
STUDY LEVEL	POSTGRADUATE, MSc			
COURSE CODE	**BMET205**	**SEMESTER**	**B**	
COURSE TITLE	**Control systems in biomedical engineering**			
TEACHING			**HOURS**	**ECTS**
	LECTURES AND WORKSHOPS		26	5
COURSE TYPE	SPECIALIZATION			
COURSE REUIREMENTS:	-			
TEACHING AND EXAMINATION LANGUAGE:	ENGLISH			
IS THIS COURSE OFFER TO ERASMUS STUDENTS	YES (IN ENGLISH)			
COURSE WEBPAGE (URL)	https://eclass.uniwa.gr/courses/319/			

(2) LEARNING OUTCOMES

Learning outcomes

Course Objectives:
The course will assist students towards understanding the fundamentals of control systems, acquire the skills to mathematically model biophysical systems, translating real-world phenomena into mathematical equations for analysis and control system design, explore and comprehend the application of control systems in the regulation of physiological processes within the human body, gain hands-on experience in implementing control systems through numerical control, utilizing hardware such as Arduino for practical applications.

Learning Outcomes:
By the end of this course, students should be able to:
1. Understanding of fundamental control system concepts, able to differentiate between various types of control systems and explain the importance of feedback in control processes.
2. Ability to represent complex biological processes using mathematical equations.
3. Application of control system principles to understand and analyze the regulation of physiological processes in the human body.
4. Through hands-on projects and exercises using Arduino, students will demonstrate the ability to implement numerical control systems, write code for hardware interfaces, and troubleshoot practical challenges.
5. Critically evaluation and discussion of the application of control systems in biomedical devices, understanding the role of control systems in artificial organs and medical interventions.
6. Develop problem-solving skills and critical thinking in the context of control systems, enabling students to analyze, design, and optimize control systems for various biomedical scenarios.

Achievement of Course Objectives and Learning Outcomes:
In order to meet the stated objectives and achieve the outlined learning outcomes, students will be exposed to the fundamental control system concepts. Through hands-on laboratory sessions, they will engage in practical experimentation with control systems using Arduino and programming for numerical simulation of biophysical processes. The course will involve the completion of a final project centered around a real-world control system problem. This project will provide students with the opportunity to integrate all of the learning outcomes, fostering both comprehensive understanding and self-development in a real-world application context.

General abilities
• Search, analysis and synthesis of data and information, using the necessary technologies • Adaptation to new situations • Decision-making • Autonomous work • Teamwork • Working in an international environment • Working in an interdisciplinary environment

(3) COURSE CONTENT

"The Basis of Control Systems"
Fundamental concepts related to control systems. Manipulation of variables to achieve desired outcomes. Types of control systems (open-loop and closed-loop), feedback mechanisms, and the basic components of control systems.

"Mathematical Modeling of Biophysical Systems"
Representation of biological and physiological processes using mathematical models. Translation of real-world phenomena, such as the behavior of biological systems, into equations and mathematical relationships.

"Control Systems at Human Body Level"
Examples of control systems within the human body, such as thermoregulation (temperature control), osmoregulation (regulation of water and solute balance), and blood glucose regulation (important in diabetes).

"Numerical Control Systems and Hardware Implementation in Arduino"
Practical aspects of control systems. Hands-on approach, workshop.

"Applications of Control Systems in Biomedical Processes"
Real-world applications of control systems in the biomedical field.

(4) TEACHING AND LEARNING METHODS - EXAMINATIONS

<table>
<tr><td>COURSE DELIVERY</td><td>Physical presence, face to face at the auditorium</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES</td><td>The theoretical part of the course involves the use of a projector for presenting fundamental concepts and is supplemented by the use of the blackboard at the auditorium. The practical workshop part of the course is conducted in the laboratory, encompassing the hands-on implementation using ARDUINO.</td></tr>
<tr><td>TEACHING ORGANIZATION</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Teaching / lectures</td><td>26</td></tr>
<tr><td>Lecture material study</td><td>30</td></tr>
<tr><td>Unsupervised literature review and preparation of the final project</td><td>69</td></tr>
<tr><td>Total</td><td>125</td></tr>
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<tr><td>STUNDET EVALUATION</td><td>100% oral or written exam and individual project. The project involves describing the supporting theoretical aspects and an implementation of a solution, towards a practical control system problem.</td></tr>
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(5) SUGGESTED LITERATURE

Books, scientific articles and related scientific resources:

[1] Fernández de Cañete, J., Galindo, C., Barbancho, J., Luque, A. Automatic Control Systems in Biomedical Engineering. Springer, 2018.
[2] Olfa Boubaker, Control Theory in Biomedical Engineering, Science Direct, 2020.
[3] Lewis, Paul H., Basic control systems engineering, Prentice Hall, 1997.
[4] Nise, Norman S., Control systems engineering, Bejamin/Cummings Pub. Co., 1995.

Scientific journals:

[1] Journal of Biomedical Instrumentation and Applications, https://norcaloa.com/BMIA.
[2] Biomedical Sciences Instrumentation, https://journal.rmbs.org/index.php/BiomedSciInstrum.
[3] IEEE Reviews in Biomedical Engineering, https://www.embs.org/rbme/.
[4] IEEE Transactions on Biomedical Engineering, https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=10.