COURSE CONTENT

(1) GENERAL INFO

SCHOOL	ENGINEERING			
DEPARTMENT	BIOMEDICAL ENGINEERING			
MSc PROGRAM	BIOMEDICAL ENGINEERING AND TECHNOLOGY			
STUDY LEVEL	POSTGRADUATE, MSc			
COURSE CODE	**BMET202**	**SEMESTER**	**B**	
COURSE TITLE	**Biomedical Instrumentation**			
TEACHING			**HOURS**	**ECTS**
	LECTURES AND WORKSHOPS		39	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/316/			

(2) LEARNING OUTCOMES

Learning outcomes

Course Objectives:
The primary aim of this course is to explore the fundamental structure of selected biomedical systems, particularly biosignal recording systems. A detailed analysis will be conducted on the constituent components of an integrated digital biomedical system, elucidating how each element contributes to the overall functionality of the system. The course will cover essential principles, including measurement sensors, preamplification, amplification, analog signal modulation, signal processing circuits, digitization circuits, digital signal modulation and processing using microcontrollers and microprocessors, and user interface modes. Students will gain theoretical insights into designing an integrated digital biomedical system for biosignal recording (e.g., temperature, pressure, heart rate), acquire practical skills in constructing and implementing such systems in a laboratory setting, learn to apply the systems for recording measurements, and develop proficiency in analyzing the obtained data. Additionally, the course will delve into the foundational aspects of neuroengineering and implants.

Learning Outcomes:
1. Gain a comprehensive understanding of biomedical instrumentation, encompassing neuroengineering and implants, with knowledge of key definitions and concepts.
2. Describe and differentiate the individual components constituting an integrated biomedical biosignal recording system.
3. Comprehend the operational principles and conduct a comparative evaluation of various biosignal recording systems, such as electrocardiographers, electroencephalographers, and electromyographers.
4. Understand, investigate and experimentally assess the reliability of biomedical systems.
5. Theoretically design and experimentally implement an integrated digital biosignal recording system using microcontrollers and microprocessors.
6. Acquire knowledge of the fundamental principles of biosensor circuit implementation, preamplification, amplification, filtering, digitization, and software implementation for programming microcontrollers and microprocessors.

Achievement of Course Objectives and Learning Outcomes:
To fulfill the above objectives and learning outcomes, students will be taught basic concepts of sensors, analog and digital signal modulation, and end-user interfacing methods. Subsequently, the course will

investigate the individual components of a biomedical biosignal recording system, such as the electrocardiographer. In the laboratory, students will implement a biosignal recording system, covering microcontroller and microprocessor programming concepts, as well as the implementation of preamplification, amplification, and filtering circuits. Emphasis will be placed on the specific requirements of these circuits for biomedical applications. By the end of the workshop, students will possess the ability to theoretically design, experimentally implement, and comprehensively understand all individual parts of a biosignal recording system. The experimental phase will involve collaborative activities among students, and each student will be required to present an individual assignment on the theoretical design of a biosignal recording system similar to the one implemented in the lab. The final module of the course will explore advanced topics in biomedical instrumentation, with a particular focus on neuroengineering and implants, analyzing both fundamental principles and current developments.

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

«Introduction to biomedical instrumentation»
Definitions, basic concepts, biosensors, analog signal modulation circuits, signal digitization, signal storage, signal compression and transmission, user interfaces, system reliability, patient safety, interaction of current with humans, protocols, standards, regulatory frameworks, biomedical system design criteria.

«Biosignal recording and monitoring systems»
Definitions, basic concepts, electrophysiology, biodynamics, membrane potential, action potential and stimulation of nerve, cardiac and muscle cells, basic operating principle and instrumentation of electrocardiographer, electroencephalographer and electromyographer with references to human anatomy and physiology of the organs involved.

«Microcontrollers and microprocessors»
Definitions, basic concepts, basic principles of operation, internal organization, digital circuits, numerical microprocessor, RAM, ROM, EEPROM, programming of Basic Stamp microcontroller and/or ARDUINO microprocessor, software development.

«Theoretical design and experimental implementation of a biosignal recording system»
Definitions, basic concepts, design specifications, identification and selection of suitable electronic components compatible with the design specifications, study and analysis of techniques to assess the resolution and reliability of the designed system, circuit implementation, circuit reliability and safety testing, obtaining measurements from the integrated circuit, processing and analysis of measurements.

«Advanced topics in biomedical instrumentation»
Definitions, basic concepts, principle of operation in neuroengineering and implants, implant instrumentation, implant design and implementation issues, examples of implants in epilepsy management and vision recovery.

(4) TEACHING AND LEARNING METHODS - EXAMINATIONS

<table>
<tr><td>COURSE DELIVERY</td><td>Physical presence, face to face at the auditorium or laboratory</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 of circuits on a breadboard and programming of microcontrollers/microprocessors.</td></tr>
<tr><td>TEACHING ORGANIZATION</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Teaching / lectures</td><td>39</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>56</td></tr>
<tr><td>Total</td><td>125</td></tr>
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<tr><td>STUNDET EVALUATION</td><td>50% Final exam paper with multiple-choice questions, short-answer questions, and problem-solving questions.
30% Hands-on examination in the laboratory involving the implementation of circuits and programming of microcontrollers/microprocessors.
20% Individual written assignment.</td></tr>
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(5) SUGGESTED LITERATURE

Books, scientific articles and related scientific resources:

[1] J. Webster, Medical Instrumentation: Application and Design, Wiley; 4th edition, 2009.
[2] R.S.Khandpur , Handbook of Biomedical Instrumentation, McGraw Hill Education, 2014.
[3] G. Zouridakis, Biomedical technology and devices handbook, CRC Press, 1st edition, 2003.
[4] Texas Instruments, Understanding and Interpreting Standard Logic Data Sheets, http://focus.ti.com/lit/an/szza036b/szza036b.pdf.
[5] H. Abelson, G. Sussman, J. Sussman, Structure and Interpretation of Computer Programs, 1996, MIT, https://web.mit.edu/6.001/6.037/sicp.pdf.

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.