# COURSE OUTLINE

## (1) GENERAL

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|---|---|---|---|
| **SCHOOL** | Engineering | | |
| **DEPARTMENT** | Electrical and Computer Engineering | | |
| **LEVEL OF STUDY** | Undergraduate (B Devision) | | |
| **COURSE UNIT CODE** | 8.016 | **ΕΞΑΜΗΝΟ ΣΠΟΥΔΩΝ** | 8ο |
| **COURSE TITLE** | Biomedical Signals and Applications | | |

| **COURSEWORK BREAKDOWN** | **TEACHING WEEKLY HOURS** | **ECTS Credits** |
|---|---|---|
| Theory (Lectures) | 4 | 3 |
| Tutorial/Exercises | 1 | 1 |
| **TOTAL** | **5** | **4** |

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|---|---|
| **COURSE UNIT TYPE** | Specialized knowledge/Skills development |
| **PREREQUISITES** | Digital Signal Processing |
| **LANGUAGE OF INSTRUCTION/EXAMS** | Greek |
| **COURSE DELIVERED TO ERASMUS STUDENTS** | No |
| **WEB PAGE (URL)** | https://eclass.hmu.gr/courses/ECE146/ |

## (2) LEARNING OUTCOMES

**Learning Outcomes**

Biomedical signals and informatics applications have radically changed the science of medicine in recent decades. Biomedical signals can be defined as measurable changes in physiological processes of the human body over time using appropriate sensors and hardware.

The desired learning outcome is for the student to understand the entire workflow required for a scientist to process bio-signals, analyze them, and develop appropriate computational tools to more easily draw conclusions about human physiology/pathology.

The purpose of the course is to introduce students to the field of biomedical signal analysis and processing, as it primarily requires an understanding of both the physiological (and pathological) processes they represent and the specialized informatics knowledge needed to read, analyze, and implement software that can assist in medical diagnosis or treatment monitoring.

Upon successful completion of the course, the student will be able to:

- Know the basic characteristics of the most important medical signals, namely the electrocardiogram (ECG), electroencephalogram (EEG), as well as 2D (X-Ray) and 3D (tomographic) medical images (MRI, PET, CT).
- Understand medical data and standards, mainly the DICOM standard, which will enable students to process any medical image data.
- More easily develop autonomous software and signal processing applications in the spatial and frequency domains with the ultimate goal of assisting in diagnosis and medical decision-making.
- Combine knowledge from other courses such as Pattern Recognition, Computational Vision, Neural Networks, etc., to extend their capabilities in classification, clustering, and automatic lesion recognition (segmentation) in real medical problems related to biomedical signals.

**General Skills**

- Search, analysis, and synthesis of data and information, using the necessary technologies.

- Autonomous work
- Teamwork
- Search, analysis and synthesis of data and information, using the necessary technologies
- Decision making
- Promoting liberal, creative and inductive/deductive thinking

## (3) SYLLABUS

**Theory Syllabus Outline:**

- Introduction to biomedical signal analysis.
- Properties and characteristics of electrical signal transmission in cells and living tissues. Detailed description of action potential and signal transmission through synapses. Artificial stimulation in neurons and effects of AC-DC voltages.
- Introduction to digital electrocardiography. Acquisition of electrocardiogram and digital electrocardiography standards - SCP-ECG, HL7 annotated ECG, and the IEEE 1073/ISO 11073 series of standards. Transfer of electrocardiogram to an information system.
- Processing of digital electrocardiography signals (noise, filters). Methods for detecting pathology in the frequency and spatial domains. Electrocardiographic interpretation of heart pathologies: Cardiac lesions and arrhythmias.
- Applications of electroencephalography in medicine, analysis, and measurement of evoked potentials. Brain physiology and electroencephalogram.
- Processing and analysis of biomedical electroencephalography signals in the frequency domain and applications in medicine.
- Introduction to the Principles of Medical Imaging.
- Digital radiology, Computed Tomography, Nuclear Medicine, and Magnetic Resonance Imaging.
- The DICOM standard.
- Processing of tomographic medical images MRI/PET/CT.

**Laboratory Syllabus Outline:**

- Familiarization with the use of Python/Matlab for biomedical signal processing.
- Examples of processing physiological and pathological signals (e.g., analysis of electrocardiogram showing arrhythmia in Matlab).
- Familiarization with multidimensional biomedical signals.
- 2 Laboratories on electrocardiogram.
- 2 Laboratories on electroencephalogram.
- Presentation of Biomedical Signal Analysis Project.

## (4) TEACHING METHODS - ASSESSMENT

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| **MODE OF DELIVERY** | In-Class Face-to-Face |
| **USE OF INFORMATION AND COMMUNICATION TECHNOLOGY** | ▪ Use of ICTs in lecturing<br>▪ Use of ICTs in Lab work<br>▪ Use of ICTs for the communication with students via the e-class platform |
| **TEACHING ORGANIZATION** | |

| Method description/Activity | Semester Workload |
|---|---|
| Lectures | 35 |
| Laboratory work | 20 |
| Lab Assignment | 20 |

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|---|---|---|
| | Weekly assignments | 15 |
| | Homework | 30 |
| | **Total Contact Hours** | **120** |
| **ASSESSMENT METHODS** | All announcements for the course are posted in the course web page. The course grade incorporates the following evaluation procedures:<br><br>1. Written final examination (50 %)<br>• Problem solving.<br>• Short answer questions<br>• Multiple choice<br>2. Lab project (report and oral exam) 30%<br>3. Weekly assignments (20%)<br>The evaluation criteria will be announced each year on the beginning of the semester. | |

## (5) RECOMMENDED BIBLIOGRAPHY

*Books:*


1. *Κουτσούρης Δ., Παυλόπουλος Σ., Πρέντζα Α. "ΕΙΣΑΓΩΓΗ ΣΤΗ ΒΙΟΙΑΤΡΙΚΗ ΤΕΧΝΟΛΟΓΙΑ ΚΑΙ ΑΝΑΛΥΣΗ ΙΑΤΡΙΚΩΝ ΣΗΜΑΤΩΝ",Εκδόσεις Τζιόλα, 2004.*
2. *Τσιπούρας, Μάρκος, Γιαννακέας, Νικόλαος, Καρβούνης, Ευάγγελος, Τζάλλας, Αλέξανδρος, Ιατρική Πληροφορική (Ψηφιακή Επεξεργασία Βιοϊατρικών Σημάτων, Digital BioSignal Processing https://repository.kallipos.gr/handle/11419/2975*
3. *Digital Signal Processing: Principles, Algorithms and Applications (3rd Edition) by John G. Proakis, Dimitris Manolakis, Prentice Hall, 1996.*


*Journals:*


1. *IEEE Transactions on Biomedical Engineering (https://tbme.embs.org/)*
2. *Journal of Biomedical and Health Informatics (https://jbhi.embs.org/)*
3. *Biomedical Signal Processing and Control (https://www.journals.elsevier.com/biomedical-signal-processing-and-control)*