EUROPEAN UNIVERSITY FOR CUSTOMISED EDUCATION

STUDY GUIDE

DECODING LIFE SIGNALS: INNOVATIONS IN BIOMEDICAL ENGINEERING

Organised by

University of Peloponnese

1. IDENTIFYING DATA.	
· **Course Name.**	Decoding Life Signals: Innovations in Biomedical Engineering
· **Coordinating University.**	University of the Peloponnese
· **Partner Universities Involved.**	Open to all EUNICE partner universities
· **Course Field(s).**	Biomedical Engineering; Artificial Intelligence; Data Processing and Analysis; Public Health; Telemedicine / m-Health
· **Related Study Programme.**	Electrical and Computer Engineering / interdisciplinary elective shared course
· **ISCED Code.**	0715 - Biomedical engineering
· **SDG.**	SDG 3 Good Health and Well-being; SDG 4 Quality Education; SDG 9 Industry, Innovation and Infrastructure
· **Study Level.**	Open for Bachelor (B) and Master (M) students
· **EUNICE Key Competencies**	● Green – strongly ● Orange - moderately ● Red – partially ● Blank cell - not at all

Problem solving	[green]
Teamworking	[orange]
Communication	[green]
Self-management	[orange]
Cognitive flexibility	[orange]
Digital competence	[green]

	Technical competence	
	Global intercultural competence	

· **Number of ECTS credits allocated.**	5 ECTS
· **Mode of Delivery.**	Online live with asynchronous support in Moodle
· **Language of Instruction.**	English
· **Course Dates.**	Spring Semester 2027 Mid-February to late May 2027 12 teaching weeks plus final project presentations
· **Precise Schedule of the Lectures.**	Weekly schedule over 12 weeks: - 1 x 2-hour live lecture - 1 x 1-hour live lab / demonstration / discussion session - Guided asynchronous study, practical exercises and project work in Moodle (approximately 6-7 hours per week) - Milestone sessions for project proposal feedback and final presentations
· **Key Words.**	EEG, ECG, EMG, biomedical signal processing, biosensors, AI for healthcare, data analysis, Python
· **Catchy Phrase.**	"Learn to turn raw biosignals into meaningful health insights through hands-on biomedical engineering."

· **Prerequisites and co-requisites.**	Eligible EUNICE students enrolled at one of the alliance universities. Recommended background: introductory knowledge of signal processing and basic Python programming. Study levels: Bachelor (B) and Master (M). Required language level: English B2 or equivalent.
· **Number of EUNICE students that can attend the Course.**	30 students in total.
· **Number of EUNICE students that can attend the course per institution**	2 places reserved per EUNICE institution as a minimum.

· **Course inscription procedure(s).**	Standard EUNICE application and selection process.

2. CONTACT DETAILS.	
· **Department.**	Department of Electrical and Computer Engineering
· **Name of Lecturer.**	Athanasios Koutras, Associate Professor
· **E-mail.**	koutras@uop.gr
· **Other Lecturers.**	Dr. Nyi Nyi Tun, Biomedical Engineer Dr. Dionysios Anyfantis, Post-doc Researcher in medical imaging Invited guest lecturers from academia and industry in biomedical engineering and digital health

3. COURSE CONTENT.

This interdisciplinary course introduces students to the acquisition, processing, interpretation and responsible use of biomedical signals, with emphasis on EEG, ECG and EMG. Through a blend of live lectures, guided demonstrations and project-based work, students explore how life signals can be transformed into clinically and scientifically meaningful information.
The course combines signal processing foundations with practical exposure to modern open-source workflows in Python. Students work with real datasets, learn preprocessing and artifact handling, apply time-domain, frequency-domain and time-frequency analysis, and are introduced to AI and machine learning methods for pattern discovery and decision support in healthcare contexts.
A distinctive feature of the course is its strong applied orientation. Students use openly available databases and software tools, and they may also observe demonstrations with devices such as OpenBCI and wearable biosignal platforms. The course culminates in a project where international student teams investigate a real biomedical engineering question, design an analysis pipeline, and communicate their findings clearly to both technical and non-technical audiences.

4. LEARNING OUTCOMES.

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

1. Explain the physiological meaning and engineering relevance of major biomedical signals, especially EEG, ECG and EMG.
2. Acquire or import biosignal data, assess data quality, and perform preprocessing steps such as filtering, segmentation and artifact reduction.
3. Apply core analysis methods in the time, frequency and time-frequency domains and interpret the resulting features.
4. Use Python-based open-source tools to visualize, analyse and document biomedical data workflows.

5. Describe the role of AI and machine learning in biomedical engineering and implement basic supervised analysis pipelines on biosignal datasets.
6. Design and complete a small-scale biomedical engineering project using real data and an appropriate methodological approach.
7. Communicate technical findings effectively through visualisations, written reporting and oral presentation.
8. Work productively in an international and interdisciplinary learning environment while respecting ethical principles, privacy and responsible data use.

5. OBJECTIVES.

The course aims to:

1. Provide a solid foundation in biomedical signal processing for students from engineering and related disciplines.
2. Develop practical competence in data acquisition, cleaning, analysis, visualization and interpretation.
3. Introduce contemporary AI-oriented approaches relevant to biosignal analysis and digital health applications.
4. Strengthen problem-solving, communication and project implementation skills through authentic case studies and teamwork.
5. Promote ethical awareness, reproducible research practices and the use of open educational resources and open datasets.
6. Foster international collaboration within EUNICE through shared learning activities and project-based interaction.

6. COURSE ORGANISATION.

UNITS	
1.	Biomedical signals and digital health foundations - EEG, ECG, EMG and multimodal biosignals - Physiological interpretation and biomedical engineering use cases - Ethics, privacy and responsible innovation
2.	Data acquisition, preprocessing and quality control - Biosignal recording principles and sensor basics - Open datasets, data formats and annotation - Filtering, artifact handling and signal preparation
3.	Analysis, visualisation and AI for biosignals - Time-domain, spectral and time-frequency analysis - Feature extraction and interpretation - Introductory machine learning workflows in Python
4.	Project-based applications in biomedical engineering - Team project design and milestone planning

	- Real-data case studies in healthcare and human-centred technology - Final report and presentation

LEARNING RESOURCES AND TOOLS.

- Moodle course space with lecture notes, slides and recordings
- Open-source Python ecosystem: NumPy, SciPy, Matplotlib, pandas, scikit-learn
- Biomedical analysis tools such as MNE-Python and BioSPPy
- Open datasets from PhysioNet, OpenNeuro and related repositories
- Live demonstrations with biosignal acquisition devices where available

PLANNED LEARNING ACTIVITIES AND TEACHING METHODS.

- Interactive live lectures
- Demonstrations and guided lab sessions
- Hands-on practical exercises in Python
- Small international team project
- Project proposal feedback, peer discussion and final presentation

7. ASSESSMENT METHODS, CRITERIA AND PERIOD.

Assessment strategy:
- Short quizzes / knowledge checks: 10%
- Practical assignments: 15%
- Project proposal and milestone submission: 15%
- Final team project report and presentation: 60%

Assessment criteria:
Conceptual understanding, technical correctness, quality of analysis, appropriate use of tools, clarity of visualisation, originality, teamwork and communication.

Assessment period:
Continuous assessment throughout the semester. The proposal is submitted during the first third of the course, while the final report and presentation are delivered at the end of the teaching period.

OBSERVATIONS.

The course is intentionally designed to be accessible across the EUNICE alliance. No specialised hardware is required to complete the course successfully, since all essential activities can be carried out with open-source software and publicly available datasets. Whenever possible, live demonstrations with biosignal acquisition equipment will enrich the learning experience.

The course encourages collaboration between students from different disciplinary and cultural backgrounds. Project themes may include brain-computer interfaces, wearable health monitoring, emotion recognition, sleep analysis, rehabilitation technologies and related biomedical engineering applications.

The course is graded

8. BIBLIOGRAPHY AND TEACHING MATERIALS.

Indicative bibliography and teaching materials:

1. Bruce, E. N., Biomedical Signal Processing and Signal Modeling.
2. van Drongelen, W., Signal Processing for Neuroscientists.
3. Selected instructor-provided notes, articles and case studies available through Moodle.
4. Official documentation and tutorials for MNE-Python, SciPy, NumPy and scikit-learn.

Open resources and datasets:

- PhysioNet
- OpenNeuro
- MNE-Python documentation and examples
- Additional openly licensed datasets and notebooks shared through the Moodle course space

All essential teaching materials will be made available digitally to enrolled EUNICE students through Moodle and/or openly accessible sources.