GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Biosignals, PG_00068221		
Field of study	Biomedical Engineering		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2027/2028
Education level	first-cycle studies	Subject group	Optional subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	3	Language of instruction	Polish
Semester of study	5	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Biomedical Engineering -> Faculty of Electronics Telecommunications and Informatics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. Marcin Gruszecki	
	Teachers	dr hab. Marcin Gruszecki	

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	0.0	15.0	0.0	0.0	45

E-learning hours included: 0.0

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	45	4.0	51.0	100

Subject objectives

To familiarize students with the mechanisms responsible for the generation of signals and their properties

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U09] can carry out a critical analysis of the functioning of existing technical solutions and assess these solutions, as well as apply experience related to the maintenance of technical systems, devices and facilities typical for the field of studies, gained in the professional engineering environment	Student evaluates recorded biosignals and proposes appropriate processing methods	[SU4] Assessment of ability to use methods and tools [SU2] Assessment of ability to analyse information
[K6_W51] Knows and understands, to an advanced extent, selected aspects of biomedical diagnostics and human anatomy and physiology, constituting general knowledge related to the field of study	The student knows: - Selected topics in biomedical diagnostics - The basics of human anatomy - The basics of human physiology - The importance of interdisciplinary knowledge in biomedical science.	[SW1] Assessment of factual knowledge
[K6_W02] knows and understands, to an advanced extent, selected laws of physics and physical phenomena as well as methods and theories explaining the complex relationships between them, constituting the basic general knowledge in the field of technical sciences related to the field of study	Student - Identifies processes be responsible for generation biopotentials - Differentiates the types of signals generated by the human body - Selects the appropriate method of signal analysis - Constructs processing algorithms and analysis of signals - Defines the characteristics of signals generated by the various tissues and organs	[SW1] Assessment of factual knowledge

Subject contents	Course content – lecture 1. Introduction to Biosignals What are biosignals (ECG, EEG, EMG, EDA, PPG, BP) Parameters describing a biosignal: amplitude, frequency, phase Signal classification: time-domain, frequency-domain, stochastic 2. Measurement Systems and Data Acquisition Structure of the measurement chain Electrodes, transducers, bioelectrical amplifiers Aliasing and the sampling theorem (Nyquist theorem) 3. Analog and Digital Biosignal Processing Noise in biosignals: sources and characteristics Low-pass, high-pass, and band-pass filters FFT and spectral analysis of biosignals Time windows, power spectra Example: HRV (Heart Rate Variability) analysis 5. ECG Signals Cellular potential. Heart cell model QRS detection in ECG, artifact detection Extraction of time-domain and frequency-domain features Feature-based classification 6. Electroencephalographic Signals (EEG) Neuron cell model Structure and functions of EEG Band analysis: delta, theta, alpha, beta Applications: BCI, sleep, epilepsy 7. Electromyography (EMG) and Muscle Biosignals Muscle cell potential EMG characteristics and measurement techniques Processing: filtering, RMS, contraction detection 8. Signals from Photoplethysmographic Sensors (PPG) Operating principle, pulse oximetry HR and SpO measurement, motion artifacts 9. Mechanical and Acoustic Biosignals Blood pressure (BP), phonocardiography, lung sounds Signal combinations: e.g., ECG + phonocardiogram 10. Electrooculogram (EOG) 11. Blood Pressure 12. Blood Glucose Level 13. Thermography 14. Detection and Classification Using ML/AI Introduction to machine learning in biosignals Classification models: SVM, k-NN, decision trees Example: stress recognition based on PPG + EDA (electrodermal activity)
Prerequisites and co-requisites	Physics, mathematics

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Midterm colloquium	51.0%	40.0%
Practical exercise	51.0%	60.0%

Recommended reading		
	Basic literature	Allen R.L., Milles D. W., Signal analysis, IEEE Press, 2004 Cohen, A., Biomedical signal processing, vol. 1, 2, CRC Press, 1988 Devasahayam S. R., Signals and systems in biomedical engineering , Kluwer Acad., 2000 Laboratory instructions Rangayyan J., Biomedical signal analysis, Wiley Interscience, 2002 Wtorek J., Lecture notes - Biosignals
	Supplementary literature	Biomeasurements, ed Nalecz, Biocybernetics and biomedical engineering 2000, EXIT - 2001
	eResources addresses	
Example issues/ example questions/ tasks being completed	Describe methods for obtaining information on heart rate variability (HRV) based on an electrocardiographic signal.	

Practical activites within the subject	Not applicable

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