GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Medical Apparatus, PG_00064138		
Field of study	Mechanical and Medical Engineering		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2027/2028
Education level	first-cycle studies	Subject group	Obligatory subject group in the field of study 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	5.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Institute of Mechanics and Machine Design -> Faculty of Mechanical Engineering and Ship Technology -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	Michał Penkowski	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	0.0	30.0	0.0	0.0	60

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	60	5.0	60.0	125

Subject objectives

Acquainting with the construction, principle of operation and use of basic medical equipment.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W06] has knowledge in specific areas related to the application of mechanical engineering in medicine or in the field of medical and rehabilitation devices	He/she can describe basic types of medical equipment. Can explain physical basis of its work and can propose different alternative ways of measurements.	[SW1] Assessment of factual knowledge
[K6_U09] is able to use basic medical equipment and devices or has knowledge of medical imaging appropriate for the program	He/she can apply analytical method for solving some problems found in construction of medical apparatus.	[SU4] Assessment of ability to use methods and tools
[K6_U05] has skills to work in industry and follow the rules of safety regulations, he/she is able to analyze basic economics problems to delineate the direction of solution by using engineering methods	He/she can estimate role of medical engineering in modern medical practice.	[SU4] Assessment of ability to use methods and tools

<table>
<tr><td>Subject contents</td><td>Course content – lecture
Measurements and parameters of signals (ECG, EEG, EMG, nystagmographic etc.). Patient isolation and protection against electrical shock. Types of isolation bariers. Modern element base applied for measurements of bioelectrical signals. Specific parameters of bioelectrical signals frequency range, amplitude, periodicity. EEG registration. Types of electrode arrangements. Deconvolution of signal patterns. Location of signal sources. Magnetoecephalography basic theory. Detection of ultraweak magnetic fields. Application of optical detection in medicine: spectrophotometry, absorption measurements in UV and VIS ranges. Detector types, spectral responses, application schemes. Synchronous detection. Light sources. Basic theory of light absorption in solutions. Detection of proteins and nucleic acids presence. Mechanical solutions improving stability and repeatability of measurements. Measurements of oxygen saturation in blood. Optical method of detection. Isosbestic point. Layout of oxygen level monitor. OCT application of optical scanning for detection of retinal voids. Application of OCT for blood vessel scanning. Nonmedical applications of OCT. Therapeutic application of ultrasound. Basic structure of lithotripter. Methods of power ultrasound generation. Piezoelectric, spark and electrodynamic sources. Methods of focusing. Dialyzer basic idea. Microwave diathermy application and basic theory of physical phenomena. Structure of microwave source. Antennas. Efficiency of energy transfer. Basic facts about spectra of bioelectric signals. Sampling, resolution and detection of periodicity. Filtration LP, HP, BP, BR. Estimation methods applied for filter selection. Practical realization of different filter types. Impedance measurements applied in medicine and biology. Impedance spectroscopy. Applications in cardiology. Body composition measurements. Application of impedance spectroscopy in detection of blood vessel anomalies.
Course content – laboratory
Measurements and parameters of signals (ECG, EEG, EMG, nystagmographic etc.). Patient isolation and protection against electrical shock. Types of isolation bariers. Modern element base applied for measurements of bioelectrical signals. Specific parameters of bioelectrical signals frequency range, amplitude, periodicity. EEG registration. Types of electrode arrangements. Deconvolution of signal patterns. Location of signal sources. Magnetoecephalography basic theory. Detection of ultraweak magnetic fields. Application of optical detection in medicine: spectrophotometry, absorption measurements in UV and VIS ranges. Detector types, spectral responses, application schemes. Synchronous detection. Light sources. Basic theory of light absorption in solutions. Detection of proteins and nucleic acids presence. Mechanical solutions improving stability and repeatability of measurements. Measurements of oxygen saturation in blood. Optical method of detection. Isosbestic point. Layout of oxygen level monitor. OCT application of optical scanning for detection of retinal voids. Application of OCT for blood vessel scanning. Nonmedical applications of OCT. Therapeutic application of ultrasound. Basic structure of lithotripter. Methods of power ultrasound generation. Piezoelectric, spark and electrodynamic sources. Methods of focusing. Dialyzer basic idea. Microwave diathermy application and basic theory of physical phenomena. Structure of microwave source. Antennas. Efficiency of energy transfer. Basic facts about spectra of bioelectric signals. Sampling, resolution and detection of periodicity. Filtration LP, HP, BP, BR. Estimation methods applied for filter selection. Practical realization of different filter types. Impedance measurements applied in medicine and biology. Impedance spectroscopy. Applications in cardiology. Body composition measurements. Application of impedance spectroscopy in detection of blood vessel anomalies.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Basic knowledge about elementary mathematics, electronics, especially measurements. Basis of anatomy and physiology.</td></tr>
<tr><td>Assessment methods and criteria</td><td><table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>Final exam</td><td>60.0%</td><td>100.0%</td></tr></table></td></tr>
<tr><td>Recommended reading</td><td><table><tr><td>Basic literature</td><td>R. Tadeusiewicz.: Inżynieria biomedyczna. AGH 2008

P. Augustyniak.: Elektroniczna aparatura medyczna.

G.Pawlicki.: Podstawy inżynierii medycznej. Warszawa 1997, Podstawy inżynierii biomedycznej t. I i II. AGH 2009.</td></tr><tr><td>Supplementary literature</td><td>R.Tadeusiewicz.: Podstawy elektroniki medycznej. AGH 1978</td></tr><tr><td>eResources addresses</td><td></td></tr></table></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td>Amplitude, frequency range and periodicity of ECG, EEG and EMG signals. CMRR. Types of isolation bariers. Protection against electrical shock. Differential amplifier. Low noise amplifier. External noise sources. Shielding of cables. Noise suppression techniques. Definition of absorbance. Optical detectors. UV and VIS light sources. Synchronous detection in optics. Types of optical elements. Light transmission through different materials. Absorption spectra of nucleic acids and proteins. Absorption spectra of oxygenated and deoxygenated blood. Led diode spectral response. Superluminescent diode. Basic structure of OCT. Piezoelectricity. Electric spark in water. Focusing methods of ultrasound. Power density. Water molecules relaxation. Absorption of microwaves in water. Protection against microwave exposition. Antenna types. Basic facts about spectra of bioelectric signals. Selection of filter for given application. Impedance spectroscopy. Two and four electrodes. Dispersions of biological matter. Application of impedance spectroscopy.</td></tr>
<tr><td>Practical activites within the subject</td><td>Not applicable</td></tr>
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