University of Gdańsk

Subject card

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| Subject name and code | Medical Apparatus, PG_00182162 | | | | | | |
| Field of study | Medical Physics | | | | | | |
| Date of commencement of studies | October 2026 | | Academic year of realisation of subject | 2027/2028 | | | |
| Education level | Bachelor's studies | | Subject group | Obligatory subject group in the field of study | | | |
| Mode of study | full-time studies | | Mode of delivery | at the university | | | |
| Year of study | 2 | | Language of instruction | Polish | | | |
| Semester of study | 4 | | ECTS credits | 4.0 | | | |
| Learning profile | academic | | Assessment form | exam | | | |
| Conducting unit | Faculty of Mathematics, Physics and Informatics -> Rector | | | | | | |
| Name and surname of lecturer (lecturers) | Subject supervisor | | dr 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 | | 0.0 | 60.0 | | 120 |
| Subject objectives | 1. Familiarity with medical equipment.<br>2. Understanding of the principles applicable during measurements with medical equipment.<br>3. Ability to perform a measurement using the equipment discussed within the subject.<br>4. Ability to select a signal processing method that is adequate for a given problem.<br>5. Knowledge of parameters measured in medical diagnostics along with their variability range.<br>6. Ability to propose a measurement method for a given medical problem. | | | | | | |

| Learning outcomes | Course outcome | Subject outcome | Method of verification |
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| | [FIZMEDL3_U06] Can present in an accessible way the latest achievements in the field of medical physics, the principles of operation of diagnostic and therapeutic equipment and the principles of radiation protection. | The student is able to clearly explain the operating principles of complex medical equipment and clarify key aspects of its application, including diagnostic and therapeutic procedures, as well as radiological protection principles. | [SU6] demonstration of practical skills |
| | [FIZMEDL3_U09] Can communicate effectively with colleagues and other employees, works in a team, including interdisciplinary teams, and manages his/her own and his/her colleagues' time appropriately. | The student is capable of working effectively in a team, including an interdisciplinary one, while operating medical equipment. They can communicate efficiently with medical and technical staff, as well as plan and organise their own work and that of their colleagues to complete assigned tasks. | [SU8] observation of student's independent or team work |
| | [FIZMEDL3_K02] He is ready to constantly update his knowledge in physics and medical physics to solve cognitive and practical problems independently and to use the opinions and assistance of experts. | The student is prepared to independently update their knowledge of medical equipment, including radiological and dosimetry devices, to solve practical problems effectively. When faced with challenges, they can identify the need for expert consultation and actively seek their assistance to verify and refine their solutions. | [SK8] observation of student's independent or team work |
| | [FIZMEDL3_K01] He is ready for a critical evaluation of his own knowledge and the information he receives, and understands the need for further education and for improving professional and personal competencies. | The student can critically assess their knowledge of medical equipment and understand the necessity of continuous learning, given the dynamic development of technology. They are prepared to independently enhance their skills to ensure the high quality of their work. | [SK4] test/exam - oral or written |
| | [FIZMEDL3_U03] He is able to select and apply appropriate medical equipment to perform selected diagnostic measurements or to carry out basic and specialised tests, and to prepare a report containing a description, analysis, error discussion, and conclusions regarding the results of the studies within the competence of a medical physicist. | The student:<br>Operates radiological equipment and evaluates and interprets diagnostic images within the scope of a medical physicist's competence.<br>Performs basic measurements of biomedical signals, accounting for interference.<br>Differentiates between fundamental transducers used in medical measurements. | [SU6] demonstration of practical skills |

| Course outcome | Subject outcome | Method of verification |
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| [FIZMEDL3_W09] Knows at an advanced level the construction and operating principles of measurement instruments, electronic systems, and diagnostic and therapeutic equipment used in physics research and in medical diagnosis and therapy. | The student:<br>Understands the fundamental principles of medical devices, with a specific focus on imaging and radiotherapy equipment.<br>Has an advanced knowledge of the structure and operating principles of X-ray diagnostic and medical imaging equipment, including other devices used in RTG (radiology), angiography, ultrasound, computed tomography (CT), and magnetic resonance imaging (MRI) systems. This includes knowledge of the procedures for performing CT, MRI, conventional and Doppler ultrasound, and mammography examinations.<br>Understands the basic operating principles of medical electronics devices, including the parameters measured and their diagnostic significance, as well as methods for processing signals generated by medical equipment.<br>Knows the fundamentals of medical measurement techniques and understands the methodology for describing electronic systems, including signal and circuit theory methods.<br>Is familiar with the characteristics of fundamental biomedical signals. | [SW4] test/exam - oral or written |

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| Subject contents | **A. Lecture Topics**<br><br>**Fundamentals of Measurement Techniques in Medicine:** Characteristics of medical signals (temperature, pressure, ion and hemoglobin concentrations, etc., electrical signals), Variability ranges, frequency bandwidth, and normal values, Basic electronic components of medical equipment (operational amplifier, nonlinear circuits, filters, detectors), Medical signal interference and mitigation, shielding, patient isolation, and differential signal amplification, Types of measuring transducers (pressure, temperature, pH, electrodes for electrical signals), Electrode polarization phenomena and special electrodes (ionometry, oximetry).<br><br>**Fundamentals of Signal and Circuit Theory:** Concept of a digital signal, Convolution of continuous and discrete functions, Discretization and quantization, Continuous and discrete Fourier transforms, Linear systems theory, transfer function, frequency characteristics, Laplace transform, Two-port and four-port networks, Fundamentals of analog and digital filtering.<br><br>**Radiological Equipment:** Construction of an X-ray tube, X-ray image acquisition and X-ray tomography, Angiography equipment and digital subtraction angiography devices, Construction of computed tomography (CT) and magnetic resonance imaging (MRI) machines, Design of ultrasound and Doppler ultrasound devices.<br><br>**Radiotherapy Equipment:** Types of radiation sources (isotopic, X-ray tubes, bremsstrahlung accelerators, particle beam therapy), Collimation in radiotherapy, Radiotherapy planning equipment, Ancillary radiotherapy instrumentation and shielding, Other methods for limiting absorbed dose, Medical dosimetry: TL (thermoluminescence) and alanine dosimeters, dosimetric phantoms, online dosimetry, semiconductor dosimetry, and ionization chambers for medical dosimetry applications.<br><br>**Nuclear Medicine Equipment:** Construction of a conventional gamma camera, Scintillation crystal, photomultipliers, scintillation phenomena, signal characteristics, and collimators, SPECT (Single-Photon Emission Computed Tomography): device construction and image reconstruction, PET (Positron Emission Tomography): device construction.<br><br>**B. Laboratory Topics**<br><br>**Other Medical Equipment:** Electrical equipment (ECG, EEG, EMG), Medical analyzers, exemplified by blood analyzers, Physiotherapy equipment, audiometry, and hearing prosthetics, Impedance measurements (plethysmography, body composition), Physiological calorimetry, Mechanical and thermal effects of ultrasound, hyperthermia, medical thermometry, Defibrillators, recorders (Holter), dialysis, electromanipulation techniques, high-frequency current ablation, biodielectroscopy, laser therapy, EPR spectroscopy in the study of free radical generation and trapping in lipid membranes, Impedance rheocardiography.<br><br>**Radiological Equipment:** Digitalization of radiological images, Fundamentals of medical image analysis, Methods for image processing and recognition.<br><br>**Nuclear Medicine Equipment:** Hybrid equipment: SPECT/CT, PET/CT, PET/MRI, Multimodal medical images, Synergistic imaging, Segmentation and processing methods for multimodal MRI, PET/MRI, SPECT/CT, and PET/CT images, Prerequisites for the implementation of PET/MRI. |
| Prerequisites and co-requisites | A. Formal requirements: Medical Physics Mathematical Methods, Medical Signals Laboratory<br><br>B. Prerequisite requirements: Fundamentals of physics and mathematics at a higher level, Continuous Fourier transform |

Assessment methods and criteria

| Subject passing criteria | Passing threshold | Percentage of the final grade |
|---|---|---|
| exam | 51.0% | 60.0% |
| credit | 51.0% | 40.0% |

| Recommended reading | | |
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| | Basic literature | not applicable |
| | Supplementary literature | not applicable |
| | eResources addresses | |

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| Example issues/ example questions/ tasks being completed | not applicable |
| Work placement | Not applicable |

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