GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Optical Measurement Techniques, PG_00048097		
Field of study	Electronics and Telecommunications		
Date of commencement of studies	October 2026	Academic year of realisation of subject	2029/2030
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	4	Language of instruction	Polish
Semester of study	7	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Metrology and Electronic Systems Department -> Faculty of Electronics Telecommunications and Informatics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Maciej Wróbel	
	Teachers	dr inż. Maciej Wróbel	

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	15.0	0.0	0.0	30

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	30	3.0	42.0	75

Subject objectives

Provision of knowledge and abilities in the field of key optical measurement methods used in the industry and science.

Learning outcomes

Course outcome	Subject outcome	Method of verification

Subject contents	Course content – lecture **1. Basic properties of light, interactions of light with matter.** Electromagnetic wave, wavelength, optical spectrum ranges Intensity, photometric and radiometric units, Polarization, Jones vector, Stokes vector, Poincare sphere Refraction and reflection of light, Diffraction, Near and far field, Diffraction limit, Diffraction orders Absorption, Absorbance, Lambert-Beer law. **2. Light scattering and measurements of scattering parameters.** Light scattering, physical basics, Mie scattering description parameters Measurements of scattering and absorption parameters Integration spheres, construction, applications, Method of measuring radiometric parameters using spheres, Method of measuring scattering parameters using the IAD method, application in biomedicine. **3. Synchronous detection in optical measurement methods.**The problem of noise in optical measurements Synchronous (phase-sensitive) detection theory Lock-in amplifier circuit Measuring applications **4. Microscopy.** Basics of microscopy, image formation, resolution, PSF, contrastContrast improvement methods, bright field, dark field, Polarizing microscopy, phase contrast, confocal microscopy **5. Spectrometry, Fluorescence.** Basics of spectral measurement methods, Jabłoński diagram, fluorescence, phosphorescence, absorption spectroscopy, fluorescence microscopy, emission and excitation spectra, spectrofluorimeter, confocal laser fluorescence microscopy, fluorescence lifetime, applications of measurement methods. **6. Raman spectroscopy and IR spectroscopy.** Raman spectroscopy, configuration of measurement systems, basics of operation. IR spectroscopy, configuration of measurement systems, basics of operation. Raman microspectroscopy, optical probes, applications of measurement methods, analysis of measurement data. **7. Interferometry.** Amplitude and wavefront division interferometers, interferometer designs, Advanced interferometric methods: FTIR, FT-Raman, Low-coherence interference, Optical coherence tomography (OCT) - in the time domain (TD-OCT) and spectrum (SD-OCT).
Prerequisites and co-requisites	No requirements
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
Laboratory	50.0%	60.0%
Exam	50.0%	40.0%

Recommended reading	
Basic literature	1. P.K. Rastogi, Optical Measurement Techniques and Applications, Artech Book House, 1998 2. F Ratajczyk, Dwójłomność i polaryzacja optyczna, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2000 3. M. Pluta, Mikrointerferometria w świetle spolaryzowanym, WNT Warszawa 1991 4. M. Born, E. Wolf, Principles of Optics, np. 6th Edition, Pergamon Press, Oxford 1993
Supplementary literature	No requirements
eResources addresses	

Example issues/ example questions/ tasks being completed	1. Describe the phenomenon of dispersion and its use in spectroscopy. Physical basis, patterns, diagram of elements using this phenomenon. 2. Describe the parameters describing scattering and how they are measured, diagram of the measurement system, algorithms, applications. Describe the principle of operation, construction, measurement method and measurement applications of integration spheres. 3. Present the method of describing the state of polarization, explain the method of describing partially polarized light based on the Poincaré sphere. 4. Describe the principle of operation of the synchronous detection method, the purpose of its use, the method of operation and the circuit diagram, formulas. 5. Introduce different methods for obtaining better contrast in microscopy. Describe the structure of a phase contrast microscope. 6. Describe the principle of operation of a confocal microscope. Scheme, idea and applications, also as a system in combination with other measurement methods. 7. Describe, based on Jabłoński diagrams, the phenomena of absorption, fluorescence, phosphorescence and scattering of elastic light. 8. Describe the principle of operation, physical basis, measurement systems, and basic laws describing the UV-VIS absorption spectroscopy method. 9. Describe the principle of operation, physical basis, measurement systems, and basic laws describing the IR spectroscopy method, and why use ATR. 10. Describe the principle of operation, physical basis, measurement systems, fluorescence spectroscopy. 11. What is the relationship between the absorption and emission spectra of fluorophores? What is the difference between excitation and emission spectra, describe a spectrofluorimeter. 12. Describe the principle of operation, physical basis, measurement system and basic laws describing the Raman spectroscopy method, pay attention to the practical implementation of measurements, what should you pay attention to when selecting the elements of such a measurement system? 13. Describe the difference and similarities between IR spectroscopy and Raman spectroscopy. 14. Describe the different ways of constructing probes in Raman spectroscopy and their applications. 15. Describe the difference in the method of measuring Raman spectra (IR spectra) in a classic (dispersive) spectrometer and an interference spectrometer (FT-Raman) / (FTIR). 16. Describe the differences between an amplitude division interferometer and a wavefront division interferometer. 17. Describe how optical low coherence tomography (OCT) works, the principle of operation, measurement systems, differences between the source sweep system (SS-OCT, Swept Source OCT) and the spectral domain system (SD-OCT, Spectral-Domain OCT), OCT measurement applications.
Practical activites within the subject	Not applicable

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