University of Gdańsk

Subject card

Subject name and code	Microscopic Techniques, PG_00179280		
Field of study	Physics		
Date of commencement of studies	October 2023	Academic year of realisation of subject	2025/2026
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	3	Language of instruction	Polish
Semester of study	5	ECTS credits	2.0
Learning profile	academic	Assessment form	credit
Conducting unit			
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. Anna Synak	
	Teachers	dr hab. Anna Synak	

Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	20.0	0.0	0.0	0.0	0.0	20
	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	20	0.0	0.0	20

Subject objectives	
	The objective of the course *Microscopic Techniques* is to familiarize students with the physical principles underlying the operation of various types of microscopes, including optical, electron, ion, ultrasonic, and other modern imaging systems. Students will learn the principles of image formation in different microscopic techniques and the factors that influence image resolution. The course discusses the research capabilities of individual microscopes as well as the limitations of their applicability to the analysis of different types of samples and materials. It also covers the applications of microscopic techniques in natural, technical, and medical sciences.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[FIZL3_W01] has a general knowledge of basic physical concepts, principles and theories, understands their historical development and importance not only for physics, but also for other sciences and natural sciences and cognition of the world	The student possesses general knowledge of the fundamental physical concepts, principles, and theories used in microscopic techniques. They understand their historical development – from optical microscopy to modern electron and ion microscopes – and their crucial role in broadening our knowledge of the structure of matter and physical phenomena at the micro- and nanoscale. The student is aware of the enormous importance of microscopy for the development of other scientific disciplines, particularly biology, chemistry, medicine, and materials science, where microscopic techniques constitute essential research tools that enable a deeper understanding of the structure and function of matter, as well as the processes occurring in the natural world.	[SW4] test/exam - oral or written
[FIZL3_W02] understands the role of physical experiments, mathematical theoretical models approximating reality and computer simulations in the methodology of scientific research; is aware of technological, equipment and methodological limitations in scientific research	The student understands the role of physical experiments, theoretical models, and computer simulations in microscopic research. They recognize the importance of modeling optical and wave phenomena in describing the operation of microscopes and understand how experimental measurements and simulations support the analysis of obtained images. The student is aware of the technological, instrumental, and methodological limitations of various microscopic techniques.	[SW4] test/exam - oral or written

Subject contents

Fundamental laws of geometrical and wave optics.

Resolution limits of optical systems and their physical origins.

Lens and mirror aberrations.

Construction and operating principles of the optical microscope.

Stereoscopic, phase-contrast, polarizing, interference-polarizing, fluorescence, and confocal microscopes.

Electron (SEM, TEM) and ion microscopy.

Scanning probe microscopes scanning tunneling microscope (STM) and atomic force microscope (AFM).

Holographic and ultrasonic microscopy.

Technical and methodological limitations of various microscopic techniques.

Applications of microscopic methods in natural sciences and medicine.

Prerequisites and co-requisites

not applicable

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
test	51.0%	100.0%

Recommended reading	Basic literature	LITERATURA [1] M. Pluta, Mikroskopia optyczna, PWN, W-wa, 1980. [2] D. Halliday, R. Resnick, J. Walker, Podstawy fizyki, t. 4, PWN, 2012. [3] E. Hecht, Optyka, PWN, 2012. [4] R. Howland, L. Benater, STM/AFM Mikroskopy ze skanującą sondą. Elementy teorii i praktyki, W-waa, 2002. [5] P. Eaton, P. West, Atomic Force Microscopy, Oxford University Press, 2010. [6] A. Barbacki, Mikroskopia elektronowa, Wyd. Politechniki Poznańskiej, 2005. [7] W. Dziadur, J. Mikuła, Mikroskopia elektronowa, transmisyjna, skaningowa, tom 1, tom 2, Kraków 2016. [8] E. U. Kurczyńska, D. Borowska-Wykręt, Mikroskopia świetlna w badaniach komórki roślinnej, PWN, 2007. [9] J.Liu, J.Tan, Confocal Microscopy, Morgan&Claypool Publishers, 2016r. [10] A. Ho-Pui Ho, D. Kim, M.G.Somekh (Editors) Handbook of Photonics for Biomedical Engineering, Springer, 2017. [11]D.B. Murphy, Fundamentals of Light Microscopy and Imaging, John Wiley and Sons, 2001r [12] J.A.Litwin, M. Gajda, Podstawy technik mikroskopowych, Wydawnictwo Uniwersytetu Jagiellońskiego, 2011. [13] websites of microscope manufacturers eg.:Nikon and Olympus: http://www.microscopyu.com/, http://www.olympusmicro.com/A, https://www.ntmdt-si.com/page/resources [14]Springer Handbook of Microscopy

	Supplementary literature	[1] T.P.Gotszalk, Systemy mikroskopii bliskich oddziaływań w badaniach mikro i nanostruktur, Oficyna Wydawnicza Politechniki Gdańskiej, 2004. [2] M. Abramowicz a M. W. Davidson, Microscope Objectives: Numerical Aperture and Resolution. Florida State University. [3] M. W. Davidson, Basic Concepts and Formulas in Microscopy: Numerical Aperture. [4] M. Wędzony, Mikroskopia fluorescencyjna dla botaników, Kraków, 1996. [5] P. Schwille and E. Haustein, Fluorescence correlation spectroscopy, an introduction to its concepts and applications, Biophysics Textbook Online (BTOL), 133, 2004. [6] J. Pawley (Editor), Handbook of Biological Confocal Microscopy (any edition). [7] L.W. Kessler, Acoustic Microscopy, Metals Handbook, vol.17, ASM International,465-482,1989. [8] P. Zinin, W. Weise, Theory and application of acoustic microscopy, (ed. T. Kundu) Ultrasonic Nondestructive Evaluation: Engineering and Biological Material Characterization, CRC Press, ch.11, 654-724, 2004. [9] A. Kałużny, Mikroskopia fluorescencyjna w badaniach struktury i funkcji komórek, Kraków,2011. [10] J. Dobrucki, Skaningowa, fluorescencyjna mikroskopia konfokalna. Mikrobiologia Medycyna, 34-38, 1996.
	eResources addresses	
Example issues/ example questions/ tasks being completed		
Work placement	Not applicable	

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