GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Lasers in Medicine, PG_00047930		
Field of study	Biomedical Engineering		
Date of commencement of studies	October 2024	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	4	Language of instruction	Polish
Semester of study	7	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Metrology and Optoelectronics -> Faculty of Electronics, Telecommunications and Informatics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Jerzy Pluciński	
	Teachers	dr hab. inż. Jerzy Pluciński	

Lesson types and methods of instruction	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	The aim of the course is to acquaint students with the principle of the construction and operation of the laser, the types and parameters of lasers used in medicine and the rules of their safe use, as well as the impact of the laser beam on the tissue using laser in therapy and diagnostics. The aim of the course is also to acquire ability to measure the parameters of the laser beam.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W03] knows and understands, to an advanced extent, the construction and operating principles of components and systems related to the field of study, including theories, methods and complex relationships between them and selected specific issues - appropriate for the curriculum	He compares the properties of the laser beam with optical radiation from other sources, explains the structure and operation of continuous and pulsed lasers, explains the methods of tuning lasers, describes the factors destabilizing the operation of lasers and discusses the principles of their stabilization. He lists the basic types of lasers and their typical parameters, presents laser safety classes.	[SW1] Assessment of factual knowledge
[K6_W54] Knows and understands, to an advanced extent, selected aspects of biomedical diagnostics	He knows and understands the principles of operation and the possibility of using lasers and in medical diagnostics, understands the risks associated with laser beams.	[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	He explains the phenomenon of absorption, emission and stimulated emission, knows the Einstein equations describing these phenomena, knows the concept of population inversion.	[SW1] Assessment of factual knowledge
[K6_U06] can analyse the operation of components, circuits and systems related to the field of study, measure their parameters and examine technical specifications	He measures the parameters of lasers and optical elements used in laser technology, analyzes the operation of optical elements, makes measurements using lasers, including the optical properties of selected media.	[SU1] Assessment of task fulfilment

Subject contents

1. Introduction: the scope of the lecture, plan of lectures, literature, historical introduction.
2. Optical radiation and quantities associated with it.
3. Special features of the laser beam in comparison with the optical radiation from other sources.
4. Coherence time, coherence length, the coherence time of laser radiation.
5. Spatial coherence of laser radiation, the divergence of the laser beam, laser beam focusing.
6. Laser building blocks: optical amplifier, resonator, optics and electronics.
7. Absorption, spontaneous emission, stimulated emission, the amplification of the laser radiation, pumping methods of lasers.
8. Construction of an optical resonator – types of resonators.
9. Longitudinal modes and transverse modes of lasers.
10. Single-frequency lasers, tunable lasers.
11. Q-switched pulsed lasers and mode-locked lasers.
12. Types of lasers used in medicine – a continuous-wave lasers and pulse lasers.
13. Risks of laser radiation on the human body.
14. The maximum permissible exposure to continuous-wave and pulsed radiation – permissible doses.
15. Standards applicable to applications of lasers in medicine.
16. The use of lasers in medical diagnosis – introduction.
17. Transillumination.
18. Optical diffusion tomography.
19. Optical mammography.
20. Absorption spectroscopy of tissues.
21. Imaging using the acoustooptic phenomenon.
22. Photoplethysmography.
23. Laser-Doppler blood flow measurements.
24. The use of coherent sources in the diagnosis of tissue – optical coherence tomography (OCT).
25. Diagnosis of the eye by OCT.
26. The use of holography in medical diagnostics.
27. The use of lasers in medical treatment – introduction.
28. The use of lasers in surgery and microsurgery.
29. The use of lasers in cosmetic surgery and dermatology.
30. The use of lasers in the treatment of the retina.
31. The use of lasers in the correction of vision defects.
32. Methods for photodynamic treatment of cancer and skin diseases.
33. Development trends in medical applications of lasers.

Prerequisites and co-requisites

No requirements

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Midterm colloquium	50.0%	60.0%
Practical exercise	50.0%	40.0%

Recommended reading	Basic literature	1. Instructions for laboratory exercises, available on: http://uno.biomed.gda.pl. 2. H. Jelinkova: Lasers for Medical applications. Diagnostics, therapy and surgery. Woodhead Publishing Ltd, Oxford, 2013. 3. O. Svelto: Principles of Lasers, 4th Edition, Plenum Press, New York, 1998. 4. B. E. A. Saleh, M. C. Teich: Fundamentals of Photonics, 2nd Edition. John Wiley & Sons, New York, 2007. 5. F. Täger: Springer Handbook of Lasers and Optics. Springer, Berlin, 2007. 6. M. H. Niemz: Laser-Tissue Interactions: Fundamentals and Applications, 3rd Edition. Springer, Berlin, 2007. 7. K. Barat: Laser Safety Management. CRC, Boca Raton, 2006.
	Supplementary literature	No requirements
	eResources addresses	Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed		
Work placement	Not applicable	