Wrocław University of Science and Technology
Doctoral School

COURSE CARD

1. Basic information

Course name in English:	Advanced photonics structures	
Course name in Polish:	Zaawansowane struktury fotoniki	
Number of hours:	30	
Type of course:	Elective course	
Form of course:	lecture	
Code of course:	AEQ100469W/ W12AEE-SD0165W	
Course leader:	Damian Pucicki, DSc, PhD, Eng.	
Faculty of the course leader:	W12 Faculty of Electronics, Photonics and Microsystems	
Email address of the course leader:	Damian.Pucicki@pwr.edu.pl	
Scientific discipline(s) assigned to the course (doctoral students representing the marked disciplines can participate in the course):	Architecture and urban planning	☐
	Automation, electronic, and electrical engineering	☒
	Information and communication technology	☒
	Biomedical engineering	☐
	Chemical engineering	☐
	Civil engineering and transport	☐
	Mechanical engineering	☐
	Environmental engineering, mining, and energy	☐
	Mathematics	☐
	Chemical sciences	☐
	Physical sciences	☐
	Management and quality studies	☐

2. Objectives

1. Familiarizing with the newest technical and technological aspects of advanced semiconductor devices and their working principle.
2. Analyse and discussion about actual and developing fields of application advanced optical system.
3. Presentation of selected areas of application of advanced photonics, with special emphasis placed on optical communications.
4. Presentation of physical fundamentals and technology of contemporary photonic devices.

3. Content

Detailed information about the course content, including topics and form of classes.

No.	Topic	Number of hours	Form of classes
1	Selected aspects of technology of semiconductor structures (epitaxy): modes and modifications of epitaxial crystal growth, selective epitaxy, epitaxial	4	lecture

	anisotropy, aerotaxy, types of epitaxial quantum structures, structural characterization.		
2	Properties of quantum structures: band and electron structure, the mechanism of interaction of light with matter in low-dimensional structures.	4	lecture
3	Structures, technology and properties of advanced optoelectronic devices: technological limitations, design constraints, electro-optical modulation.	2	lecture
4	Advanced semiconductor light sources and radiation detectors.	4	lecture
5	Fundamentals of design and technology of advanced photonics structures: optical modulators and multiplexers, photonics integrated circuits.	2	lecture
6	Fundamentals of nonlinear optics: classification and description of nonlinear optical phenomena, application of optical nonlinearities in photonics, properties and technology of photonic crystals.	2	lecture
7	Photonic crystals: fundamentals and technology.	4	lecture
8	Modern optical communications: devices and systems.	4	lecture
9	Silicon photonics	2	lecture
10	Plazmonics	2	lecture

4. Prerequisites

List of prerequisites relating to knowledge, skills and other competences for course participants.

1. Master-level knowledge of physics and mathematics
2. Solid state physics

5. Learning outcomes

List of learning outcomes at level 8 of the Polish Qualifications Framework assigned to the course (mark the learning outcomes in the last column).

Symbol	**Learning outcome**	
	KNOWLEDGE. Doctoral student knows and understands:	
SzD_W3	the main trends in the development of the scientific or artistic disciplines covered in the curricula;	☒
SzD_W4	research methodology;	☒
SzD_W5	the rules for the dissemination of scientific results, including in open access mode;	☐
SzD_W6	the fundamental dilemmas of modern civilization;	☐
SzD_W7	the legal and ethical conditions of scientific activity;	☐
SzD_W8	the economic and other relevant conditions of scientific activity;	☐

SzD_W9	basic principles of knowledge transfer to the economic and social spheres and commercialisation of results of scientific activity and know-how related to these results.	☒
	SKILLS. Doctoral student is able to:	
SzD_U2	use knowledge from different fields of science or art to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular: - define the purpose and subject of scientific research, formulate a research hypothesis, - develop research methods, techniques and tools, and use them creatively, - draw conclusions on the basis of scientific research; critically analyse and evaluate the results of scientific research, expertise and other creative work and their contribution to knowledge development; transfer the results of scientific activities to the economic and social spheres;	☒
SzD_U3	communicate on specialised topics to the extent that they enable an active participation in the international scientific community;	☒
SzD_U4	disseminate research results, including in popular forms;	☒
SzD_U5	initiate debates and participate in a scientific discourse;	☒
SzD_U6	be able to speak a foreign language at B2 level of the Common European Framework of Reference for Languages to a level that enables them to participate in the international scientific and professional environment;	☒
SzD_U7	plan and implement an individual or collective research or creative activity, including in an international environment;	☐
SzD_U8	independently plan and act for one's own development and inspire and organize the development of others;	☐
SzD_U9	plan classes or groups of classes and implement them using modern methods and tools.	☐
	SOCIAL COMPETENCES. Doctoral student is ready to:	
SzD_K3	fulfilling the social obligations of researchers and creators, initiate public interest activities, thinking and acting in an entrepreneurial way;	☒
SzD_K4	maintaining and developing the ethos of research and creative environments, including: - carrying out scientific activities in an independent manner, - respecting the principle of public ownership of research results, taking into account the principles of intellectual property protection.	☒

6. Evaluation

Short description of the method(s) used to evaluate the learning outcomes assigned to the course, e.g., exam, test, report, presentation, etc.

1. Multimedia presentation followed with discussion on the lectures subjects.
2. Test or oral answers

7. Teaching methods

Short description of the teaching methods used during the course, e.g., multimedia presentation, discussion, literature studies, developing written documents, own work, etc.

1. Thematic lectures supported by the multimedia presentation.
2. Discussion on the PhD student chosen topic with preparation of short presentation by the student.
3. Consultations

8. Literature

List of primary and secondary literature used to prepare the course and including additional knowledge for participants, e.g., books, textbooks, research papers, standards, web pages, etc.

1. J. D. Joannopoulos, Photonic crystals: molding the flow of light. Princeton: Princeton University Press, 2008
2. M. C. Gupta and J. Ballato, The handbook of photonics. CRC press, 2012
3. D.Pucicki, *Struktury kwantowe w technologii przyrządów półprzewodnikowych*, Oficyna wydawnicza PWr, Wrocław 2017

9. Other remarks

Additional remarks, comments, (e.g., language of the course)