

**DOCTORAL SCHOOL OF WROCLAW UNIVERSITY OF SCIENCE AND  
TECHNOLOGY**

**SUPERVISOR/TEAM/ DECLARING/CONDUCTING COURSE:** Regina Paszkiewicz  
**DEPARTMENT:** Faculty of Microsystem Electronics and Photonics W12  
**SCIENTIFIC DISCIPLINE:** Automation, Electronics and Electrical Engineering

**COURSE CARD**

**Course name in Polish:** Technologia i Zastosowanie Niskowymiarowych Struktur  
Półprzewodnikowych

**Course name in English:** Technology and application of low dimensional semiconductor structures

**Course language Polish / English\***

**University-wide general course type\*:**

**The course is intended for all PhD students: YES / NO**

~~1) BASIC COURSE~~

2) **SPECIALIST COURSE**

~~3) SEMINAR~~

~~4) HUMANISTIC COURSE~~

~~5) LANGUAGE~~

**Subject code: AEQ100237W**

\* delete as applicable

	Lecture	Foreign language course	Seminar	Mixed forms
Number of hours of organized classes in university (ZZU)	30			
Grading	Exam	Exam	Oral presentation	Exam, inspection, evaluation classes
Number of ECTS points	<b>0</b>			

**PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES**

1. Knowledge of solid-state physics
2. Competence to gain complementary areas of knowledge and skills
3. Organizational competences related to the transfer of information

**COURSE OBJECTIVES**

C1 Ph D students introduction to the technologies of low-dimensional semiconductor structures (NSP) manufacturing

C3 Getting of Ph D students acquainted with the areas of NSP applications

C3 Getting of Ph D students acquainted with the current state and development trends of the NSP fabrication and applications

**PROGRAM CONTENTS**

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<b>Form of classes – lecture (Lec)</b>		Number of hours
Lec1	Nanotechnology, definition, classification. Areas of application	
Lec2	Miniaturization, scaling, new functional properties of nanostructures. Nanostructures architecture	
Lec3	Basics of semiconductor nanostructures manufacturing technology	
Lec4	Infrastructure of modern technological laboratory of "clean room" type (purity of gases, water and reagents, security problems)	
Lec5	Lithographic and non-lithographic methods of nanostructures manufacturing, nano-substrates	
Lec6	Review of basic technological processes (bulk crystallization, deposition, doping, etching, oxidation, lithography, self-organization and catalysis)	
Lec7	Selected methods of photonic crystal fabrication ("micropulling"), epitaxy of low-dimensional layers and structures (techniques: CVD, MOVPE, MBE)	
Lec8	Methods of pattern fabrication, limitation of optical lithography (techniques: UV, DUV, EUV)	
Lec9	X-ray lithography (LIGA technique), ion-lithography, electron-lithography, sampling methods ("dip-pen", "nanoscratching"), nanoimprint	
Lec10	Self-organizing semiconductor structures. Quantum wells, wires, dots: growth, positioning and stability	
Lec11	Properties and fabrication of individual nanoparticles: carbon nanotubes, non-diamond, DLC, graphene, organic materials - their application for devices	
Lec12	Selected methods of nanostructures properties characterization	
Lec13	Examples of nanostructures application in devices (lasers, HEMT transistors, transducers and sensors)	
Lec14	Current trends in nanotechnology, new materials (nano-powders, nano-crystals, nano-composites, layered materials, gradient structures) devices (3D transistors, nano-sensors) and nano-tools	
Lec15	Summary of the lecture	
Total hours:		

<b>Form of classes – foreign language course (Lng)</b>		Number of hours
Lng1		
Lng2		
Lng3		
..		
Total hours:		

<b>Form of classes – seminar (Sem)</b>		Number of hours
Sem1		
Sem2		
Sem3		
...		
Total hours:		

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<b>Form of classes – mixed forms (mix)</b>		Number of hours
Mix1		
Mix2		
Mix3		
...		
Total hours		

<b>TEACHING TOOLS USED</b>
N1. Thematic lectures - traditional method N2. Thematic laboratory visits - demonstration and discussion N3. Own work - preparation for a lecture N4. Consultations

<b>ACHIEVED SUBJECT LEARNING OUTCOMES</b>		
Type of learning outcome	Code of learning outcome	Assessment of learning outcome
Knowledge	P8SU-W	Oral answers, colloquium
Knowledge		
...		
Skills	P8U-U	Oral answers
Skills	P8S-UW	Speeches prepared for the given issue
...		
Social competence	P8S-KO	Timework at problematical assembly
Social competence		
...		

<b>PRIMARY AND SECONDARY LITERATURE</b>
<p><b><u>PRIMARY LITERATURE:</u></b></p> <p>[1] Marc J. Madou, Fundamentals of Microfabrication and Nanotechnology, Third Edition, Boca Raton, USA, 2011</p> <p>[2] S. Franssila, Introduction to Microfabrication, John Wiley &amp; Sons Ltd, England, 2004</p> <p>[3] Kazuaki Suzuki, Microlithography: Science and Technology, Second Edition, CRC Press, Boca Raton, USA, 2007</p> <p>[4] G. Cao, Y. Wang, Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, Second Edition, World Scientific Publishing Co., Pte. Ltd., Singapore, China, 2011</p> <p><b><u>SECONDARY LITERATURE:</u></b></p> <p>[1] Journals: Journal of Nanostructures, Compound Semiconductors, Semiconductor Engineering</p>
<b>SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)</b>

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