Course Unit Descriptor

Study Programme: Physics		
Course Unit Title: Quantum electronics and photonics		
Course Unit Code: FD18KEF		
Name of Lecturer(s): Full Professor Vesna Bengin Crnojević		
Type and Level of Studies: PhD		
Course Status (compulsory/elective): Elective		
Semester (winter/summer): Summer		
Language of instruction: English		
Mode of course unit delivery (face-to-face/distance learning): Face-to-face		
Number of ECTS Allocated: 15		
Prerequisites:		
Course Aims: Students will gain an extensive knowledge of the physics and applictaions of modren semiconductor quantum optoelectronic devices (quantum wells and superlattices, infra-red and terahertz lasers and photodetectors).		
Learning Outcomes: On completion of this module, student should be able to understand basic ideas and reasoning behind the development of quantum theory and its application to semiconductor quantum mechanics and quantum optoelectronics/photonics. Student should also be able to independently develop models and designs of quantum semiconductor structures, lasers and photodetectors operating in infrared and far-infrared spectral range. Student will be able to develop his/her own project idea, design the model and realise the project, deliver the presentations at international conferences and publish research results in journal papers.		
Syllabus: Understand basic ideas and reasoning behind the semiconductor quantum mechanics. Analytical and numerical approaches to electronic structure calculation in quantum structures. Symmetrical and asymmetrical semiconductor quantum structures. Light absorption in quantum wells and super-lattices. Nonlinear optical properties. Carrier scatterings in hetero-structures. Infrared photodetectors. Semiconductor inter-subband (quantum-cascade) lasers. Electronics structure and carrier transport in quantum-cascade lasers. Physics and design of optical waveguides. Growth of heterostructure lasers by Molecular Beam Epitaxy (MBE). Infrared spectroscopy with quantum-cascade lasers. Introduction to the terahertz frequency range, and potential application areas. Terahertz quantum-cascade lasers and terahertz spectroscopy. Applications of mid infra-red and terahertz lasers.		
Required Reading: 1. Quantum Wells, Wires and Dots, Theoretical and Computational Physics of Semiconductor Nanostructures, (3rd & 4th edition), John Willey & Sons, Chichester 2009/2016., Paul Harrison (Ed) 2. Quantum Cascade Lasers, Oxford University Press, Oxford 2013, Jerome Faist. 3. Wave Mechanics Applied to Semiconductor Heterostructures, John Willey & Sons, New York, 1990, Gerard Bastard 4. Semiconductor quantum microstructures, University of Belgrade, Belgrade 1997, Vitomir Milanovic and Zoran Ikonic		
Weekly Contact Hours:	**Lectures:** 6	**Practical work:** 4
Teaching Methods: Lectures and students group work		
Knowledge Assessment (maximum of 100 points): 100		

Pre-exam obligations	points	**Final exam**	points
Active class participation	10	written exam	
Test I and Test II		oral exam	50
Preliminary exam(s)		…….	
Seminar(s)	40		
The methods of knowledge assessment may differ; the table presents only some of the options: written exam, oral exam, project presentation, seminars, etc.			