RTU Course "Basics of Integrated Photonics"

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General data

Code	RDE718
Course title	Basics of Integrated Photonics
Course status in the programme	Compulsory/Courses of Limited Choice; Courses of Free Choice
Responsible instructor	Aleksandrs Mariņins
Academic staff	Vjačeslavs Bobrovs
Volume of the course: parts and credits points	1 part, 4.0 Credit Points, 6.0 ECTS credits
Language of instruction	LV, EN
Annotation	We are at the witness of revolutionary change in communication and microsystems technologies, combining photonics and electronics in one platform. By combining large-scale photonic integration with large-scale electronic integration, whole new types of system-on-chip will emerge in the coming years. Electronic-photonic circuits will play a ubiquitous role worldwide, affecting areas such as high-speed communications for mobile devices (smartphones, tablets), optical communications in computers and data centres, sensor systems, and medical applications. We can expect the earlier effects to emerge in telecommunications, data centres and high-performance computing, with the technology eventually migrating into higher-volume, shorter-reach consumer applications. The purpose of this course is to introduce basic knowledge of integrated photonics technology. Students will get familiar with the main principles of photonic integrated circuit (PIC) operation. This includes PIC fabrication, modelling, and characterization.
Goals and objectives of the course in terms of competences and skills	The aim of the study course is to make students familiar with the novel field of integrated photonics. Tasks of the study course: - to explain basic physics principles behind integrated photonics technology; - to provide an overview on existing integrated photonics material platforms (silicon photonics, indium phosphide, etc.) and explain fabrication processes; - to teach developing and applying basic numerical models for integrated photonic device simulations and integration to the PIC platform; - to demonstrate PIC test routines and characterization.
Structure and tasks of independent studies	Within the study course, students' independent work will be organized as follows: - to solve the tasks defined by the academic personnel, showing the use of the knowledge acquired in the lectures; - applying the acquired knowledge in developing simple numerical models of typical integrated photonic devices and integrating them into the simulative PIC platform; - analyse the state-of-the-art from the latest published research works of integrated photonics technology.
Recommended literature	Obligātā/Obligatory: 1.Lukas Chrostowski, Michael Hochberg, “Silicon photonics design”, 2015. 2.Larry A. Coldren, Scott W. Corzine, Milan L. Mašanović, “Diode Lasers and Photonic Integrated Circuits, Second Edition”, 2012. 3.Clifford R. Pollock, Michal Lipson, “Integrated photonics”, 2003. Papildu/Additional: 1.Dwivedi S., Kjellman J., Marinins A. et al, “All-Silicon Photodetectors for Photonic Integrated Circuit Calibration”, in IEEE Photonics Technology Letters, vol. 33, no. 16, pp. 836-839, 2021. 2.Hermans A., Van Gasse, K., Marinins A. et al, “High-pulse-energy III-V-on-silicon-nitride mode-locked laser”, in APL Photonics, vol. 6, no. 9, 2021. 3.M. Pantouvaki et al., "Active Components for 50 Gb/s NRZ-OOK Optical Interconnects in a Silicon Photonics Platform," in Journal of Lightwave Technology, vol. 35, no. 4, pp. 631-638, 2017.
Course prerequisites	Electrodynamics, wave optics, nonlinear optics, fibre optics.

Course contents

Content	Full- and part-time intramural studies		Part time extramural studies	
	Contact Hours	Indep. work	Contact Hours	Indep. work
Introduction to integrated photonics, application overview.	6	12	0	0
PIC material platforms and fabrication.	8	12	0	0
Light sources, optical waveguides, resonators, filters, electro-optic modulators, photodetectors integration in to the PIC platform.	8	12	0	0
Optical fibre to-chip interfaces.	6	10	0	0
Non-linear optical effects in PICs.	8	12	0	0
Practical and experimental works in analogue radio-over-fibre system characterizations in a teaching-scientific laboratory.	28	38	0	0
Total:	64	96	0	0

Learning outcomes and assessment

Learning outcomes	Assessment methods
Able to explain the operation principle of integrated photonic devices such as semiconductor lasers, waveguides, modulators, photodetectors, etc.	Test, exam.
Able to explain fundamental differences between silicon photonics and III-V photonics.	Test, exam.
Able to simulate simple passive photonic devices to create a design meeting specification.	Practical works, exam.
Able to create PIC test methods and evaluate linear and nonlinear characteristics of the platform.	Laboratory works, exam.

Evaluation criteria of study results

Criterion	%
Tests	30
Laboratory and practical works	40
Exam	30
Total:	100

Study subject structure

Part	CP	Hours per Week			Tests			Tests (free choice)		
		Lectures	Practical	Lab.	Test	Exam	Work	Test	Exam	Work
1.	4.0	2.0	1.0	1.0		*			*	