RTU Course "Digital Optical Communication Systems"

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General data

Code	RDE713
Course title	Digital Optical Communication Systems
Course status in the programme	Compulsory/Courses of Limited Choice; Courses of Free Choice
Responsible instructor	Oskars Ozoliņš
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	The study course is meant to obtain knowledge about digital signal processing (DSP) in fibre optical communication systems (FOTS), which will enable students not only to understand the specifics of DSP in FOTS, but also to develop and apply effective algorithms and methods for creating a new generation of transmission systems with direct and coherent detection.
Goals and objectives of the course in terms of competences and skills	The aim of the study course is to provide knowledge about digital signal processing methods and their application in next-generation fibre optic communication systems. Tasks of the study course: * to provide basic knowledge and experience about digital optical communication systems; * to teach to design and apply the digital signal processing algorithms to increase the performance of fibre optic communication systems; * to develop skills to analyse the architecture of fibre optic communication systems and the possibilities to technically improve them.
Structure and tasks of independent studies	Students will have to solve the tasks set by the lecturer, demonstrating the acquired knowledge in the lectures. Students are expected to independently research the latest results in published scientific articles. Applying the modeling tools, it will be necessary to implement efficient DSP algorithms and methods for digital signal processing in FOTS experimental laboratory.
Recommended literature	Obligātā/Obligatory: Darli Augusto De Arruda Mello, Fabio Aparecido Barbosa. Digital Coherent Optical Systems. Architecture and Algorithms. Springer International Publishing, 2021 Le Nguyen Binh. Advanced Digital Optical Communications. Second edition. 2017 by CRC Press Le Nguyen Binh. Digital Processing Optical Transmission and Coherent Receiving Techniques. 2013 by CRC Press Papildu/Additional: K. Zhong, X. Zhou, J. Huo, C. Yu, C. Lu, and A. P. T. Lau. Digital signal processing for short-reach optical communications: A review of current technologies and future trends. Journal of Lightwave Technology, 2018 L. Zhang, J. Chen, A. Udalcovs, X. Pang, R. Schatz, U. Westergren, S. Popov, S. Xiao, O. Ozolins. Kernel Affine Projection for Nonlinearity Tolerant Optical Short Reach Systems. IEEE Transactions on Communications, 2020 J. Rodrigo Navarro, A. Kakkar, X. Pang, O. Ozolins, R. Schatz, M. Iglesias Olmedo, G Jacobsen, S. Popov. Carrier Phase Recovery Algorithms for Coherent Optical Circular mQAM Systems. Journal of Lightwave Technology, 2016 A. Kakkar, J. Rodrigo Navarro, R. Schatz, X. Pang, O. Ozolins, A. Udalcovs, H. Louchet, S. Popov, G. Jacobsen. Laser frequency noise in coherent optical systems: spectral regimes and impairments. Scientific Reports (Nature), 2017 L. Zhang, A. Udalcovs, R. Lin, O. Ozolins, X. Pang, L. Gan, R. Schatz, M. Tang, S. Fu, D. Liu, W. Tong, S. Popov, G.. Towards terabit digital radio over fiber systems: architecture and key technologies. IEEE Communication Magazine, 2019
Course prerequisites	Telecommunication theory, transmission systems, fibre optic transmission systems.

Course contents

Content	Full- and part-time intramural studies		Part time extramural studies	
	Contact Hours	Indep. work	Contact Hours	Indep. work
Introduction to FOTS DSP.	4	6	0	0
Optical transmitters for direct and coherent transmission.	6	10	0	0
Optical channel.	6	10	0	0
Phase noise.	4	6	0	0
Optical receivers for direct and coherent detection.	6	12	0	0
Kramers-Kronig receiver.	6	10	0	0
Delay and dispersions compensation using DSP.	8	10	0	0
Signal equalization using DSP.	6	10	0	0
Recovery of carrier clock signals using DSP.	8	10	0	0
Performance evaluation of FOTS systems.	10	12	0	0
Total:	64	96	0	0

Learning outcomes and assessment

Learning outcomes	Assessment methods
Able to competently understand the structures of the latest optical transmitters with DSP for direct and coherent modulation, knows the basic parameters of the main elements. Can model communication system transmitters with DSP.	Laboratory and practical works, test, exam.
Able to create an optical channel by analysing the effects of phase noise and equalization enhanced phase noise. Is able to evaluate and reduce the nonlinear disturbances in the communication system with DSP.	Laboratory and practical works, test, exam.
Able to choose the necessary optical receiver for direct and coherent signal detection, to supplement the model with DSP algorithms and is able to explain the main parameters of various components.	Laboratory and practical works, test, exam.
Able to design and implement newer generation FOTS with DSP, recover different types of signals with different modulation, using coherent and direct detection. Able to incorporate the signal performance improvement techniques in communication systems and comment on them.	Laboratory and practical works, test, exam.

Evaluation criteria of study results

Criterion	%
Tests	40
Laboratory and practical works	20
Exam	40
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		*			*	