COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
ORGANIC OPTOELECTRONICS	

Lecturer(s)	Department(s) where the course unit (module) is delivered
Coordinator: Prof. Saulius Juršėnas **Other(s):**	Physics Department, Institute of Applied Research Saulėtekio al. 3, Vilnius

Study cycle	Type of the course unit (module)
First	

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
Lectures, seminars, laboratory work	Spring sem.	English

Requirements for students	
Prerequisites: Basic knowledge on physics and mathematics on the level of the first cycles of physics or engineering studies	**Additional requirements (if any):** Basic chemistry course

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
5	140	64	76

Purpose of the course unit (module): programme competences to be developed		
Soft organic materials replace conventional semiconductors in electronics and photonics technologies. Organic optoelectronic devices market is one of the fastest growing. The course will provide the basic knowledge of physical processes in organic materials and of organic optoelectronic device technologies. Course will provide with practical skills of formation of simple organic devices and will enable better adaptation to new coming organic semiconductor devices products and technologies. Course will provide with information on the recent trends in organic optoelectronic device markets.		
Learning outcomes of the course unit (module)	**Teaching and learning methods**	**Assessment methods**
Students will acquire general basic knowledge of organic optoelectronic materials and physical processes in them. (1.1)	Lectures with visual demonstrations	Midterm (open questions)
Students will acquire a basic knowledge of organic electronics and photonics devices, their production technology and operating principles. Students will acquire knowledge on organic optoelectronic devices application areas and device market developments. (1.3, 3.4)	Lectures with visual demonstrations. Seminars.	Exam (open questions, answers in a written form) Assessment of seminar presentations
Practical skills of formation and testing of organic optoelectronic devices: OLEDs, OTFTs, OPV, photoreceptors, organic lasers, organic nonlinear optical layers, and organic sensors. (2.1, 2.2, 2.3, 3.1,3.2, 4.2)	Laboratory work, self-study.	Assessment for practical work.

Learn to analyse the scientific literature in the field of organic optoelectronics. (1.2, 2.2)	Self-study. Analysis of the latest achievements in organic optoelectronics technologies. Open discussion.	Assessment of presentation and discussion.

Content: breakdown of the topics	Contact hours							Self-study work: time and assignments	
	Lectures	Tutorials	Seminars	Exercises	Laboratory work	Internship/work placement	**Contact hours**	**Self-study hours**	**Assignments**
1. **Basic knowledge of physical processes in organic electroactive materials** **1.1 Introduction.** Soft materials- a new generation of high-technology materials. Organic electroactive and photonic materials. Other related compounds. Organic molecular crystals, Amorphous Molecular films, Polymer films. Products and Market forecast. Electronic states of a molecule. Atomic orbitals of carbon. Molecular orbitals. 1.2 **Basics on Molecular electronic states**. Electronic absorption. Fluorescence and Phosphorescence, Delayed fluorescence. Molecular solvation processes. Molecular complexes. Energy transfer processes in molecular systems. 1.3 **Basics on exciton states in molecular solids**. Frenkel excitons, Charge-transfer excitons. Exciton energy transfer. Exciton vibronic interaction. Exciton recombination processes. 1.4 **Basics on charge carrier states in organic solids**. Charge carrier mobility in organic solids: organic crystals, disordered organic films. Charge carrier photogeneration and recombination processes. 1.5 **Basic concepts of Electronic processes in conjugated polymers.** Soliton, polaron bipolaron exciton. Excited state dynamics in conjugated polymer films.	10						10	10	Prepare for midterm
2. **Basic concepts of organic**	14		6	6			26	28	Presentations on hot topics of organic

optoelectronic device technologies **2.1 Organic layer deposition technologies.** Self-assembled monolayers. Organic heterojunctions. Organic multilayer device fabrication technologies. 2.2 **Organic field effect transistors:** materials, basic structures, principles of operation. Organic circuits. Printed organic electronics. 2.3 **Organic light emitting devices**: materials, basic structures, principles of operation. Polymer light emitting diodes. Organic lasers. Organic light emitting transistors. Organic displays and general lighting devices: basic structures, principles of operation, market forecast. 2.4 **Organic photonic devices**, fabrication technologies and operation principles. Organic nonlinear optical materials and devices. 2.5 **Organic photoreceptors**: materials, device structures, principles of operation. Xerox, laser printers, structures, principles of operation, markets. Organic photodiodes. 2.6 **Organic photovoltaic devices**, materials, basic structures, principles of operation. OPVC markets. 2.7 **Organic Thermoelectric Power Devices**: materials and principles of operation. 2.8 **Organic sensor systems**. Water soluble chemical and biological sensors. Photoluminescent chemical and biological sensors. Organic transistor based sensors. Organic gas sensors. Lab-on-a-Chip devices with organic semiconductor based detection. Market forecast.									optoelectronic research (one 20 min. presentation on designated topics)
Laboratory work. Projects on relevant organic electronics and photonics devices: OLED, OTFT, OPV, photoreceptors, organic laser, organic nonlinear optical layer, organic sensor, preparation of device layout.			2	2	24		28	38	Literature analysis, introduction into experimental methods, experimentation and analysis of the results, preparation of the report and presentation.
Total	**24**		**8**	**8**	**24**		**64**	**76**	

Assessment strategy	**Weight,%**	**Deadline**	**Assessment criteria**
Midterm. Performance method: answers in a	20	Middle of the Semester	Mastered basic knowledge, %

written form. (open questions)			
Seminar presentation	20	Semester, at the scheduled time	Evaluation of presentation: novelty, completeness, presentation
Project report and presentation	30	End of Semester	Evaluation of the report and presentation of the Project: quality of experimentation, interpretation of the results, presentation
Exam. Performance method: answers in a written form. (open questions)	30	Exam session	Mastered course knowledge, %

Author	**Year of publication**	**Title**	**Issue of a periodical or volume of a publication**	**Publishing place and house or web link**
Compulsary reading				
A.Kohler and H.Bassler	2015	Electronic Processes in Organic Semiconductors		Weinheim, Germany, Wiley-VCH
Ed.: W.Hu	2013	Organic Optoelectronics		Weinheim, Germany, Wiley-VCH
M.Pope, C.E.Svenberg	1999	Electronic Processes in Organic Crystals		N.Y.: Oxford Univ. Press
W.Tress	2014	Organic Solar Cells	V.208	Heidelberg, Springer
B.D.Malhotra	2002	Hanbook of Polymers in Electronics,		Shawbury: RAPRA Technology LTD
D.A.Bernards, R.M.Owens. G.G.Malliaras eds.	2008	Organic Semiconductors in Sensor Applications	V. 107	Heidelberg, Springer
Optional reading				
Ed. W.Brutting, Ch.Adachi	2012	Physics of Organic Semiconductors		Weinheim, Germany, Wiley-VCH
Ron Mertens	2016	The OLED Handbook		Ron Mertens