COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
ORGANIC OPTOELECTRONICS TECHNOLOGY	

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

Study cycle	Type of the course unit (module)
M1	

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. Suitable for chemistry students	**Additional requirements (if any):** Basic chemistry course

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
10 cr.	190 h	72 h	208 h

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 an understanding of organic optoelectronic materials and their physical processes.	Lectures with visual demonstrations Self-study.	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.	Lectures with visual demonstrations. Seminars. Open discussion. Self-study.	Exam (open questions, answers in a written form) Assessment of seminar presentations
Will learn to model the properties of molecular	Theoretical introduction of	Acceptance of practical work.

derivatives by quantum chemistry methods.	DFT, analysis of examples, practical classes. Self-study.	
Learn to test the optical and electrical properties of organic materials and devices.	Lab works. Laboratory work, self-study.	Acceptance
Will learn to analyze the scientific literature in the field of organic optoelectronics.	Analysis of the latest achievements in organic optoelectronics technologies. Open discussion. Self-study.	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**
Introduction. Development of organic semiconductors. Comparison of organic and inorganic optoelectronic technologies. Organic photonics and electronics market development. Development of organic optoelectronic technologies in Lithuania.	4							50	Preparing for the colloquium
Materials used in organic optoelectronics. Typical multilayer structures of devices Typical organic semiconductors. Dominant technologies: small molecules, polymers. Multifunctional materials. Molecular glasses. Charge-separation materials. Emitters: singlet, triplet. Molecular complexes. Nonlinear optical molecules. Other material.	2								
Organic layers. Methods for purification of materials. Evaporation in vacuum. Casting from solutions. Obtaining insoluble layers. Alloying. Obtaining multilayer structures by vacuum evaporation and casting methods. Langmuir-Blogett technology. Self-organizing layers. Structuring layers. Problems of longevity and degradation of organic layers. Encapsulation.	4								
Properties of organic conjugated molecules. Molecular orbitals, orbital hybridization. Molecular electronic and vibrational states. Potential energy co-configuration diagram. Excitation processes in molecules. Environmental impact, molecular complexes, excitation transfer processes. Fiorster, Dexter energy transfer.	4								
Basic knowledge of excitonic excitations in organic materials and polymers. Frenkel's excitons. State of excitons in polyacenes. Exciton-vibronic interaction. Charge-transfer excitons. Exciton polaron and polariton. Exciton transport and relaxation processes.	4								
Charge carrier states in organic layers and crystals. Optical and adiabatic band-gap. Carrier bands, carrier states density. Defect states. Polymer states. Charge transfer phenomena. Carrier mobility, its temperature and electric field dependence.	4								

Transmission band model. Carrier transport in amorphous layers. Photogeneration and recombination of charge carriers. **Organic devices.** Organic photoreceptors. Materials, devices, principles of operation. Color copying, laser printing. Market development of organic thin film transistors and circuits. OTFT: materials, derivatives, principles of operation. Printed electronics. Organic light emitting devices. OLED: materials, principles of operation. PLED, WLED devices. Organic lasers. Organic light emitting transistors. Organic displays and lighting devices: device structure, operating principles and market forecasts. Organic photovoltaic devices. OPV: materials, basic technologies, principles of operation. OPV market development.	 10								
List of selected laboratory works (perform 2 experiments 4 x 2 = 8 hours) 1. Characterization of the xerographic layer (dr. K.Genevičius) 2. TOF in the organic layer (dr. K.Genevičius) 3. Investigation of exciton fluorescence in polar organic materials (dr. S.Raišys) 4. Measurement of fluorescence quenching time by frequency resolution method (dr. P. Vitta) 5. Measurement of excitation lifetime in various molecular systems (dr. S.Raišys)					8			36	Preparing for the lab. works performance
DFT modeling exercises (16 hours)				16				34	DFT analysis of

Theoretical background of DFT. Analysis of model molecular systems. Execution of practical tasks.									teacher-specified molecular compounds
Seminars: Each student prepares two presentations. One (10-15 min.) Presents a new scientific article on the topics of organic electronics (students choose articles according to the lecturer's recommendations: new, in a high-ranking journal, relevance). The second wider presentation (20-30 min.) is prepared on the given topics: 1. Polymer LED manufacturing materials and technologies. 2. Materials and technologies for large area lighting devices. 3. Flat plastic monitor technologies. 4. Polymer sensors (artificial skin, artificial nose, artificial tongue, immunoassays). 5. Organic vapor deposition (OVPD). 6. Thermal imaging and microcontact printing. 7. Digital lithography in OTFT production. 8. Organic electronics technology "wet" by printing. 9. Organic photodiodes. 10.Organic photonic devices, production technologies and principles of operation. 11. Organic nonlinear optical materials and devices. 12. Organic thermoelectric power devices. OTEPD: substances, derivatives and principles of operation.			16					88	
Total	**32**		**16**	**16**	**8**		**72**	**208**	

Assessment strategy	Weight,%	Deadline	Assessment criteria
Midterm. Performance method: answers in a written form. (open questions)	30	Middle of the Semester	Mastered basic knowledge, %
Seminar presentation	20	Semester, at the scheduled time	Evaluation of presentation: novelty, completeness, presentation
Scientific paper report	10	Semester, at the scheduled time	Evaluation of presentation: novelty, message, presentation
Exam. Performance method: answers in a written form. (open questions)	40	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
Ron Mertens	2016	The OLED Handbook		Ron Mertens
Optional reading				
Ed. W.Brutting, Ch.Adachi	2012	Physics of Organic Semiconductors		Weinheim, Germany, Wiley-VCH
D.A.Bernards, R.M.Owens. G.G.Malliaras eds.	2008	Organic Semiconductors in Sensor Applications	V. 107	Heidelberg, Springer
B.D.Malhotra	2002	Hanbook of Polymers in Electronics,		Shawbury: RAPRA Technology LTD