COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
NANO- AND MICRO-STRUCTURE TECHNOLOGIES	

Lecturers	Department(s) where the course unit (module) is delivered
Coordinator: Prof. M. Malinauskas **Others: Dr. K. Genevičius, Dr. G. Zyla,** **Laboratory works:** **Dr. D. Ladika, J.R.A. E. Aleksandravičius**	Faculty of Physics

Study cycle	Type of the course unit (module)
First cycle	Optional

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
Lectures, seminars and laboratory works	VI (spring) semester	Lithuanian/English

Requirements for students	
Prerequisites: Knowledge of general physics, solid-state physics, growth technologies of semiconductors, background of chemistry	**Additional requirements (if any):**

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
5	150	64	86

Purpose of the course unit (module): programme competences to be developed		
Students will get familiar with the micro- and nano-structures, used materials and employed processing technologies. They will gain fundamentals of diverse nano-technologies including fabrication, characterization and applications. After the couse the students will have developed abilities to produce micro- and nano-structures, characterize their properties and evaluate functional performance.		
Learning outcomes of the course unit (module)	**Teaching and learning methods**	**Assessment methods**
Students will be able to understand the scientific literature published in English, and to accomplish experimental projects working in international teams (4.3).	Team discussion, debates	Presentation, theme
Students will be able to find and select the relevant scientific literature in the internet, scientific journals and handbooks, to learn and critically evaluate its content and systematically present (2.2)	Cross-discussion	Presentation, analysis of the particular case
Students will understand the principles of advanced technologies using the knowledge of general physics, semiconductors and chemistry.	Problem lectures, explaining	Oral questioning, written quiz

They will be able to apply it for creating functional micro-nano-prototypes (3.3, 3.4, 4.4)		
They will be able to perform standard laboratory work procedures, to synthesize compounds, to apply knowledge of chemistry in technological steps (2.3)	Project	Research work

Content: breakdown of the topics	**Contact hours**							**Self-study work: time and assignments**	
	Lectures	Tutorials	Seminars	Exercises	Laboratory work	Internship/work	**Contact hours**	**Self-study hours**	**Assignments**
1. Introduction to Nano- and Micro-Technologies	4		3					**3**	Preparation for the seminar, including information review, systematization, and repetition for presentation. Additional focus on discussion preparation and exam revision, including laboratory work.
2. Photopolymerization and UV Lithography	3		2					**2**	
3. Electron Beam Lithography and Focussed Ion Beam Milling	3		2					**2**	
4. Nanoimprint and Soft-Lithography	3		3					**2**	
5. Light-/Laser-Based 3D Printing by Stereolithography	3		2		4			**2**	
6. Light-/Laser-Based 3D Printing by Multi-Photon Lithography	3		3		4			**2**	
7. Materials for large area electronics	3		3					**2**	
8. Solubility and crosslinking, drop and dip coating, spin coating, inkjet printing	3		2					**2**	
9. Doctor blade, self-assembly, Langmuir-Blodgett technology, zone casting, soft lithography	3		2					**2**	
10. Fabrication of organic and hyrid solar cells and FET	4		3					**3**	
Total	**32**		**24**		**8**		**64**	**86**	

Assessment strategy	**Weight, %**	**Deadline**	**Assessment criteria**
Laboratory work rating	20*	All course	Preparation to answer theoretical questions, quantity of errors in circuit connection, the quality of the work description, ability to describe the results. Evaluation in 10 scores system, the final score is multiplied by the weight coefficient. * It is obligatory to finish all laboratory works.
Seminars rating	20	All course	Ability to understand and accomplish the tasks during the seminars

Exam (written form)	60	During the exam session	3 open questions. Assessment of answer particularity, consistency and mistakes.

Author	**Year of publication**	**Title**	**Issue of a periodical or volume of a publication**	**Publishing place and house or web link**
Compulsary reading				
T. Baldacchini	2020	Three-Dimensional Microfabrication Using Two-Photon Polymerization	2nd. Ed.	https://doi.org/10.1016/C2018-0-00278-9
G. Zyla, M. Farsari	2024	Frontiers of Laser-Based 3D Printing: A Perspective on Multi-Photon Lithography	Laser Photonics Rev **18**, 2301312	https://doi.org/10.1002/lpor.202301312
M. Caironi, Y.-Y. Noh	2015	Large area an flexible electronics		Wiley-VCH Verlag GmbH & Co., 592 p. (ISBN: 978-3527336395)
E. Skliutas, G. Merkininkaitė, S. Maruo, W. Zhang, W. Chen, W. Deng, J. Greer, G. von Freymann, M. Malinauskas	2025	Multiphoton 3D Lithography,	Nat. Rev. Meth. Primers, **in press**	
Optional reading				
H. Wang, W. Zhang, D. Ladika, H. Yu, D. Gailevicius, H. Wang, C.-F. Pan, P. Nair S, Y. Ke, T. Mori, J. Y. E. Chan, Q. Ruan, M. Farsari, M. Malinauskas, S. Juodkazis, M. Gu, and J. K.W. Yang	2023	Two-photon Polymerization Lithography for Optics and Photonics: Fundamentals, Materials, Technologies, and Applications	Adv. Func. Mater. **33**(39), 2214211	https://doi.org/10.1002/adfm.202214211
A. Camposeo, L. Persano, M. Farsari, D. Pisignano	2018	Additive Manufacturing: Applications and Directions in Photonics and Optoelectronics	Advanced Optical Materials 2019, 7, 1800419	https://doi.org/10.1002/adom.201800419
J. Huang, Q. Qin, J. Wang		A Review of Stereolithography: Processes and Systems	Processes, 2020, 8, 1138	https://www.mdpi.com/2227-9717/8/9/1138
H. Klauk	2012	Organic Electronics II: More Materials and Applications	1st edition	Wiley-VCH Verlag GmbH & Co. 420 p. (ISBN: 978-3527326471)