COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
Nanostructures and Material Engineering	

Lecturer(s)	Department(s) where the course unit (module) is delivered
Coordinator: Ass. Prof. Renata Butkutė **Other(s):**	Faculty of Physics

Study cycle	Type of the course unit (module)
Second (master)	Compulsory

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
Lectures, seminars	II (spring) Semester	Lithuanian/English

Requirements for students	
Prerequisites: Knowledge of general physics, solid state physics and quantum mechanics, new materials and technologies. General chemistry knowledge is preferable	**Additional requirements (if any):**

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		
To provide the knowledge of nanostructures and material engineering sience, especially growth techniques, engineeging of microelectronic and nanoelectronic fabrication, processing as well as pecularities of characterization of nanostructures		
Learning outcomes of the course unit (module)	**Teaching and learning methods**	**Assessment methods**
Skills of using of deposition and processing methods for solving problems in the field of manufacturing of semiconductor-based nanodevices	Seminars and cross-discussions	Analysis of the particular case Evaluation of presentation quality, of ability to answer to the questions, of ability to summarize the obtained information
Understanding and knowledge of the modern technologies of growth and formation of nanostructures	Lectures, video material analysis debates	Written exam

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. **Introduction.** Introduction. History of nanotechnology. „Bottom-Up" and „Top-Down"	2						**2**	**4**	Repetition for exam.

methods. Goals and priority of nanotechnology									
2. **The background of physical chemistry**. Surface energy. Chemical potential. Electrostatic stabilization of nanoparticle	10						**10**	**12**	Repetition for exam.
3. **Engineering of nanoparticles**. Principles of fabrication. Examples and analysis of nanoparticles, common principles and peculiarities	12						**12**	**12**	Repetition for exam.
4. **1D nanostructures, nanowires**. Methods of synthesis: control of nanowire dimensions. Self-assembling of molecules and nanostructures. The growth and formation of self-assembled and ordered nanostructures. Fullerenes and carbon nanotubes, growth methods, control. Characterization of nanostructures. The interaction of 1D nanoparticle with substrate. Application of nanomaterial in biotechnology, spintronics and photonics, cosmos, medicine and sensors fabrication	12						**12**	**12**	Repetition for exam.
5. **0D structures. Nanoparticles**. The mechanisms of seeds formation and growth - nucleation. The synthesis of nanoparticles of metals, semiconductors and oxides. Formation of porous material using coloids. Insert of nanoparticles to the solid material. Methods of introduction. Characterization of nanoparticles properties. Application in chaysis, biotechnology, optoelectronics, sensors fabrication	12						**12**	**12**	Repetition for exam.
Seminars (separate topics): Analysis of review articles on nanotechnology and nanosciences; Analysis of hybrid nanostructures Application of nanostructures in the field of environmental science and medicine			16				**16**	**24**	Analysis of the literature on the given topic, preparation of presentation and short report
Total	**48**		**16**				**64**	**76**	

Assessment strategy	**Weight, %**	**Deadline**	**Assessment criteria**
Seminars rating	50	All course	Ability to understand and accomplish the tasks during the seminars
Exam (written form)	50	During the exam session	2 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				
Bhushan, Bharat	2010	Handbook of nanotechnology		Berlin : Springer Science+Business Media
George M. Whitesides* and Bartosz Grzybowski	2002	Self-Assembly at All Scales		Science, Vol 295, p. 2418-2421
Cheng, C., Gonela, R. K., Gu, Q., and Haynie, D. T. (2005)..	2005	Self-assembly of metallic nanowires from aqueous solution		Nano Lett. 5, 175–178. doi:10.1021/nl048240q
William D. Calhslev	2001	Fundamentals of Materials Science and Engineering		John Wiley&Sons, Inc., N. Y
Stephen A. Campbell	2001	The science and engineering of microelectronic fabrication		Oxford University Press
Charles P. Poole, Jr., Frank J. Owens	2003	Introduction to Nanotechnology		John Wiley&Sons
Optional reading				

Chris A. Mack	2007	Fundamental principles of optical lithography– the science of microfabrication		John Wiley and Sons