COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
New materials and technologies	

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, laboratory works	I (autumn) Semester	Lithuanian/English

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

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
10	280	80	200

Purpose of the course unit (module): programme competences to be developed		
To provide the knowledge and skills of materials engineering and advanced growth technologies. To realize the peculiarities of fabrication and processing of micro- and nano- optoelectronic devices		
Learning outcomes of the course unit (module)	**Teaching and learning methods**	**Assessment methods**
Student's ability to apply basic knowledge in technological processes of advanced materials growth and characterization. Ability to improve the practical skills. Knowledge of the operating principles of various technological methods	Lab works, visit and practice in the technological cleanroom, team discussion	Oral questioning, assessment of practical skills
Ability to understand scientific literature, to exchange the information and to present the results. Ability to perform comparisons of materials of different categories and to analyse their application, taking into account various physical processes and phenomena occurring during the production (construction). Ability to use material parameter and data catalogs, manuals, calculations and formulas	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
Deepening of theoretical knowledge for materials engineering. Ability to understand the technical literature. Ability to interpret and apply knowledge. Understanding the problems of materials engineering and generating of possible solutions	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	**Contact hours**	**Self-study hours**	**Assignments**
1. **Introduction.** Basics of materials science and technology. Micro- and nanoscale technology, history, concepts of routes and technological operations. Work safety and ecology problems. Classification of materials	4						**4**	**4**	Repetition for exam.
2. **Mechanisms and kinetics of phase transformation**. Mechanical properties of materials. Phase diagrams, their formation. Phase diagrams of multicomponent compounds. Diagram interpretation and application for monocrystals and thin layers growth	6						**6**	**20**	Repetition for exam.
3. **Methods of crystals growth**. Self- and heterogeneous formation of crystal seeds, crystal growth and structural defects. Physical chemical analysis methods. Crystal growth methods. Peculiarities of crystal growth of elemental and complex materials. Methods of crystal growth: Czochralski, Bridgman and zone melting. Principles, peculiarities, applications. Glass and glass compound technology. Processing and application aspects of bulk crystals	6						**6**	**18**	Preparation for laboratory works. Repetition for exam.
4. **Doping of crystals.** Diffusion in crystals. Fick laws	6						**6**	**24**	Repetition for exam.
5. **Methods of manufacturing semiconductor, dielectric and conductive layers**. Initiating processes in layers. Nucleation. Types of layer formation and growth. Types of layers: epitaxial, polycrystalline and amorphous layers	6						**6**	**16**	Repetition for exam.
6. **Chemical technologies of thin layer production**. Classification of reactions. Gas epitaxy, chemical deposition using metallo-organic sources	6						**6**	**16**	Repetition for exam.
7. **Physical thin layer technologies**. Thermal evaporation, electron beam deposition. Peculiarities of coating of metal layers. Laser and magnetron deposition. Peculiarities of growth of oxides and multi-component layers. Epitaxial technologies. Molecular beam epitaxy. Homoepitaxy and heteroepitaxy. Heterogeneous compounds and structures. Nanoscience and nanotechnologies	6						**6**	**18**	Preparation for laboratory works. Repetition for exam.
8. **Modern technologies of photovoltaic cells**. Peculiarities of thermal evaporation of multicomponent solar cells. Production of photovoltaic cells by magnetron sputtering using multiple sources. Formation of the crystalline structure by ex-situ annealing process. Routes for forming photovoltaic contacts	8						**8**	**20**	Repetition for exam.
Seminars (separate topics): • Analysis of review articles on material engineering;			16				**16**	**16**	Analysis of the literature on the given topic, preparation of

• Analysis of examples of materials engineering; • Material engineering in the field of photovoltaics									presentation and short report
Lab works: • Thin layer deposition technologies 1. Deoxidation of GaAs substrate in MBE reactor 2. GaAs homoepitaxy using MBE technique 3. Growth rate evaluation from reflection of high energy electron diffraction intensity oscillations 4. Characterisation of optical and electrical properties of GaAs layers					16		**16**	**24**	Preparation for laboratory works, writing of reports
Total	**48**		**16**		**16**		**80**	**200**	

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				
I.Šimkienė	2008	Moderniosios medžiagų technologijos		Vilnius, VU leidykla
A.Kvedaravičius, R. Navickas	1987	Silicio integrinių schemų gamybos vadovas		Vilnius, Mokslas
David A. Glocker and S. Ismat Shah	1995	Handbook of thin films process technology		Philadelfia, DA1906
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
T. Markvart, L. Castañer	2005	Solar cells: materials, manufacture and operation		Elsevier Advanced Technology
Bhushan, Bharat	2010	Handbook of nanotechnology		Berlin : Springer Science+Business Media
Optional reading				
Chris A. Mack	2007	Fundamental principles of optical lithography– the science of microfabrication		John Wiley and Sons
J. Poortmans, V. Arkhipov	2006	Thin film solar cells: fabrication, characterization and applications		John Wiley and Sons