COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
Solid-State Lighting Technology	

Lecturer(s)	Department(s) where the course unit (module) is delivered
Coordinator: Dr. Pranciškus Vitta **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, lab-works	III (autumn)	Lithuanian/English

Requirements for students	
Prerequisites: Knowledge of general physics (optics and electricity) and solid-state physics or semiconductor physics at the level of first-cycle studies in physics or engineering	**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

Introduction of students to the rapidly developing technology of solid-state lighting and at the preparation for research and development, as well as for industrial activity in the field of optoelectronics. Todevelop competences such as: to apply the knowledge of solid-state physics. calorimetry and semiconductor engineering for practical development of solid-state lighting sources and systems; to analyse scientific (publications, conference proceedings) as well as industrial (patents) literature.

By the end of the course the students are expected to understand the principles of operation of LEDs, to have knowledge on materials systems, structures, and properties of LEDs, the main fields of the application of solid-state lighting (signage, displays, measurements, plant growth, phototherapy, and general lighting), and to be able to measure the main optical, electrical, and thermal parameters of LEDs and to apply solid-state lighting technology in practice.

Learning outcomes of the course unit (module)	Teaching and learning methods	Assessment methods
Ability to apply the theoretical knowledge of solid-state physics for the investigation of devices and systems of optoelectronics in order to reveal the reasons of raised problems as well as search of possible solutions.	Lab-works	Control questions, assessment of the ability to present and validate the measurement results and conclusions.
Ability to search and anise modern scientific and industrial literature (publications, proceedings, patents) of specific individual topic.	Seminars, investigation methods.	Presentations (2).
Theoretical knowledge of solid-state llighting and physics, necessary for practical problem solving; Ability understand proefeesional literature,	Lectures	Two intermediate tests and final exam presentation with discussion.

knowledge exchange, present the results.		

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. Light and colours. Optical radiation, radiometric, photonic, and photometric quantities and units. Spectrum and colour of light, colour difference, and colour rendition.	4							**5**	
2. Evolution of light sources. Before electricity, electrical lamps, evolution of LEDs.	3							**5**	
3. Recombination of nonequilibrium carriers. Radiative and nonradiative recombination, recombination time constant and internal quantum efficiency	3		1					**10**	
4. Injection of nonequilibrium carriers. Injection of minority carriers in p-n diode, injection in double heterostructure and quantum wells, tunnelling injection. Injection efficiency, voltaic efficiency and optical refrigeration	3		1					**10**	
5. Materials for LED chips. Requirements for materials for LED chips.. GaAsP, AlGaAs, AlInGaP and AlInGaN materials systems. Technology of compound semiconductors (growth of bulk crystals from melt, liquid-phase epitaxy, vapour phase epitaxy, metalorganic chemical vapour deposition, molecular beam epitaxy).	5		2		4			**25**	Preparation for lab-works, development of reports.
6. Design of LEDs. Feeding of LED chips. Heat management. Light extraction. LEDs with rectangular chips. High-extraction technologies. Photon mode engineering.	5		2					**20**	
7. White solid-state light sources. Obtaining white light using colour mixing. LEDs with partial and complete conversion in phosphors, single-chip semiconductor and multichip light sources.	5		2		4			**25**	Preparation for lab-works, development of reports.
8. Power supplies of LEDs. Resistive and electronic ballasts, switching converters. Pulsed driving, pulse width modulation, driving with photoregulation.	4		2		4			**25**	Preparation for lab-works, development of reports.
9. Parameters of LEDs and measurement of those. Spectral and colour parameters, output characteristics, electrical parameters, frequency response, thermal properties, lumen maintenance.	4		2		4			**25**	Preparation for lab-works, development of reports.
10. Optical measurements using LEDs. Stability and noise of LEDs. Measurements of optical transmittance, luminescence, and luminescence decay time. Raman scattering, surface-plasmon resonance sensor, low-coherence interferometry,	4							**20**	

photoreflectivity.									
11. Optical communication. Optical fibres. LEDs for fibre optical communication. Communication in open space.	3		2					**10**	
12. Applications of solid-state lighting. Nonvisual fields (plant growth, phototherapy, photochemistry, thermophotonics). Visual fields (signage, displays, machine vision, general lighting).	5		2					**20**	
Total	**48**		**16**		**16**		**80**	**200**	

Assessment strategy	**Weigh t,%**	**Deadline**	**Assessment criteria**
Evaluation of lab-works	20	During the semester	Readiness to answer theoretical questions, quality of work results description, ability to present the obtained results and conclusions.
Seminar activity	20	During the semester	Ability to accomplish individual tasks. Preparation and presentation of two reports-presentations.
Intermediate tests	30	During the semester	Two intermediate quizzes, consisting 5-10 questions for each topic/lecture.
Exam presentation	30	During exam session	Analysis and presentation of scientific literature for specific individual topic. Assessment of the particularity of analysis and discussion.

Author	**Year of public ation**	**Title**	**Issue of a periodical or volume of a publication**	**Publishing place and house or web link**
Compulsary reading				
A. Žukauskas	2008	Puslaidininkiniai šviestukai		Progretus, Vilnius,
E.F. Schubert,	2006	Light-Emitting Diodes		Cambridge Press, Cambridge
Optional reading				
A. Žukauskas, M.S. Shur, and R. Gaska	2002	Introduction to Solid-State Lighting		Wiley, New York
S. M. Sze	2002	Semiconductor Devices. Physics and Technology (2nd edition)		Wiley, New York