COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
Solid State Lasers	

Lecturer(s)	Department(s) where the course unit (module) is delivered
Coordinator: Dr. Balys Momgaudis **Other(s): assoc. prof. Rytis Butkus, Arūnas Čiburys**	Laser Research Center, Faculty of Physics

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

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
	Autumn semester	Lithuanian/English

Requirements for students	
Prerequisites: Courses of Optics, Laser Physics (or Quantum Electronics)	**Additional requirements (if any):**

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
10	**196**	**64**	**132**

Purpose of the course unit (module): programme competences to be developed		
General: training of critical thinking, ability to work in a team with members of different levels of competence. Specific: Ability to understand and explain the physical working principles of laser media, the design of complex laser systems as well as usage this knowledge in creation and construction new systems of this laser type. Understanding and ability to explain the main different working modes of laser operation and the components essential to the realization of these systems such as the working principle of electro-optical, acousto-optical and optical components commonly found within solid state lasers. Gain practical experience in working with some of the most common solid state laser systems that can be found in scientific laboratories and numerical modelling of such laser using LASCAD and WINLASE programming packages.		
Learning outcomes of the course unit (module)	**Teaching and learning methods**	**Assessment methods**
The working principles of solid-state laser systems, composition, common issues, limiting factors and related physical phenomena.	Lectures	Exam
Training of practical skills, ability to apply the theoretical and methodological knowledge in practice via identification of solid-state lasers operation problems and investigation of the laser parameters.	Laboratory work	Defense of laboratory work 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. **Introduction. Solid state laser** optical schemes, limiting parameters and benefits. Historical overview of solid-state laser development.	2						**2**	**3**	Reading of lecture notes and textbooks
2. The working principles of solid-state lasers. Methods of optical pumping. Three, four and quasi-three level laser systems. Threshold pumping power and how it relates to the spectral properties of the activator.	2						**2**	**3**	Reading of lecture notes and textbooks
3. Pumping sources. Pumping using flash and arch lamps. Diode lasers. Pumping using intermediate lasers. Pumping schemes.	2				3		**5**	**6**	Reading of lecture notes and textbooks, laboratory assignments.
4. Solid state laser materials. The essential properties of solid-state laser host matrices and activators. Crystal hosts. Glass hosts. Ceramic hosts. Activators. Non radiative transitions. Sensibilization of laser materials.	4		1				**5**	**9**	Reading of lecture notes and textbooks, laboratory work
5. Resonators used in solid state lasers. The main types of stable laser resonators. Sensitivity of stable resonators. Unstable resonators. Selective resonators. Mirrors and optical elements used to modify selectivity used in solid state laser resonators.	4		1		6		**11**	**15**	Reading of lecture notes and textbooks. Laboratory assignments.
6. Thermooptic phenomena observed in solid state laser devices. The origin of thermooptic phenomena. Cooling of rod laser media. The relation of thermooptical effects to the geometry of laser media. Thin disk and fiber laser systems.	3		1		3		**8**	**12**	Reading of lecture notes and textbooks, laboratory work. Laboratory assignments.
7. Solid state lasers based on electronic to electronic state laser transition. The most commonly used electronic to electronic state transition laser activators. Nd:YAG, Nd:glass, Cr:GSGG, Yb, Er:YAG, Ho, Cr, Er:YAG laser properties.	3		1				**4**	**7**	Reading of lecture notes and textbooks
8. Solid state laser systems based on electronic – vibronic state transition. The most commonly used laser material for electronic – vibronic lasers. Alexandrite, Ti:sapphire and Cr:LISAF lasers.	3		1				**4**	**7**	Reading of lecture notes and textbooks, laboratory work
9. The working principles of various modes of laser operation. The optical shemes of continuous wave and free running lasers. Quality swiching. Passive, active, additive impulse and Ker's lens mode locking.	4		1		12		**17**	**22**	Reading of lecture notes and textbooks, laboratory work
10. Very high power solid state laser complexes. Laser amplifiers. Chirped pulse amplification in solid state laser media.	2		1				**3**	**6**	Reading of lecture notes and textbooks
11. colour center lasers. Creation of colour center. Spectral properties of colour centers. Laser construction and parametesrs.	2		1				**3**	**6**	Reading of lecture notes and textbooks
12. Preparation for the exam								**36**	
Iš viso	**32**		**8**		**24**		**64**	**132**	

Assessment strategy	Weight,%	Deadline	Assessment criteria
Laboratory work	30	During the semester	5 laboratory works, each work is defended separately. The final mark is from 0 to 3, which add to a final course mark
Written assignment and oral presentation	20	During the semester	The written assignment and the oral presentation are graded separately. From 0 to 1. The final mark of 0-2 is added to the final course mark.
Exam	50	By the end of the course	Exam in written form, 5 questions from the whole course. Answers to each topic are marked as follows: 0 (incorrect answer), 0.5 (partially correct) and 1 (correct). All marks sum up.
Overall	100		The overall mark is the sum of the above items and is rounded. <5 below threshold 5 – weak 6 – satisfactory 7 – average 8 – good 9 – very good 10 – excellent

Author	Year of publication	Title	Issue of a periodical or volume of a publication	Publishing place and house or web link
Compulsory reading				
E. Gaižauskas, V. Sirutkaitis	2008	Kietojo kūno lazeriai (in Lithuanian)		VU leidykla, Vilnius, 290 p.
W. Koechner	2006	Solid - State Laser Engineering	6 th. Ed.	Verlag, New York, .
		Lazerių skaitmeninio modeliavimo laboratoriniai darbai		VU, Kvantinės elektronikos katedros elektroninis leidinys
Optional reading				
R.C.Powell	1998	Physics of Solid - State Laser Materials		Springer - Verlag, New York,
F.Gan	1995	Laser Materials		World Scientific, Singapore
A. E. Siegman	1986	Lasers		University Science Books, Mill Valley, CA