COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
Biomedical applications of laser-generated secondary radiation	

Lecturer(s)	Department(s) where the course unit (module) is delivered
Coordinator: Mantas Grigalavičius	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
Lecture format and online	Spring semester	English

Requirements for students	
Prerequisites:	**Additional requirements (if any):**

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
5	**140**	**48**	**92**

Purpose of the course unit (module): programme competences to be developed		
The purpose is to provide the understanding on: 1) The principles of secondary radiation generation and its applications in biomedicine; 2) The interaction of ionizing radiation with biological tissue and the choice of radiation type in case of specific treatment The competencies of master's students will be developed in the following directions: 1) Knowledge and understanding, 2) Technological analysis, 3) Technology design, 4) Research, 5) Practical activities, 6) Personal skills.		
Learning outcomes of the course unit (module)	**Teaching and learning methods**	**Assessment methods**
The principles of generating ionizing radiation with lasers and the possibilities of its use	Lectures	Cumulative score consisting of the following assessments: written exam, presentation and a short report on one of the given topics

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. **Presentation of the subject.** Assessment criteria, time scale, lecturers, lecture topics, preliminary topics of presentations and reports, the importance of interdisciplinarity in biomedicine, relevant laboratories and collaborations.	2						**2**	**2**	Reading review papers and retrieving the information from official websites
2. **Modern research-grade infrastructures hosting**	4						**4**	**2**	Reading of lecture

biomedical experiments. Available conventional facilities for production of proton, electron, neutron and photon (x-rays and gamma rays) beams.									notes and textbooks
3. **High power laser development for intense applications**. Fundamentals of laser wakefield acceleration. Laser technologies providing extreme peak and average powers.	6						**6**	**8**	Reading of lecture notes and textbooks
4. **Laser-based neutron sources**. PhotoFusion, PhotoNuclear, Laser spalliation. Targets, interactions, diagnostics.	6						**6**	**4**	Reading of lecture notes and textbooks
5. **Ionizing radiation interactions with biological matter**. Direct and indirect biological effects. Energy transfer. Relevant dosimetry and radiation safety. Hands-on computational models for microdosimetry.	6			2			**8**	**6**	Reading of lecture notes and textbooks.
6. **Background on radiation- induced cell death and main observation methods.** Apoptosis, necrosis, autophagy, immunogenic cell death.	3						**3**	**3**	Reading of lecture notes and textbooks
7. **Combined modality treatments in radiotherapy**. Application of radiosensitising compounds and nanoparticles, advances in photodynamic therapy	3						**3**	**3**	Reading of lecture notes and textbooks
8. **Presentation and report assignments**. Freely select topics			16				**16**	**32**	
9. **Preparation for the exam**								**32**	
Iš viso	**48**						**48**	**92**	

Assessment strategy	Weight,%	Deadline	Assessment criteria
Written report	20	By the end of semester	The final mark is from 0 to 2, which add to a final course mark
Report presentation	20	By the end of semester	The final mark is from 0 to 2, which add to a final course mark
Exam	60	By the end of the course	Exam in written form, 6 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				
T. Tajima et al.		Laser Acceleration. The Basic Philosophy of Laser Wakefield Acceleration	pp 1–10	https://www.physics.uci.edu/tajima/Review_Paper_Tajima_8_15.pdf
E. J. Hall et al.	2006	Radiobiology for the Radiologists. Cell Survival curves	pp 44–45	https://www.google.lt/books/edition/Radiobiology_for_the_Radiologist/6HhjwRyqBzgC?hl=en&gbpv=1&pg=PP7&printsec=frontcover

V. Ahire et al.	2023	Radiobiology Textbook. Radiobiology of Combining Radiotherapy with Other Cancer Treatment Modalities	pp 311–386	https://link.springer.com/chapter/10.1007/978-3-031-18810-7_6
Optional reading				
S. R. Mirfayzi et al.	2020	Proof-of-principle experiment for laser-driven cold neutron source	10(20157)	https://www.nature.com/articles/s41598-020-77086-y

Invited speakers
Karoly Osvay, Hungary (Laser-based neutron sources) Kevin Ching Wei Li, Norway (Hands-on computational models for microdosimetry) Rimantas Budriūnas, Lithuania (High power laser development for intense applications)