Course title	**Laser physics**
Course code	Fizi5032
Scientific field	Physics
Scientific subfield	
Credit points	2
ECTS credits	3
Total contact hours (CH) *Number of hours for lectures* *Number of hours for seminars and practical assignments* *Number of hours for laboratory assignments* *Number of hours for course paper*	32 16 16

Course developer (-s)
Dr.phys., professor Antonijs Salītis

Prerequisite knowledge (course title, part of the program where the course is learnt)
Optics, electromagnetism

Course abstract:

Learning outcomes:

After accomplishing the course, students:

- understand and can describe the processes of spontaneous and stimulated emission of light;
- can identify and describe the function of the components of a laser;
- can apply knowledge in problem-solving and demonstrate it in presentations and seminars;
- demonstrate the ability to plan and conduct research, analyze and explain problems of physical content;
- can apply knowledge in problem-solving, demonstrate it in presentations and seminars,
- have developed and strengthened the skills needed for further studies - physical experimenting measuring and problem solving;
- can analyze, summarize and evaluate the theoretical knowledge and experimental skills and are able to apply them in physical content studies.

Course content:

Origins of Planck and Einstein's quantum theory. Spontaneous and induced radiation. Maser and laser realization. Resonators, active environmental and radiation dynamic parameter management. Q-modulation, synchronization module (ML), Kerr lens ML, pulse compression techniques. Lasers for telecommunications, research, medical and material handling industry. Semiconductor lasers and solid-state lasers - trends. Economic aspects of laser technology. Calculation and measurement of laser beam parameters. Fresnels equations. Eye and safety with lasers. Physical limitations of laser. Lasers in school physics course.

Course plan:

Course structure: Practical assignments -16 CH. Laboratory assignments – 16 CH.

1. Overview of Optics. Geometric Optics. Nature of Light. Planck’s and Einstein's quantum theories.
2. Spontaneous and stimulated radiation. Population inversion. Optical and electrical pumping schemes.

3. Realization of maser and laser. Optical generation of light quanta. Laser resonators. Longitudal and transversal modes of generation.
4. Continuous wave and pulsed wave laser output. Kerr lens modelocking.
5. Solid-state lasers: ruby laser, Nd lasers, non-linear crystals and optical fiber lasers.
6. Atomic gases and vapor lasers: He-Ne, Ar +, Cd +, Cu lasers. Molecular and chemical gases lasers. Dye lasers and solid-state lasers with adjustable wavelengths. Semiconductor diode and free electron lasers.
7. Laser safety. Main risks in working with laser.
8. Laser applications - 3D scanner. Practical assignment.
9. Spectral characteristics of laser radiation. Multi-mode and single-mode operation. Stabilization of the frequency.
10. Laser beam parameters. Gaussian beam, diameter and depth of focus of the beam.
11. Measurement of laser beam parameters. Practical assignment.
12. Applications of laser (industry, medicine, etc.)
13. Basics of industrial laser treatment. Practical assignment.
14. Laser beam interaction with matter. Holography.
15. Basics of holography recording. Practical assignment.
16. Discussion on practical assignments results. Summary of the course. Evaluation.

Individual work: study of theoretical questions, solving home exercises and tests.

Requirements for awarding credit points:

1) attendance and participation - 20%
2) preparation and presentation of two chosen topics - 20%
3) problem solving - 30%
4) practical assignments -30%

Compulsory reading:

1. 1. O. Svelto. Principles of Lasers, 4th ed., Plenum Press, NY-London, 1998.
2. 2. W. T. Silfvast. Laser Fundamentals, Cambridge University Press, 1996.
3. 3. Lāzeru fizikas praktikums – metodiski norādījumi (J. Spīgulis, M. Tamanis, J. Kļaviņš, I. Klincāre). – LU FMF, 1999.