Laser physics, SK2411

7.5 points

Course description

The course is aiming at giving general understanding of lasers and laser components and their function in the laser. Furthermore, to prepare students in atomic and molecular physics, quantum optics and physical optics for work in research and technology.

Learning outcomes

After the course the student should be able to:

1. Apply physical *principles* for explaining how light amplification and laser action is obtained in different material systems. (LO1)
2. Apply laser engineering principles to design and analyze laser parameters in the context of a particular application. (LO2)
3. Obtain, analyze and present experimental data, within the scope of the goals of lab practice, and complying with the lab safety requirements and rules of conduct in a given lab environment. (LO3)

Main content

- Essentials of quantum-mechanical description of optical gain media, including atoms, molecules, and solid-state materials.
- Essentials of quantum-mechanical description of the interaction between photons and electrons in optical gain media.
- Basic properties of lasers and photon amplifiers.
- Physical principles of laser action.
- Essential knowledge of laser building blocks.
- Overview of the most important laser types.

Course pedagogic layout

Lectures: 24 hours, Exercises: 12 hours. Labs: 6 hours.5 Homeworks.

Examination and grading criteria

Written exam. Grading: A/B/C/D/E/Fx/F
Lab report grading: P/F

FX: Almost fulfilled requirements for E.

E: Performed lab practice (learning outcome 3 (LO3)); understanding of basic principles of laser action and essential laser material parameters (LO1); identification of relevant laser parameters (LO2).

D: Fulfilled criteria for E and partially for C.

C: Performed lab practice (learning outcome 3 (LO3)); understanding of laser operation in different materials (LO1); ability to perform laser parameter analysis and relate to particular applications (LO2).

B: Fulfilled criteria for C and partially for A.

A: Performed lab practice (learning outcome 3 (LO3)); analyzing laser operation in any material system (LO1); ability to design and analyze laser parameters for different applications (LO2).

Instruction language

English.

Course literature

Orazio Svelto, Principles of Lasers, Fourth edition, or later (Translation by David. C. Hanna) Kluwer Academic/Plenum Press, Springer (1998 or later) ISBN 0-306-45748-2

Recommended previous knowledge

Courses in general physics, electromagnetic waves, quantum mechanics, physical optics.

Examiner

Prof. Valdas Pasiskevicius, Applied Physics, SCI, KTH.

Contents of lectures

1	Ray and wave propagation, modes of electromagnetic field
2	Optical resonators
3	Properties of laser beams
4	Introduction, background, history and applications. Interaction of radiation with atoms and ions
5	Essential spectroscopic characteristics of atomic and molecular media
6	Semiconductors as laser gain material
7	Population inversion, pumping processes
8	Continuous wave lasers
9	Transient laser behavior, Q-switching, mode-locking
10	Types of lasers: solid state, fiber, semiconductor
11	Transformation of laser radiation: Laser amplifiers. Introduction to nonlinear optics
12	Types of lasers continued. Summary of the course

Course digital planform

Canvas.