Lasers: theory and modern applications

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Summary
This course gives an introduction to Lasers by both considering fundamental principles and applications. Topics that are covered include the theory of lasers, laser resonators and laser dynamics. In addition to the basic concepts, a variety of interesting laser systems and applications are covered.

Content
1. Introduction (Overview: History of the laser, Market application, Nobel Prizes,)- demo laser printer.
2. Basics of resonators and Gaussian beam optics.
5. Semiconductor and photonic nanostructured lasers
7. (Gas and ) Solid state lasers Optical fibers
8. Fiber laser and amplifiers Optical fibers
9. Ultrafast lasers, Femtosecond laser Frequency Metrology, Mode locked lasers, autocorrelation, FTIR
10. Ultrafast lasers, Femtosecond laser Frequency Metrology, Mode locked lasers
11. Detection of laser light (detector basics)
12. Optical parametric oscillators (OPO), Raman Lasers
13. Tools of laser light manipulation

Learning Prerequisites
Important concepts to start the course
This course requires an understanding of introductory physics in wave theory (incl. complex numbers) and familiarity with Maxwell equations and electromagnetism.

Learning Outcomes
By the end of the course, the student must be able to:
- Able to compute absorption cross-section
- explain in details YAG, He-Ne, Ti-saphirre, external cavity lasers, fiber lasers
- Know shot and thermal noise, laser linewidth, relaxation oscillation
- know passive and active modelocking, methods to characterize pulse duration
- Know phase matching, method to obtain phase matching
- know parametric gain, singly and doubly resonant lasers

Teaching methods

2 hours of class + 1 hour of exercises
Part of the class will be given via MOOC videos.

**Assessment methods**

Written exam.
Homework will be given every week. Solutions will be handed out. Homework will not be graded. It is strongly advised to make the effort to do the homework weekly.

**Resources**

**Bibliography**
Main text book:
Milonni, Eberly "Laser Physics" (Wiley Interscience)
Additional chapters will be selected from:

**Ressources en bibliothèque**
- Quantum Electronics / Yariv
- Fundamentals of Photonics / Saleh
- Optical Electronics in Modern Communications / Yariv
- Laser Physics / Milonni

**Notes/Handbook**
Polycopié:
"Theory and applications of lasers" by Tobias J. Kippenberg and Christophe Moser (available as pdf on Moodle)