IF2651 Quantum Electronics 7.5 credits

Kvantelektronik

This is a translation of the Swedish, legally binding, course syllabus.

If the course is discontinued, students may request to be examined during the following two academic years

Establishment

Course syllabus for IF2651 valid from Autumn 2008

Grading scale

A, B, C, D, E, FX, F

Education cycle

Second cycle

Main field of study

Physics

Specific prerequisites

The course is designed for students having followed introductory courses in Optics, Electromagnetic Field Theory, and preferably some background course in Quantum Mechanics.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

The foundations of what we are seeing today in terms of optics and photonics technology stems from the last few decades of research on lasers, non-linear optics and semiconductor physics; the collective terminology for these fields being Quantum Electronics.The aim of the quantum electronics course is to provide a basis in modern quantum electronics, ranging from electromagnetic fields and propagation, to the interaction of light and matter, and its application in linear and nonlinear optical systems. Since there are some other courses to follow that will deal more specifically with laser diodes and fiber optics, the present course will not treat these issues in any great detail. After the course you should be able to1. Describe the basic knowledge of electromagnetism and quantum mechanism required for quantum electronic/optical devices.2. Explain the principles and mechanism behind the modern optical laser system. 3. Describe the concepts of nonlinear optics. Apply your knowledge to explain the related nonlinear phenomena, such as second harmonic generation, parametric amplification, and four waves mixing.4. Identify basic semiconductor materials for quantum electronic/optical devices. Describe the basic physical properties of these materials and their corresponding applications for fundamental optical devices. 5. Apply your knowledge to model and design optical resonator systems, in particular, for applications related to lasers or optical spectrum analyzer. 6. Implement the coupled mode theory to model the wave coupling phenomena in wave-guiding structures. With your knowledge, you should be able to design simple coupler devices, such as, a co-directional waveguide coupler. 7. Read and survey the engineering literature on the subject, such as IEEE Journal of Quantum Electronics.

Course contents

The course will consists on lectures and exercise classes on the following topics: Optical resonators, temporal coherence, interaction between radiation and atoms, laser oscillation, nonlinear optics, light modulation, coupled mode theory, semiconductor optoelectronics, and modern quantum optics. The topics are all covered in the course literature

Course literature

Optical Electronics in Modern Communications, ISBN ., Amnon YarivUpplaga: 5:th edition Förlag: Oxford University Press År: 1997ISBN: 0-19-510626-1

Examination

- PRO1 - Project, 2.5 credits, grading scale: P, F
- TEN1 - Examination, 5.0 credits, grading scale: A, B, C, D, E, FX, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

Other requirements for final grade

Course examination method The course has two types of assessments: home assignments and a project with presentation. Home assignments: You will be given five sets of home assignments, each containing two questions related to the course lectures and the book. You must hand in your solutions (handwritten, not electronically written) for the each assignment two weeks after they have been handed out. Failure to hand them in on time will result in a 0.5 (of two) point reduction of the grade for that exam for each week of delay. The problems will be corrected and returned to you the 1-2 weeks after. You can discuss on the problems with each others, but you must solve the questions and represent the solutions INDIVIDUALLY. Project report & presentation: The task is first to write a (maximum) 5 page report on one of the research papers listed on the course home page. You can work 2 persons on the project. The report should contain the following:1) Explain the central idea/concept discussed in the paper2) From the two central equations given in the paper try to give a physical proof and discussion concerning the validity of the equations, how they are derived and the consequences.3) Discuss the consequences of the paper, and how it has influenced the work in the area that has followed.4) (applicable if two persons working on the project) A short description of individual contributions to the project report. Your report should be written using your own words! Do NOT "cut and paste" from INTERNET (this we will find out), and it will not be accepted. Please select the paper before the second lecture. The report should be written in MS Word or LATEX and handed in electronically latest one week after all our lectures. After submitting the report, each group shall give a 10 minutes presentation, plus another 2 minutes for questions from the audience. The scheme/dates will be discussed with you and posted on the course homepage. The presenter of each group will be chosen randomly by the course examiner, while the other one will be responsible for answering questions.Each group will be asked to mark for other groups' presentations using a provided presentation evaluation sheet (see the last page, also on the course homepage). Criteria of grading are given in the presentation evaluation sheet, which includes for instance, presentation skill, substance, originality, and so on. The grading is from failed, 3, 4 or 5 according to a scheme given in the course PM.

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.