Course analysis: SK2902 Light-Matter Interaction, 2020/2021 academic year, period 3, Oct. 2020 – Jan. 2021

Course data

Credits: 7.5 hp
Obligatory course for the Optics/Photonics track in the MSc programme in Applied Physics
Course teachers: Valdas Pasiskevicius and Saulius Marcinkevicius
Course assistants: Patrick Mutter and Kjell Mølster.

Quantitative data

Number of students: 4.
Result: 100% (Percentage of those who successfully finished the course).
Grades: A - 1, B - 1, C - 1, D - 1.
The final course result was assessed by considering two lab reports (obligatory), five homework solutions with a weight of 25% and exam results with a weight of 75%.

Course purpose:

The course was given for the second time after reorganisation of the Optics/Photonics track in the MSc programme in Applied Physics. The purpose of the course is to provide basic knowledge on light interaction with atoms, molecules and solid-state media that is further used in more specialised courses of the programme. In that way, teachers of these specialised courses do not have to repeat the basics, and the teaching process can proceed in a more efficient way.

Course implementation

The course consisted of 12 lectures, 5 problem solving sessions (led by the course assistants) and two labs. After each problem a set of homework problems was given.

The primary course textbook was M. Fox, Optical Properties of Solids (Oxford, 2010). Chapters from M. Fox, Quantum Optics (Oxford, 2010) and W. Demtröder, Atoms Molecules and Photons (Springer, 2010) were also used.

The course covered a broad number of topics. The basics include light interaction with a damped linear oscillator, the concepts of light absorption and emission, Einstein coefficients, homogeneous and inhomogeneous broadening. These general concepts were applied for the analysis of light interaction with single and multi-electron atoms, and molecules. Light interaction with solid-state materials, primarily semiconductors, was analysed. In this area, light interaction with different particles and quasi-particles, such as electrons, holes, excitons, phonons, plasmons and polaritons was explored. Peculiarities of light emission and absorption on quantum-confined structures (quantum wells, quantum dots) were discussed. The course primarily dealt with the linear optical properties; however, some basic quantum and nonlinear properties were also introduced, often using quantum dots as a model structure.

During the exercise sessions, students were encouraged to solve exercises relevant to the course. In addition, solutions prepared by the teachers were explained. Homework tasks were aligned with the problems solved in class. In order to give a prompt feedback, the problems were corrected until the next lecture. Homework bonus points were given for some complex derivations omitted during the lectures.

The two labs were arranged in research labs using advanced scientific equipment (femtosecond lasers, a streak camera, etc.) and were used to illustrate concepts discussed in the course (e.g. measurement of photoluminescence spectra and dynamics in different semiconductor materials, THz spectroscopy). This is an important activity showing how theoretical concepts discussed during lectures work in "real life" and encouraging students to pursue career in research. However, due to a few cases of the covid-19 illness that occurred during the second part of the course, the labs did not take place. Instead, data taken by the teachers were provided to the students for analysis.

The students approached the homework and lab tasks very seriously: not a single homework problem was missed by a single student. Attendance of course meetings was also close to 100%. Overall, the class showed a very serious attitude when taking this course. Most of the lectures and exercise sessions took place in the classroom. Only the last three lectures and two exercise classes, due to the covid-19 situation, via zoom.

Exam contained 8 problems to be solved during 5 exam hours. To meet the grading criteria, the problems were of different difficulty, where solution of the basic level problems was sufficient for the lower grades, while more advanced problems demanding creative thinking were required for the highest grades. The students solved the exam problems at home during the strictly controlled exam duration.

Changes for the next year

Hopefully, in 2021 the teaching will take place entirely in the classroom and labs, not via internet.

Student survey and course evaluation

A student survey was handed out during the exam. Three of four students responded. The answers could have been provided in a semi-quantitative (yes, more yes then no, more no than yes and no) form with a possibility to comment. Typical questions/statements were: the course was useful for my education; the labs were useful part of the course; the exercise sessions were productive; the lecturers devoted time to answer questions, etc. All but a few student answers fell into the first two categories, none was in "no" and “more no than yes”. Students acknowledged learning new concepts that they were not aware before. The only complaint was that one of the labs that was changed from “live” to data analysis was not accompanied by a video that shows how the data were taken.