LUND UNIVERSITY

Faculty of Science

FYST28, Physics: Laser-based Combustion Diagnostics, 7.5 credits

Fysik: Laserbaserad förbränningsdiagnostik, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2007-06-14 to be valid from 2007-07-01, autumn semester 2007.

General Information

The course is an elective course for second-cycle studies for a scientific candidate or Master's degree (120 credits).

Language of instruction: English and Swedish
If needed, the course is given in English.

Main field of studies	*Depth of study relative to the degree requirements*
Physics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Learning outcomes

The aim of the course is that students should have acquired the following knowledge and skills on completion of the course:

Knowledge and understanding

On completion of the course, the student should be able to

- explain the background physics to the laser-based measurement methods treated in the course.
- analyse possibilities and limitations for these laser-based methods.
- describe advantages and disadvantages with these laser-based methods compared with probe methods.

Application and assessment

On completion of the course, the student should be able to

- analyse a given measurement problem and through calculations choose lasers, optical components and detectors.
- design and build a simple experimental arrangement.
- calculate parameters as temperature, concentration and velocity from given measurement values.

Ability to communication

After passing course, the student should be able to

- write laboratory reports with adequate analysis of measurement data and discussion of sources of errors.
- summarise a scientific paper within laser-based diagnostics and present it orally.

Learning skills and information competence

On completion of the course, the student should be able to

- absorb the essential information in simple scientific articles and an advanced English textbook.
- solve assignments that require use of information from other sources than the course material, e.g. earlier courses within laser/optics-area.

The aim of the course

The course intends to give a basic physical understanding of the potential of laser diagnostic methods to non-intrusively measure parameters as e.g. temperature and species concentrations in combustion processes. Central elements in the course are thereby interaction between radiation and matter, lasers and their properties, optics, optical measuring technique, molecular physics and combustion. The unique information that can be received from combustion processes with laser diagnostics can together with advanced modelling lead to a detailed knowledge of combustion processes. Such understanding is important to increase efficiency with lower concentrations of contaminants, which are important in view of the fact that combustion processes contributes to more than 90% of the energy supply of the world.

Course content

The course consists of 4 subparts:

In the initial part of the course, subjects are presented and discussed that for students with different background can imply different grade of specialisation and repetition. The fields that are treated are molecular spectroscopy, statistical physics, combustion and experimental equipment for laser-based combustion diagnostics. Comparison is made between probe methods and optical methods of measurement. A detailed overview of the laser techniques that are most important for combustion studies is given. These are mainly Rayleigh scattering, Raman scattering, laser-induced incandescence (LII), laser-induced fluorescence (LIF), coherent anti-Stokes Raman scattering (CARS), and particle-image velocimetry (PIV). The technologies are discussed from their physical background and the analysis of measurement data that

take place to decide relevant combustion parameters such as temperatures, species concentrations, particle properties (e.g. sizes), and velocities. Emphasis is placed to analyse possibilities and limitations for the methods.
The scientific articles that the students should process in the project should be nearest the research area and highlight expansions of the already presented technologies. Orientation takes place also about new technologies that are developed within the research field. During the course, regular visits in laboratories for demonstration of the course sections take place.
Laboratory sessions take place on laser-induced incandescence and laser-induced fluorescence. The laboratory session in laser-induced incandescence treats measurement of soot volume fraction in sooting flames and the laboratory session in laser-induced fluorescence concerns two-dimensional visualisation of flame radicals such as the OH-molecule. Both the laboratory sessions are relatively student-centered where the students perform alignment/optimisation of the experiment set-up.

Course design

Type of instruction. The teaching consists of lectures, laboratory sessions, project work, exercises and written assignments. Participation in laboratory sessions, project work and thereby integrated other teaching is compulsory. Several different teaching methods are used. Lectures summarise and clarify the section of the textbook. Self-study of the textbook takes place by means of reading instructions. Exercises give possibility for the students to work with practical assignments and ask teachers and other students. Laboratory sessions give students training in experimental work and to summarise a study in a technical report. Demonstrations illustrate course sections and facilitate learning. Written assignments train the student in problem-solving and stimulate learning through imposed processing of the course material. In the project, the student studies a scientific article in the research area of the subject and summarise it both orally and in writing. The feedback to the student on the work that is made with written assignments, the laboratory report and the project is an important part of the student's learning process.

Assessment

Examination. To pass the course, certain credits must be reached on examination at the end of the course, laboratory sessions, written assignments and projects. Examination, most often written, consists mainly of assignments of a general nature where the student's ability to create synthesis of the course material is tested. The two laboratory sessions are summarised individually in a technical report that is written individual or in a group of two. The assessment is made from preparatory assignments, commitments under the laboratory session and the quality of the written report. Compulsory written assignments are treated during the course. The assessment is made based on the effort the student makes to process assignments and absorb this knowledge. Students who do not pass the regular exam are offered a new possibility shortly after the regular exam. Retake is normally a written examination that is followed in direct connection up of an oral test, where the issues from the written examination are deepened.

Subcourses that are part of this course can be found in an appendix at the end of this document.

Grades

Marking scale: Fail, Pass, Pass with distinction.
To pass the entire course, approved examination, approved laboratory reports, passed written assignments, passed project report and participation in all compulsory parts are required.
The final grade are received through weighting of the results of examination (50%), written assignments (25%) and laboratory sessions (25%).

Entry requirements

For admission to the course is required:

English B

FYSA31, Physics 3, Modern physics, 30 credits or the equivalent.

Subcourses in FYST28, Physics: Laser-based Combustion Diagnostics

Applies from V08

0701 Laser-based Combustion Diagnostics, 7,5 hp
Grading scale: Fail, Pass, Pass with distinction