Course syllabus

Laserbaserad diagnostik
Laser-Based Diagnostics

FBRN05, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED F/Pi
Date of Decision: 2023-04-18

General Information

Elective for: F4, F4-f, MFOT1
Language of instruction: The course will be given in English on demand

Aim

The aim of the course is to provide a fundamental understanding (based on physics) of the potential for laser-based techniques to non-intrusively measure parameters such as species concentrations and temperatures under harsh conditions, such as reacting flows and energy conversion processes. Of central importance is interaction between radiation and matter, lasers and their characteristics, optics, optical measurement techniques, molecular physics and combustion. The unique information that can be obtained from laser diagnostics techniques can together with advanced modelling lead to improved detailed knowledge in field relevant to the industry and transport sector. Typical areas can be high temperature chemistry and use of renewable fuels. Such understanding is highly important to improve efficiency and decrease harmful emissions, which is of global importance since 90% of the energy usage in the world can be related to combustion processes. Also after a transition to renewable energy sources, combustion will be an important tool for converting chemical energy into heat.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to explain the physics behind the laser-based methods treated in the course.
- be able to analyse the possibilities and limitations for these laser-based methods.
- be able to describe the advantages and disadvantages for laser-based methods in

comparison with other methods.

Competences and skills
For a passing grade the student must

- be able to analyse a problem and through calculations choose lasers, optical components and detectors.
- be able to design and build a simple experimental setup.
- be able to calculate parameters such as temperature, species concentration and velocity from given measurement data.
- write reports from laboratory exercises with thorough analysis of measurement data and discussion about uncertainties.
- be able to write an extended abstract of a scientific paper in the laser diagnostic area and present it orally.
- be able to assimilate the important information in scientific papers of more basics character and in an advanced English text book.
- be able to solve problems with help from other sources than the course material, for example previous courses within the laser/optics area.

Contents

In the initial part of the course some topics are presented and discussed which for students with different backgrounds will mean repetition and extension to different degree. The areas that are treated are molecular spectroscopy, combustion and experimental equipment for laser-based diagnostics. Comparison is performed between probe methods and optical methods. A detailed discussion is made of the most important methods for applied diagnostics. They mainly include Rayleigh scattering, Raman scattering, laser-induced incandescence, laser-induced fluorescence, coherent anti-Stokes Raman spectroscopy, particle-image velocimetry and thermographic phosphors. The techniques are discussed from their physical background and the analysis of measurement data performed for evaluation of relevant parameters such as species concentrations, temperature, velocities, particle properties, etc. Emphasis is put on identifying the potential and the limitations of the techniques.

The scientific papers studied by the students in their projects should be close to the front line of research and present extensions of the already discussed techniques. Orientation about new techniques developed within the research field is made. Frequently during course demonstrations are made in the research laboratories of the division to illustrate different parts of the course.

The laboratory exercises are laser-induced incandescence(LII) and laser-induced fluorescence (LIF). The laboratory exercise on LII treats measurements of soot concentrations in reacting flows, and the one in LIF treats visualisation of radicals in gas phase. Both exercises are relatively student-oriented where the students take relatively big part in the alignment and optimisation of the experimental setup.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: To pass the course the student must pass the written examination, the laboratory exercises and the project. The grade is dictated by the examination result. The written examination tests the students ability to synthesize the course material. For the

exam, understanding the course content is more important than memorizing. The work on the laboratory exercises are summarized in technical reports, written by a single student or in a group of 2. The grading is based on preparatory exercises, engagement during laboratory exercise, and the quality of the technical report. The voluntary exercises assist the student in understanding and assimilating knowledge. In the project work the student analyzes a scientific paper which is summarized and presented orally for the other students in the course. Re-examination is scheduled after discussion with the responsible teacher, and is normally a written examination directly followed by a discussion where the questions from the written examination are penetrated in greater depth.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Admission

Assumed prior knowledge: FAFN01 Lasers and FAFN25 Atomic and Molecular Spectroscopy.
The number of participants is limited to: No
The course overlaps following course/s: FBR024, FBRN01

Reading list

- Eckbreth, A.C: Laser Diagnostics for Combustion Temperature and Species, Gordon and Breach, 1996 and additional text.

Contact and other information

Course coordinator: Mattias Richter, mattias.richter@forbrf.lth.se
Course homepage: http://www.forbrf.lth.se