LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Turbulent förbränning
Turbulent Combustion

MVKN85, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED M
Date of Decision: 2023-04-11

General Information

Elective for: F5, M4
Language of instruction: The course will be given in English

Aim

The objectives of this course are to give a fundamental understanding of turbulent combustion process found in typical combustion devices; to give basic knowledge about the structures of the reaction zones in turbulent flames and how turbulence and the reaction zones affect each other; and to develop skills to analyze and model turbulent combustion processes in engineering combustion devices.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to describe the basic transport processes involved in combustion processes, i.e., transport of mass, momentum and energy
- be able to describe basic chemical reactions involved in combustion, i.e., chain initiating, branching and terminating reactions and the effect of temperature and pressure on these reactions
- be able to analyze basic flame structures in premixed flames, diffusion flames, and partially premixed flames, and explain different mechanisms of turbulence eddy and flame interaction
- be able to describe different modeling approaches for turbulent combustion, and propose and apply relevant models for typical engineering turbulent combustion processes

Competences and skills
For a passing grade the student must

- be able to use the knowledge of elementary reactions to determine, for typical premixed flames, the flame propagation properties, i.e., lean and rich flammability limits, burning velocity, quenching distances
- be able to use flamelet theory to determine, for typical jet diffusion flames, the flame quenching conditions, and to explain the process of flame stabilization by the burner rim, the bluff body and the inflow swirl
- be able to use relevant models to determine the composition and temperature of gaseous mixture in the reaction zones and post-flame zone of premixed turbulent flames
- be able to determine the regimes of turbulent premixed and diffusion flames based on turbulent eddy scales and flame scales
- be able to in groups, under the supervision of teachers, use the theory and models discussed in the course to predict and analyze typical turbulent combustion processes found in gas turbines, piston engines and furnaces

Judgement and approach
For a passing grade the student must

- be able to actively participate the discussions about turbulent combustion processes
- be able to in both written and oral form, present analysis of turbulent combustion processes in typical engineering devices

Contents

The course starts by going through fundamental knowledge of thermo-chemistry, chemical kinetics, transport processes and fundamental equations for turbulent reacting flows. Then, laminar premixed and non-premixed flames will be studied, followed by turbulent flame theories and modeling of turbulent combustion. Existing models for turbulent combustion process will be discussed, based on systematical understanding on how turbulence and chemical reaction interact. The last part of the course deals with application of turbulent combustion theory and modeling to typical engineering combustion devices, e.g., gas turbines, piston engines and furnaces.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: To pass the course the student has to pass a written examination. In addition to this, obligatory home works and project works must be carried out satisfactorily. The obligatory home works shall be presented in written form. Project work shall be presented both orally and in a written report form.

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

Admission requirements:

- MMV021/MMV211/MMVF10 Fluid Mechanics

Assumed prior knowledge: MMVF01 Thermodynamics and Fluid Mechanics, MVK140/MVKN90 Turbulence - Theory and Modelling.
The number of participants is limited to: No

Reading list

- S. R. Turns: An Introduction to Combustion: Concepts and Applications, 3rd Edition. McGraw-Hill, 2011, ISBN: 9780071086875.

Contact and other information

Course coordinator: Professor Xue-Song Bai, Xue-Song.Bai@energy.lth.se
Examinator: Professor Xue-Song Bai, Xue-Song.Bai@energy.lth.se
Course homepage: https://www.energy.lth.se/english/education/
Further information: The course will be based on lectures, exercise, projects and home works.