LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Brandkemi - värmetransport
Fire Chemistry and Heat Transfer

VBRF20, 13 credits, G2 (First Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED BI/RH
Date of Decision: 2023-04-12

General Information

Compulsory for: BI2
Language of instruction: The course will be given in Swedish

Aim

The objective of the course is to provide the students with background knowledge about heat transport and combustion. The course is also aimed at increasing the students' engineering skills and their capabilities to construct and analyse models.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to explain and apply the fundamental concepts of heat conduction, convection, and radiation.
- be able to explain numerical methods for heat conduction.
- be able to calculate convective heat transfer rates.
- be able to calculate view factors.
- be able to calculate vapour pressures for various types of fuels and fuel mixtures.
- be able to describe enthalpy diagrams and to calculate the heat of combustion for various fuels and reactions.
- be able to calculate flame temperatures.
- be able to describe various ignition theories and to calculate spontaneous combustion temperatures.
- be able to calculate flammability limits for various fuels and fuel mixtures.
- be able to describe the structure of a pre-mixed flame and to calculate the least

quenching distance.
- be able to define detonations and deflagrations.
- be able to explain ignition for solid materials.
- be able to formulate an energy balance for a burning liquid-surface and to describe the diameter-dependent burning rate.
- be able to identify various zones in a smouldering fire.
- be able to describe concentration profiles in the event of a gas leakage into an enclosure.
- be able to calculate the pressure build-up in the event of a gas explosion in an enclosure.
- be able to describe the soot generation process and the influence of soot on visibility.
- be able to calculate the range of visibility in combustion gases.
- have knowledge of present research and developments within the area of fire science.

Competences and skills
For a passing grade the student must

- be able to apply standard thermal conduction equations and Fourier's Law.
- be able to solve numerically simple problems of heat conduction.
- be able to estimate the thermal heat transfer properties of different materials.
- be able to apply various boundary conditions in transient heat conduction.
- be able to evaluate the effects of thermal radiation on humans and on fuel.
- be able to estimate the combustion efficiency of various fuels.
- be able to judge the capacity of various building components to withstand an explosion, and to design pressure vent areas.
- be able to defend, both verbally and in writing, the reasons for choosing certain models and assumptions for thermal transport calculations and calculations concerning fundamental combustion physics.
- be able to present results from fire safety engineering experiments in technical reports.
- be able to plan and set up fire safety engineering experiments and be familiar with measurement techniques and methodology.
- be able to balance simple combustion reactions

Judgement and approach
For a passing grade the student must

- be able to demonstrate a capacity to make assessments of the applicability of various computational models to various types of problems.
- be able to demonstrate insight into the responsibilities of a fire engineer in choosing and reporting parameters in such a way that the models are used properly and ethical.

Contents

- Heat transport: Conduction, convection, and radiation.
- Fire chemistry: Vapour pressure, enthalpy diagrams, standard enthalpy of formation, heat of combustion, combustion efficiency, adiabatic flame temperature, equivalence ratio, and chemical reactions during combustion.
- Ignition sequence: Semenov's theory of ignition, Frank-Kameneskii's theory of ignition, minimum energy of ignition, temperature of spontaneous ignition, flammability limits, explosion limits.
- Flame spreading: Pre-Mixed flames, detonation, deflagration, diffusion flames, liquid fires, smouldering fires, gas explosions and dust explosions.
- Combustion gases: Soot concentration and visibility.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: The final grade is based on a written examination, home assignments (individual), computer laboratory (individual) and laboratory reports (work in group) as well as participation in obligatory seminars and laboratories

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.

Parts
Code: 0116. **Name:** Fire Chemistry and Heat Transfer.
Credits: 6,5. **Grading scale:** TH. **Assessment:** The examination process will be based on both an individual and a group-work basis. During the course, two sub-examinations will be given. During the course, the students will be responsible for three compulsory home assignments and one computer laboratory. Reporting of home assignments and computer laboratory will take place in seminars for which attendance is compulsory. At the end of the course there will be a written examination. **Contents:** Lectures and exercises treat fire risk for gaseous, liquid and solid fuels, fire development, smoke production, heat transfer and fire physics. Own problem solving work is therefore important for the course.
Code: 0216. **Name:** Laboratory and Home Work.
Credits: 6,5. **Grading scale:** UG. **Assessment:** The course is based, in part, on four laboratory sessions. Approved laboratory reports and attendance at all lab sessions are requirements for final certification. **Contents:** Contents of the laboratories: 1: Oxygen index; 2: Flammability limits; 3: Ignition; 4: Rate of heat release, smoke production from pool fires.

Admission

Assumed prior knowledge: FMAA05 Mathematics, Calculus in one variable or FMAB65 Calculus in One Variable B1 together with FMAB70 Calculus in One Variable B2FMAB20 Linear Algebra, FAFA30 Physics: Electricity – Fluids.
The number of participants is limited to: No
The course overlaps following course/s: VBR021, VBR121, VBR022

Reading list

- Drysdale, D: An introduction to fire dynamics. John Wiley & Sons , 2011, ISBN: 978-0-470-31903-1.
- Analytisk lösning av värmeledningsekvationen. Stencil, 1990.
- Självantändning. Stencil.
- Harris: The Investigation and Control of Gas Explosions in Buildings and Heating Plant, Utdrag ur (Extract). E&FN Spon, 1983, ISBN: 978-0419132202.
- Ann-Ida Petterson, Patrick van Hees: Kurslitteratur - Brandkemi. Brandteknik och riskhantering, 2014.
- Murty Kanury: Introduction to Combustion Phenomena, Utdrag ur (Extract). Gordon&Breach, 1975, ISBN: 978-0677026909.

Contact and other information

Examinator: Margaret McNamee, margaret.mcnamee@brand.lth.se
Further information: Active participation in group work is required. Each group member must be able to report and be responsible for the content individually. If a group member does not fulfill the requirements for active participation, or disregards his/her commitments, she/he can be reassigned by the examiner to another group or get a fail

result. Some lectures may be given in English.