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MATH45142 - 2011/2012

General Information

- Title: Introduction to Combustion Theory
- Unit code: MATH45142
- Credits: 15
- Prerequisites:
- Co-requisite units: None
- School responsible: Mathematics
- Members of staff responsible: Dr. Joel Daou

Specification

Aims

The course introduces basic modelling concepts which describe combustion phenomena and their solution, often using boundary layer theory.

Brief Description of the unit

Chemically reacting systems, which describe ignition, flames, detonation, etc., often involve small or large parameters, and wide variations in scale. Techniques used in boundary-layer theory, such as non dimensionalisation, scaling, asymptotic approximation and matching, were developed to help obtain good approximate solutions for such systems. The course will introduce the basic ingredients in the modelling of combustion, and use boundary-layer theory to provide approximate solutions for a number of combustion phenomena. Properties of flames, such as their stability, will also be examined.

Learning Outcomes

On successful completion of the course unit students should understand

- the basic modelling of combustion processes, their dimensionless forms and important dimensionless numbers;
- the asymptotic solution in simple cases, for large Zeldovich number, of homogeneous self-ignition and steady-state nonhomogenous models yielding ignition limits;
- the asymptotic description of flame-balls and planar premixed flames in gases and solids;
- the linear stability of premixed flames;
- simple models of planar diffusion flames and their multiple solution branches.

Future topics requiring this course unit

None.

Syllabus

- Combustion Phenomena and classification of flames. Governing equations of chemically reacting flows.
- Flames in zero-dimension: stationary solutions for the well stirred-reactor and their stability. Distinguished asymptotic limits. Ignition and extinction phenomena.
- Premixed Flames: Matched asymptotic analysis of flames. Jump conditions and their use. Effect of heat-loss. Flame balls.
- Diffusion Flames: Passive scalars and the Burke-Schumann fast chemistry limit. The S-shaped curve and asymptotic analysis.
- Stability Analysis in combustion: General approach and several examples including the thermo-diffusive instability.

Textbooks

- F A Williams, *Combustion Theory,* (2nd Edition), Benjamin Cummins 1985.
- J D Buckmaster and G S S Ludford, *Theory of Laminar Flames*, Cambridge University Press 1982.

Teaching and learning methods

24 lectures and 12 examples classes. In addition students should expect to do at least seven hours private study each week for this course unit.

Assessment

Mid-semester coursework: weighting 20%
End of semester examination: two and a half hours weighting 80%

Arrangements