Applied Combustion

AE/ME 525 Course Outline Spring Semester 2000

Lecturer: Joseph Majdalani, Ph.D.

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Office Hours: 2:00~4:00 p.m., MWF, Haggerty Hall, Rm. 251.

Section No.: 1701. Course Call No.: 52066/88906.

Prerequisites: Thermodynamics (MEEN 104) and Mechanics of Fluids (ENME 151)


Scope of Textbook: Targeted at senior and first year graduate level courses in combustion, this text covers more material than can be covered in a single semester course, but at a level that is easily comprehended by undergraduate students.

References:
Combustion Related Links:
voyager5.sdsu.edu/index.html
www.wssci.org/
www.cis.yale.edu/engineer/Comb_Studies.html
www.en.com/users/crle/industrialmarketing/eog/basic.htm
www.seas.columbia.edu/~sa233/
users.telerama.com/~combust/
www.erc.wisc.edu/
www.ca.sandia.gov/CRF/index_4.html
www.combdyn.com/
odie.seas.ucla.edu/

Combustion Elements: The science of combustion involves complex interactions among many constituent disciplines, including thermodynamics, chemical kinetics, fluid mechanics, heat and mass transfer, material structure and behavior.

Combustion Topics:

Thermodynamics
- Equation of State
- First and Second Laws
- Gibbs-Dalton Law and its Implications

Thermochemistry – First Law of Thermodynamics Applied to Chemically Reacting Flows
- Enthalpies of Formation, Reaction and Combustion
- Thermochemical Laws
- Heat of Reaction

- Free Energy
- Chemical Equilibrium
- Adiabatic Flame Temperature

Conservation Equations
- Mass, Momentum, Energy and Species

Chemical Kinetics
- Collision Theory
- Chain Reactions

Diffusion Flames
- Shvab-Zeldovich Formulation
- Conservation Conditions at the Interface
- Droplet Burning
- Boundary Layer Combustion
- Flame Propagation

Premixed Gas Flames
- Ignition
- Extinction Flammability Limits

Scope: This course covers the fundamentals of combustion systems, fire and explosion phenomena. Topics covered will be chosen from the following themes: thermochemistry,
chemical kinetics, laminar flame propagation, detonations and explosions, flammability and ignition, spray combustion, and the use of computer techniques in combustion problems.

**Objective:** To provide a sound fundamental understanding of the physics of combustion phenomena, and to apply this knowledge to various applications in order to understand how the devices have been designed to recover useful work from the energy release while abating the associated pollutant emissions.

**Motivation:** There is a tremendous need for undergraduate students interested in the thermal sciences to have a basic knowledge of combustion science and its applications. This course is the first to present the essential theory and background material that is helpful for understanding the more complex literature on combustion, in a format that is teaching rather than reference oriented. The theory is reinforced by examples, review questions and problems.

**1999-2000 Catalog Data:** Topics in Thermo-fluids Science and Engineering: … chemical kinetics and combustion.

**Contents:**
1. Introduction.
2. Combustion and Thermochemistry.
3. Introduction to Mass Transfer.
5. Some Important Chemical Mechanisms.
6. Coupling Chemical and Thermal Analyses of Reacting Systems.
8. Laminar Premixed Flames.
9. Laminar Diffusion Flames - Burning Jets.
10. Laminar Diffusion Flames-Droplet Burning.
11. Introduction to Turbulent Flows.
12. Turbulent Premixed Flames.
13. Turbulent Non-Premixed Flames.


**Homework Assignments:** Homework assignments will be made in class. Late homework will only be accepted with an acceptable excuse. The homework will be graded on both correctness and style. Failure to present one’s work in a concise, easy to follow manner is likely to result in deductions.

**Grade Distribution:** A) Homework: 20%. B) Exams: 2@25%. C) Final: 30%.
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10 FINAL EXAM 8:00-10:00 PM Wednesday