

Handout No. 1 Prerequisites, Curriculum, Grading Policy

I assume that students are familiar with thermodynamics at the undergraduate level, and in particular the first law and simple relationships between properties of a perfect gas (equation of state, gas mixtures, energy, pressure and temperature). In addition, the students should have been exposed to conservation equations of mass, momentum and energy, and to the laws of heat conduction and species diffusion (Fourier's and Fick's laws). All mechanical engineering seniors or graduate students should have an adequate background in these areas. Students from other fields may need to devote some extra time to these matters.

Course objectives and outcomes

The objective of MAE 543 is to introduce students to the principal concepts and tools used in combustion research and engineering practice. Upon completion of the course, students should

- understand the concepts of internal energy, enthalpy and equilibrium constants;
- calculate the composition of a perfect gas mixture at equilibrium and its adiabatic flame temperature using complete equilibrium and/or the major/minor species approach;
- be familiar with Stanjan and the JANAF tables;
- calculate concentration time-histories in elementary kinetic mechanisms;
- be familiar with the concept of a rate-limiting step;
- recognize the basic reactions responsible for the formation of NO, the combustion of CO, and the combustion of hydrogen;
- understand the structure of a one-dimensional detonation wave and associated calculations;
- understand how to calculate the steady combustion in a well-stirred reactor;
- extrapolate flammability limits from one set of conditions to another using a simple model of laminar flame speed;
- discuss the limits of stability of a laminar flame on a Bunsen burner;
- understand the derivation of equations for mass, momentum, energy and species conservation for laminar slot burner diffusion flames;
- be familiar with the concepts of diffusion-limited and kinetic-limited processes;
- understand and exploit the conserved scalar approach to calculate profiles of species mass fraction in a laminar diffusion flame and around a burning droplet;
- understand combustion at the surface of an ideal isothermal solid and in its porous structure;
- gain an appreciation for the complexity of real combustion systems and for the importance of this field in society.

Course Outline

Approximate number of lectures for each topic are shown below.

Thermochemistry	8 lectures
Kinetics	7 lectures
Prelim 1	Thursday, Oct. 14, 7:30-9:00pm, Upson 215
Reactors	3 lectures
Premixed flames	8 lectures
Prelim 2	Thursday, Nov. 11, 7:30-9:00pm, Upson 215

Laminar diffusion flames	7 lectures
Droplet combustion	4 lectures
Particle combustion	3 lectures

### Textbook

The suggested text is by Stephen R. Turns: An Introduction to Combustion, McGraw-Hill, 2<sup>nd</sup> Edition (2000). The readings will be supplemented by handouts available on the web at <http://blackboard.cornell.edu>

The following books have been placed on reserve in the Engineering Library:

ENGR QD516 B25 1985 BARNARD & BRADLEY -  
Flame And Combustion (2nd Ed)

ENGR QD516 F735X 1995  
FRISTROM - Flame Structure And Processes

ENGR QD516 G54 1987 C.1  
GLASSMAN - Combustion (2nd Ed)

ENGR QD516 K16 C.1 KANURY -  
Introduction To Combustion Phenomena (1975)

ENGR QD516 S91 1984  
STREHLOW - Combustion Fundamentals

ENGR TJ254.5 T88X 1996  
TURNS - An Introduction To Combustion: Concepts And Applications

ENGR QC168 V77  
VINCENTI & KRUGER - Introduction To Physical Gas Dynamics

ENGR QD516 W72 1985  
WILLIAMS - Combustion Theory

Suggested reading assignments will be announced in the appropriate lectures or on the web.

### Grading

There will be seven homeworks assigned for either one or two weeks. They will be available on the web at <http://blackboard.cornell.edu> and collected as shown on the problem statement. Penalties for late homeworks will amount to 10% of the maximum grade per business date late.

The final grade will be computed according to the following weights:

Homeworks	20%
Prelim 1	20%
Prelim 2	20%
Final	40%

All exams will be open book.

Office Hours: 4-5pm MWF or by prior arrangement.