ME 524 - Combustion

Spring 2015

Text: Glassman, I., Yetter, R. A., Glumac, N. G.: *Combustion (5th Ed.)*, Academic Press (2015). Supplemented by web handouts. You can probably make do with the 4th edition if you have it.

Schedule: Monday, Wednesday, Friday, 10:30AM to 11:20AM

Outline: This indicates planned schedule and associated reading.

Grading: One midterm @ 100, final @150, projects/ homework 150, total points 400.

Final Exam: Monday, June 8, 8:30 to 10:20AM

Instructor:

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Office Hours: 8:00-10:00AM Monday, Tuesday, Friday, and when you can catch me.

TA:

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http://courses.washington.edu/mengr524/sp15

	Monday	Wednesday	Friday
March	**30** Course Intro. Stoichiometry	**1** First Law for Reacting Systems Adiabatic Flame T (Frozen Systems) *1-8*	**3** Equilibrium Fundamentals *8-16*
April	**6** Equilibrium Applications *16-31 (skim after 21)*	**8** Basic Kinetics Chain Mechanisms *41-51*	**10** Pressure Effects Partial Equilibrium *53-65*
	12 Explosions *71-78*	**15** Explosions *79-85*	**17** Premixed Flames: Basic Theory *147-151*
	20 Detonations *255-269*	**22** Deflagrations *151-159*	**24** Flat Flames *174-189* *189-210 (Skim)*
	27 Simple Kinetic Models: Plug Flow *(Notes)*	**29** Simple Kinetic Models: Stirred Reactor *(Notes + 231-235)*	**1** Stirred Reactor Applications
May	**4** Diffusion Flames (Jets) *301-312*	**6** Diffusion Flames (Jets) *(Notes+319-320)*	**8** **Midterm Exam**
	11 Diffusion Flames (Droplets) *322-335*	**13** Diffusion Flames (Droplets) *335-346*	**15** Solid Particles *(Notes)*
	18 Environmental *393-401*	**20** Environmental *401-419*	**22** Environmental *419-424* *438-443*
	25 *Memorial Day*	**27** Turbulent Combustion *210-227*	**29** Turbulent Combustion *227-231*
June	**1** Turbulent Combustion *(Notes*	**3** Turbulent Combustion *(Notes)*	**5** Turbulent Combustion *(Notes)*

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Overview

The study of combustion fundamentals is a fascinating problem because it brings together the individual disciplines of fluid dynamics, heat transfer, mass transfer, and energetic chemistry. Fortunately, most combustion problems can be placed into simplified categories such as: laminar vs. turbulent, fuel/air premixed vs. initially separated, combustion in one phase vs. two phases. Our goals are to: (1) develop an intuitive understanding of the way the fundamental processes come together to govern combustion behavior, and (2) develop the tools needed to perform quantitative predictions of flame dynamics. To reach these goals we start from advanced undergraduate thermodynamics and fluids and move forward through the following steps:

1. Review of the concepts of combustion stoichiometry and First Law balances around reacting systems.
2. Establishment of the principles of chemical equilibrium, including the general Gibbs energy minimization approach used for multi-species systems.
3. Development of the basic concepts of gas-phase chemical kinetics, including the chain mechanisms that are at the heart of combustion.
4. Development of the simple problems of explosion, detonation, deflagration, and premixed reactors (plug-flow and perfectly-stirred).
5. Analysis of the diffusion flame (*i.e.*, the jet flame that is the prototype of many industrial applications), the droplet flame, and the solid particle flame.
6. An overview of the major approaches to the problem of turbulent combustion.

Lectures

Lecture notes will be posted on the class website as scanned pdf files shortly after the lecture is given. These are intended as a supplement to the lecture, not as a reason to forego the lectures. The lectures will also be available as streaming video. Procedures for accessing the video will be announced.

Problem Sets

I firmly believe you only really learn and understand this material if you apply it yourself. No matter how clear the lectures or reading may seem, you don't really understand the material until you try to do something with it **on your own**. The problem sets are your principal tool to do this. These are designed to be somewhat extensive and difficult, but after all, this is graduate school! Problem sets will be assigned on Mondays or Tuesdays on the website, due at 4:30PM on the following Tuesday. Assignments may be turned in to me or dropped off at the collection box in the ME main office. EDGE students should submit their assignments via the class electronic dropbox using a procedure that will be announced.

Out of fairness to everybody. I do enforce a no-late-homework-no-matter-what policy. Please plan accordingly.

Exams

About one week ahead of each exam, a set of learning objectives for that exam will be posted on the web. This will give information about the material to be covered, what I will be looking for on the exam, and other logistical information.

Grading

The final grades will be based on your class ranking as determined by your percentage of 400 total points (Homework=150, Midterm=100, Final=150). There is neither a fixed formula relating the percentage you achieve to your grade nor a grading curve. Instead, the mean grade for the class will be based on my subjective assessment of how well the class, overall, is getting the material. The spread will be based on another subjective judgement on how your individual performance relates to the class average. The class grades will, however, be positively correlated with class rank, *i.e.*, nobody with fewer points than another person will get a better final grade. It is theoretically possible that everybody could get a 4.0.