AME 60636–Fundamentals of Combustion
Spring 2024

Prof. Joseph M. Powers–Instructor
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Office hours: when available

Course web page: https://www3.nd.edu/∼powers/ame.60636

Course time and location: MW, 3:30-4:45 PM, 302 DeBartolo

Listserver address: sp24-ame-60636-01-group@nd.edu. When e-mail is sent to this address, the entire class will receive a copy of the mail.

Prerequisites: undergraduate heat transfer and differential equations is highly useful.

Catalog description

"Thermodynamics and chemical kinetics of combustion reactions, modeling of reacting fluid mechanical systems, subsonic and supersonic combustion, detailed and one-step kinetics, ignition theory, asymptotic and numerical techniques for modeling combustion systems."

Instructor's emphases

This course is designed to give the student a background in combustion theory. The course focuses on the interplay between chemistry and fluid mechanics. In addressing relevant problems, the student will also be introduced to some advanced methods involving non-linear wave mechanics, dynamic system analysis, asymptotic analysis, stability theory, computational methods, and self-similarity. Specific topics are

- Detailed chemical kinetics in reaction systems,
- Governing equations of fluid mechanics with reaction, advection, and diffusion,
- Linear analysis of a simple reaction-advection-diffusion system
- Ignition and stability of simple reaction-diffusion systems
- Laminar flame analysis for a simple reaction-advection-diffusion system.
- Detonation theory for simple reaction-advection systems,

The course notes are be self-contained and does follow the main text closely; the recommended texts are extensive in scope and are made available for the student who wants supplementary material. The course is open to undergraduates, who have competed successfully in past years, and graduates.

Text available in bookstore

Powers, J. M., *Combustion Thermodynamics and Dynamics*, Cambridge: New York, 2016.

Recommended Texts

Law, C. K., *Combustion Physics*, Cambridge: Cambridge, 2010.
Fickett, W., and Davis, W. C., *Detonation: Theory and Experiment*, Dover: New York, 2012.
Warnatz, J., Maas, U., and Dibble, R. W., *Combustion: Physical and Chemical Fundamentals, Modelling and Simulation, Experiments, Pollutant Formation*, fourth edition, Springer: Berlin, 2006.
Kuo, K. K., *Principles of Combustion*, second edition, Wiley, New York, 2005.
Zel'dovich, Y. B., and Razier, Y. P., *Physics of Shock Waves and High-Temperature Hydrodynamic Phenomena*, Dover, New York, 2002.
Williams, F. A., *Combustion Theory*, Addison-Wesley: New York, 1985.
Kanury, A. M., *Introduction to Combustion Phenomena*, Gordon and Breach: New York, 1975.
Lewis, B., and von Elbe, G., *Combustion, Flames, and Explosions of Gases*, Academic Press: Orlando, 1987.
Turns, S. R., and Haworth, D. C., *An Introduction to Combustion*, 4th edition, McGraw-Hill: New York, 2020.
Faraday, M., *The Chemical History of a Candle*, Dover: Mineola, New York, 2002.

Required Work and Grading

There will be one midterm examination and a comprehensive final examination.

Homework will be assigned regularly from the text and other sources. Homework will be submitted on `CANVAS`. Homework must be done on *one side only* of 8 1/2" by 11" *engineering* paper with no frayed edges. You should briefly restate the problem, give a sketch if helpful, give all necessary analysis, and place a box around your final answer. Correct units must always accompany numerical answers. Neatness and effective communication are considered in grading as well as numerical answers.

Grades will be assigned based on students' performance on examinations, homework, and papers. The weights assigned to each are as follows:

Midterm Exam	30	Wednesday, 28 February 2024
Final Exam	40	Monday, 6 May 2024, 4:15 PM-6:15 PM
Homework	30	
Total	**100**	

Honesty Policy

Academic honesty is expected. When confronted with an apparent violation, I will enforce the honor code to the best of my ability. I will also try to make my expectations clear. By and large, though, these issues are out of my control and as such I do not seek out violations. Instead, I depend upon your basic integrity to prevent any problems.

In brief my expectations are as follows. I encourage you to freely discuss the homework amongst one another as you formulate your solutions *individually*. *Your* written work should represent *your* understanding of the problem . In practice this means copying (in whole or in part) another student's homework, exam, computer program, or paper is *not* permitted. If you choose to discuss your work with a colleague, it should be a discussion in which one teaches another or both work to a mutual understanding. As a counter-example, it is not acceptable to give a friend your homework five minutes before class so that friend can copy your work. I also consider it unacceptable to copy work from a student who was in the class in a previous year. In your written reports, be careful to correctly use quotation marks for words that did not originate with you. Also be sure to properly cite all sources you used. As is done in the scientific literature, you should *briefly* acknowledge in writing any significant discussions or interactions you had regarding the work you submit. As a general principle, I do not accept the justification that you were not sure of my intentions. If you feel you may be in an ethical grey area, then you should consult with me *before* acting.