Chemical Engineering 641
Combustion Modeling

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Spring, 2013

M, W, F: 9:00 am, 384 CB

Catalog Description:

Theory of combustion systems and quantitative procedures for computing performance of combustion chambers. Applications include turbulent combustion of gases, sprays, and particulates.

Course Objective:

The objective of this course is to provide students with tools (i.e., familiarity with computer programs) to analyze complex combustion systems. In addition, experience will be gained in analyzing results of computer calculations.

Recommended Texts:

These three texts will be used in the course, and would be a valuable asset to each student's library (but not required):

- L. Douglas Smoot and Philip J. Smith, Coal Combustion and Gasification, Plenum, 1985.
- Turns, S., An Introduction to Combustion: Concepts and Applications, McGraw-Hill, 2011.
- Bartok, W. and A. F. Sarofim, eds., Fossil Fuel Combustion, Wiley, 1991.

Secondary Sources:

- L. Douglas Smoot and David T. Pratt, editors, Pulverized-coal Combustion and Gasification, Plenum, 1979. (green)
- L. D. Smoot (editor), Fundamentals of Coal Combustion for Clean and Efficient Use, (Coal Science and Technology 20), Elsevier, Amsterdam, 1993.
- S. V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill, 1980.
- Kee, R. J., M. E. Coltrin, and P. Glarborg, Chemically Reacting Flow, Theory and Practice, John Wiley & Son, 2003.
- Peters, N., Turbulent Combustion, Cambridge University Press (2000).
- Cant, E. S. and E. Mastorakos, An Introduction to Turbulent Reacting Flows, Imperial College Press, 2008.

Notes:

A scanned copy of all lecture notes will be placed on the J: drive in a CAEDM groups folder for ChE 641, along with selected reading material and files for computing.

Prerequisites:

This course is a follow-on course to Chemical Engineering 633, Combustion Processes (or Mechanical Engineering 522, Combustion). Much of the course will deal with the use of computer simulations of combustion systems. Both gaseous and particle-laden systems are to be treated. The fundamental tools used to describe these processes include turbulent fluid mechanics, heat transfer, mass transfer, thermodynamics, and reaction kinetics. It is expected that each student is well-founded in these subjects before beginning this course. Additionally, the description of these processes most usually involves differential equations that often require numerical methods to solve. It is expected that students be comfortable in the use of the computer to solve these problems. **Ch En 633 (Combustion Processes) or Me En 522 (Combustion) is recommended prior to taking this class.**

Class Format:

Much of the work is anticipated to be on the computer; class will therefore consist of both lectures and computer lab periods for demonstrations and class projects. Student participation in planning and developing course materials is essential. Focus will be on understanding and using existing computer codes in meaningful ways rather than on writing new programs.

Class Projects:

Three class projects (plus one mini-project) will be required during the semester. The mini project involves an equilibrium code (such as NASA-CEA). The main projects will be for (1) chemical kinetics (Chemkin, Cantera, etc.), (2) gaseous turbulent flow (Fluent, STARCCM+), and (3) particle-laden turbulent reacting flow (Fluent, etc.). Projects may either be industrially-oriented (posing a question) or classroom oriented (code improvement). Projects will be presented in class. Teams of 2 to 3 students are required on each project. A different partner is required for each project. Projects must be approved after submitting a 1-page proposal. Occasionally students have set up the lectures and lab demonstrations for different portions of the course; this service has counted as the project in that area of the course. Please let me know if you are qualified to help set up portions of the course.

Class Discussion and Homework:

This is an advanced graduate level course. It is expected that students will come to class having prepared themselves thoroughly on the topic to be discussed that day. Significant classroom discussion is strongly encouraged, including prepared presentations by students when appropriate. It is expected that students spend a minimum of two hours preparation for hour in class, and much of this will be spent on class projects. Therefore, individual homework assignments will not be given, but 10% of the grade will be on class preparedness and participation.

Exams:

Two exams will be given during the semester, one midterm and one final. Exams will be normalized so that the high score is 100%. These exams will be oral exams, ~30 minutes in length. These exams will test the student knowledge of both theory and how to use and interpret the computer programs.

Grading:

Since small homework problems will generally not be given, a large portion of the grade will be assigned to the classroom presentation. The final grade will be based on the following:

Class Participation	**10%**
Midterm Exam	**20%**
Class Projects	**50%**
Final Exam	**20%**

Office Hours:

Dr. Fletcher and Dr. Lignell are always available to answer questions and pursue discussions whenever they are not in any other meeting. Regular office hours will be scheduled if needed.

Contact Info:

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