ME 40 – THERMODYNAMICS

Fall 2016

Section: 1 (Class No. 28247; Final Exam: December 16, 11:30-2:30)
Lectures: M,W,F 12–1 pm
Place: 4 LeConte
Discussion: see bCourses
Instructor: Professor Michael Frenklach
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     Office hours: see bCourses for schedule
Web site: https://bcourses.berkeley.edu/courses/1454023 (log in with your CalNet ID)

INTRODUCTION

This section of the course, while covering the fundamentals, will be based on the use of MATLAB. You will be provided with a set of m-functions that (a) calculate a requested state of matter, and (b) display the results in a graphical form. The homework will include writing your own m-files that perform calculations for different processes and devices.

You will need MATLAB (release 2009 or later) installed on the computer you will be using. The course m-files can be downloaded from bCourses. You should check periodically that site; it will contain updated m-files, instructions on their use, reported bugs, homework assignments, course announcements, etc, as well as a copy of this course outline.

If you have any questions or comments or just would like to share your thoughts, please come to see me or send me an e-mail. If you cannot make the office hours, I will be glad to make another time, in which case please send me an e-mail, give me a call, or let me know of your time preference before or after the class.
COURSE OUTLINE

I. Mathematical Preliminaries (Beginning of Chapter 12; pp. 661–666)

- Partial derivatives
- Relationships between derivatives
- Exact differential

II. Basic Definitions and Concepts (Chapter 1)

- System, Boundary, Environment, etc
- State and state function
- Equilibrium
- Pressure and Temperature
- Zeroth Law of thermodynamics

III. Properties of Pure Substances (Chapter 3)

- Pure substance
- Property diagrams and tables
- Equation of state
- The virial expansion
- Ideal gas
- Other equations of state

IV. The First Law of Thermodynamics (Chapter 2)

- Reversibility
- Work and heat
- Internal energy and the First Law
- Enthalpy
- Heat capacities
- Basic processes

V. The First Law for Ideal Gas (Chapters 3 and 4)

- Isochoric, isobaric, isothermal, and adiabatic processes
VI. The First Law for Open Systems (Chapter 5)

- Control volume
- Conservation of mass
- Conservation of energy

VII. The Second Law of Thermodynamics (Chapters 6 and 7)

- Entropy
- Carnot cycle
- Inequality of Clausius
- Calculation of entropy changes

VIII. Power and Refrigeration Cycles

- Gas power cycles (Chapter 9)
- Vapor power cycles (Chapter 10)
- Combined power cycles (Chapter 10)
- Refrigeration cycles (Chapter 11)

IX. Thermodynamic Property Relations (Chapter 12)

- Legendre transformation
- Free energy functions
- The Maxwell relations
- Changes in thermodynamic properties

X. Additional Topics

- Gas and gas-vapor mixtures (Chapter 13)
- Reacting mixtures and combustion (Chapter 15)
TEXTBOOKS

Main: Y.A. Çengel and M.A. Boles, “Thermodynamics: An Engineering Approach,” Eighth (or Seventh) Edition, McGraw Hill. (This textbook is highly recommended, as it will be a good resource for you in the future. However, it is not required for homework, and all calculations in this class will be in SI units.)

McGraw Hill site: http://www.mhhe.com/cengel


GRADING

a) Homework assignments 20 %
   2 midterm tests 40 % (20 % each)
   Final exam 40 %

b) No exam or homework grades will be dropped

c) No make-up exams

d) All homeworks must be submitted in electronic form, by the time and day indicated for each homework. The format of submission will be described in the homework assignments.

e) Late homeworks: You will lose points for late homeworks in an exponential fashion with respect to how late you are. We will use the following formula:

   \[
   \text{pointsLost} = \min(\text{rawScore} \ \text{ceil}(\exp(t \times 0.18)))
   \]

   where \( t \) is the time measured in hours past the time due, and \( \text{rawScore} \) is the grade without considering the time of submission.