

CENG 300S Chemical Engineering Thermodynamics

Classroom: ML 107

Class schedule: MWF 9:00-11:15

Instructor: Michael Loewenberg

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Office hours: Monday afternoon

Objectives:

This is a rigorous introductory course in thermodynamics. Material will include the first and second laws of thermodynamics, cyclic processes, and chemical reaction and phase equilibria. The goal of this course is for students to obtain the necessary qualitative knowledge and quantitative skills for solving engineering science problems in thermodynamics.

Prerequisite: Multivariable calculus.

Texts:

1. Thermodynamics and an Introduction to Thermostatistics, H.B. Callen, 2nd Ed., Wiley.
ISBN 9780471862567. Required.
<http://cvika.grimoar.cz/callen/Callen,%20Herbert%20B%20-%20Thermodynamics%20and%20an%20Introduction%20to%20Thermostatistics%202nd%20Edition.pdf>
2. The Principles of Chemical Equilibrium, K. Denbigh, 4th Ed., Cambridge.
ISBN 0521281504. Less required.
<https://archive.org/details/ThePrinciplesOfChemicalEquilibrium>

Exams, homework, and in-class work

4 non-cumulative tests, 20% each

weekly homework assignments, 20%

Note about problem sets and tests:

Test problems will be drawn from problem sets.

Topics

- 1.** Heat, work, internal energy, entropy; extensive properties, intensive properties; fundamental equations, equations of state; temperature, mechanical equilibrium, chemical equilibrium.

Callen: Chapters 1,2

- 2.** Euler equation, Gibbs-Duhem relation; heat capacity, compressibility, coefficient of thermal expansion; specific systems: ideal gas, van der Waals fluid.

Callen: Chapter 3

- 3.** Feasible processes, maximum work theorem; cyclic processes: heat engines, refrigerators, heat pumps, efficiency; Carnot cycle, endoreversible engines, other cyclic processes.

Callen: Chapter 4

- 4.** Legendre transformations: Helmholtz, enthalpy, Gibbs, and Massieu functions, extremum principle; Maxwell relations.

Callen: Chapters 5, 6, 7.

- 5.** Stability. Phase equilibrium in single- and multicomponent systems, phase rule, phase diagrams. Chemical reactions, imperfect gases.

Callen: Chapters 8, 9, 13. Denbigh: Chapters 7,8,9

1. M July 2 Callen, Ch. 1
2. W July 4 Callen, Ch. 2
3. F July 6 Callen, Ch. 3
4. M July 9 Callen, Ch. 4.1-4.5
5. W July 11 Callen, Ch. 4.6-4.10, Ch. 5
Problem set 1 due
6. F July 13 Callen, Ch. 6.1-6.3
Test 1 (2:00pm Callen, Ch. 1-3, Problem set 1)
7. M July 16 Callen, Ch. 6.4, 7.1-7.2
8. W July 18 Callen, Ch. 7.3
Problem set 2 due
9. F July 20 Callen, Ch. 8.1-8.3
Test 2 (2:00pm Callen, Ch. 4-6.3, Problem set 2)
10. M July 23 Callen, Ch. 8.4, 8.5
11. W July 25 Callen, Ch. 9.1-9.7
Problem set 3 due
12. F July 27 Callen, Ch. 13.5, Denbigh Ch. 8-9
Test 3 (2:00pm Callen, Ch. 6.4,8.1-8.3, 13.2, Problem set 3)
13. M July 30 Phase equilibrium problems
14. W August 1 Phase equilibrium problems
Problem set 4 due
15. F August 3
Test 4 (9:00am Callen, Ch. 8.4, 8.5, 9, 13.5;
Denbigh Ch. 8-9 (lecture notes), Problem set 4)