

# **CENG S300E Chemical Engineering Thermodynamics**

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Class schedule: 6:30-8:00pm MWTh

Teaching Fellow: Atsu Kludze  
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Recitation: Tu 6:30-8:00pm, optional (starting in week 2)

## **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.

**Prerequisites:** Multivariable calculus, high school chemistry.

**Texts:**

1. Thermodynamics and an Introduction to Thermostatistics, H.B. Callen, 2<sup>nd</sup> 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, 4<sup>th</sup> Ed., Cambridge.  
ISBN 0521281504. Less required.

**Exams, homework, and in-class work**

2 tests, 30% each  
4 weekly problem sets, 20%  
class participation, 20%

**Class Website**

Log in to the Yale Canvas website with your netID to access lecture videos and lecture notes, problem sets and reading assignments, and other handouts.

**Course Expectations**

Classes (and active class participation) is essential for learning how to setup and solve the assigned problems. You will be expected to study online course materials (watch videos, read lecture notes and assigned readings) in advance of each class. Collaboration on problem sets is encouraged. The tests are closed book and closed notes.

# Syllabus

## Week 1: June 30 - July 3

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

Class 1          M 6:30-8:00pm

Class 2          W 6:30-8:00pm

Class 3          Th 6:30-8:00pm

## Week 2: July 7-10

Problem set 1 due W 11:59pm

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

Class 4          M 6:30-8:00pm

Recitation      Tu 6:30-8:00pm

Class 5          W 6:30-8:00pm

Class 6          Th 6:30-8:00pm

## Week 3: July 14-17

Problem set 2 due W 11:59pm

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

Class 7          M 6:30-8:00pm

Recitation      Tu 6:30-8:00pm

Class 8          W 6:30-8:00pm

**Test 1**          Th 6:30-8:00pm

## Week 4: July 21-24

Problem set 3 due W 11:59pm

Legendre transformations: Helmholtz, enthalpy, Gibbs, and Massieu functions, extremum principle; Maxwell relations. Chemical reaction equilibria. Stability.

Class 9          M 6:30-8:00pm

Recitation      Tu 6:30-8:00pm

Class 10        W 6:30-8:00pm

Class 11      Th 6:30-8:00pm

**Week 5: July 28- July 31**

Problem set 4 due W 11:59pm

Phase equilibrium in single- and multicomponent systems, phase rule, phase diagrams.

Class 12      M 6:30-8:00pm

Recitation    M 8:30-10:00pm

Class 13      W 6:30-8:00pm

**Test 2**      Th 6:30-8:00pm