155:208 Chemical Engineering Thermodynamics I Spring 2018

Lectures: Tue. & Fri., 12:00 p.m.–1:20 p.m., Hill-116

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Time & Location: Tue 1:40-3:00 pm, SERC 218
Thu 10:20-11:40 pm, SERC 216

Course Description: Thermodynamics relates work, heat, temperature, and states of matter to each other. From a surprisingly small set of empirically based laws, an enormous amount of information about the relationships among equilibrium parameters for a system can be deduced. This information can then be applied to physical, chemical, and biological systems including chemical process design, materials processing, and cellular processes.

Course Objectives: In this course, students learn how to apply knowledge of the laws of thermodynamics, chemistry, physics, and engineering to analyze and solve physical and chemical problems encountered in chemical and biochemical engineering. The course gives the student the opportunity to analyze and interpret data, to identify, formulate, and solve engineering problems, and to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Students will be introduced to the first and second law of thermodynamics and will learn to apply these to the solution of chemical and biochemical engineering problems. Students will be provided with the knowledge and awareness to understand the validity and physicochemical interpretation of their solutions. Students will be introduced to the available computational tools in solving thermodynamics-related problems.

Goals: The objective of this course is to introduce students to the principles of thermodynamics as they apply to physical and chemical processes.

Knowledge, Abilities, and Skills Students Should Gain From This Course: The students should understand the 1st and 2nd laws of thermodynamics and apply them to solve problems. 2. The students should be able to apply energy balances to open and closed systems and to evaluate the thermodynamic efficiency of Rankine cycles and refrigeration cycles. 3. They should be able to use equations of state to solve problems. 4. They should be able to derive property relationships using multivariable calculus and be comfortable using steam tables and generalized charts for compressibility factor, enthalpy, and entropy. In addition, the students should be able to use departure functions properly. 5. The student should be able to use computer software (such as ThermoSover) for the calculation of thermodynamic properties of pure substances and mixtures.

Impact on Subsequent Courses in Curriculum: This is the first in a sequence of two courses in Thermodynamics (155:208 & 155:309). Students completing 155:208 will be required to take 155:309 in the fall semester of their junior year.

The material covered in this course (155:208) forms the fundamental basis for the topics of phase equilibria, fugacity, chemical reaction equilibria and Gibbs free energy that will be covered in 155:309. Thermodynamics in general plays an important role throughout chemical engineering including 155:324 Design of Separation Processes, 155:427 & 428 Chemical & Biochemical Engineering Design & Economics, 155:441 Chemical Engineering Kinetics. Thermodynamics is one of the main pillars of chemical engineering; others include transport phenomena and reaction kinetics.

Textbook:
M. D. Koretsky, "Engineering and Chemical Thermodynamics," 2nd Ed., J. Wiley & Sons Inc., (2013).

Assessment:
Quizzes: 20 %, exams: 80 % (2/6, 3/2, 4/3, 4/27)

Course Content:

	Book sections
0. Introduction	
1. Basic Concepts	1.1,1.2
Properties	
Extensive/Intensive,	1.3
Dependent/Independent	1.5
Equilibrium	1.4
P-V-T properties of pure substances, property tables	1.6, 1.7
The Ideal Gas Law	1.3
2. First Law of Thermodynamics	
Heat & work	2.1
Reversible & irreversible processes	2.3
The First Law of Thermodynamics (closed system)	2.4, 2.7
Internal energy, Enthalpy, Heat capacity	2.6
The First Law of Thermodynamics (open system)	2.5, 2.8
Latent heat, Enthalpy of reactions	2.6
Thermodynamic cycles	2.9
3. Entropy & Second Law of Thermodynamics	
Directionality & spontaneity of processes	3.1
Reversibility/Irreversibility	3.2

ABET Outcomes and Assessment

Program outcomes achieved in this course

(a) an ability to apply knowledge of mathematics, science, and engineering
(e) an ability to identify, formulate and solve engineering problems; and
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

The achievement of outcomes (a), (e), and (k) will be addressed in this course as follows:

Outcome (a): an ability to apply knowledge of mathematics, science, and engineering

Equations and models used are derived from the laws and fundamental relations of thermodynamics. Concepts from chemistry and physics are correctly incorporated.

Outcome (e): an ability to identify, formulate and solve engineering problems

Systematic analysis has been applied for the solution of complex situations.

Outcome (k): an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Thermodynamic property estimators (ThermoSolver), word processing (such as WORD), data analysis packages (such as Excel), and computational tools (MATLAB), are used as needed. Graphical packages are used to generate publication-quality graphics.