CHE 222
Chemical Engineering Thermodynamics I
South Dakota School of Mines and Technology
(3 credits)

Spring 2009
CB 205E Classroom Building
Mondays, Wednesdays, and Fridays, 2:00-2:50 pm

Instructor: Prof. Kenneth M. Benjamin
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Office Hours: Monday 3:00-4:00 pm
Tuesday 3:00-5:00 pm
By appointment

Text: Engineering and Chemical Thermodynamics, First Edition,
M. D. Koretsky, John Wiley & Sons, 2004

Elementary Principles of Chemical Processes, Third Edition,
R. M. Felder and R. W. Rousseau, John Wiley & Sons, 2000

Course Website: http://web.me.com/kmbenjamin/CHE-222/CHE-222.html

Catalog Description: **CHE 222 CHEMICAL ENGINEERING THERMODYNAMICS I** (3-0) 3 credits. Prerequisite: CHE 217, concurrent registration in MATH 225. A study of the principles and applications of thermodynamics with emphasis on the first law, the energy balance.

Rationale: Thermodynamics is the study of energy, entropy, and equilibrium. In the field of chemical engineering, this has application in writing and solving energy and entropy balances to model chemical and physical processes, and in calculating the properties of materials, such as gases and liquids. The concepts developed in this course (particularly those of energy balances) will carry forward into all upper level chemical engineering courses.

Course Objectives:

1. To introduce and understand the basic laws of thermodynamics
2. To understand the relationships between various thermodynamic properties
3. To provide practice at developing critical thinking skills
4. To provide practice at developing creative thinking skills
5. To provide experience in solving open-ended problems in teams

Course Outcomes:

1. Calculate changes in thermodynamic properties such as pressure, temperature, volume, energy, entropy, and free energy through equations of state
2. Understand how the first and second laws of thermodynamics dictate the performance of all engineering processes.
3. Solve basic energy balances for closed systems.
4. Solve material and energy balances for open systems consisting of one chemical component, non-reacting mixtures, and reacting mixtures.
5. Apply fundamental concepts to the analysis of real, practical systems (power cycles, engines, and refrigeration cycles).
6. Work in teams to solve both traditional (closed-ended) and open-ended problems

Homework: There will be ten to eleven (10-11) homework assignments during the semester. You are encouraged to study in groups, where general approaches to problem solving can be discussed with peers. However, each student must work out and submit the problem solutions individually.

Regarding homework, please submit homework according to the following guidelines:

1. Use 8.5 x 11 inch paper with straight edges (not torn from a spiral bound notebook)
2. Number all pages (e.g., 1/5, 2/5, etc.), put your name on each page, and staple the pages together
3. On the first page, in the upper right hand corner, write:
    a. Your Name
    b. The Due Date of the Problem Set
4. Please write on only one side of each sheet of paper

In-Class Problems: During certain class times, in-class problems may be assigned. These problems will help reinforce concepts covered in class that day. Students will work in pairs on the problems, and ample time will be provided in class to complete each assignment. Any in-class problems will count towards the overall homework grade.

Exams: There will be three hourly exams during the semester and one final comprehensive exam at the end of the semester. The exact dates and times of the exams can be found on the course schedule. All exams will be open-book and open-note. As always, each individual should complete exams on their own, without assistance from others.

Group Design Project: Students will work in groups of 3-4 to complete a small (4-6 week) open-ended design project. This project will involve the application of energy balances to solve a research or industrially relevant problem. The project will require calculations (of the same type to be covered in class and on homeworks and exams), as well as a written report. Grades for the project will be determined by the accuracy and quality of the engineering calculations, as well as by the quality and detail of the written discussion and analysis.

Late Assignment Policy: Assignments (homeworks and group project) must be submitted at the start of class on the respective due dates. Late work will be accepted up to one day late, but 25% of the grade will be deducted. Once homework solutions are posted for a given assignment, that homework assignment will no longer be accepted.

Grading: The various course assignments will be weighted as follows:

Homework and In-class Problems	25%	
Design Project	10%	
Exams	65%	(15% for each hourly, 20% for the final)

Overall course grades will be determined from the following straight percentage scale:

A/B cutoff	90%
B/C cutoff	80%
C/D cutoff	70%
D/F cutoff	60%

ADA Statement: *Students with special needs or requiring special accommodations should contact Professor Benjamin and/or the campus ADA coordinator, Jolie McCoy, at 394-1924 at the earliest opportunity.*

Freedom in Learning Statement:
Under Board of Regents and University policy student academic performance may be evaluated solely on an academic basis, not on opinions or conduct in matters unrelated to academic standards. Students should be free to take reasoned exception to the data or views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled. Students who believe that an academic evaluation reflects prejudiced or capricious consideration of student opinions or conduct unrelated to academic standards should contact the dean of the college which offers the class to initiate a review of the evaluation.

Electronic Devices Policy: *Please turn off your cell phone before class starts. No text messaging in class. No headphones. If you wish to use a laptop in this class for purposes of note taking, that's great; however, you will be required to download DyKnow software and then join ENGL350 to activate. Any attempt to circumvent the DyKnow monitoring system will be considered a form of cheating and a breach of academic integrity. Note that according to "Policy Governing Academic Integrity" in the SDSM&T Undergraduate Catalog, the instructor of record for this course has discretion of how acts of academic dishonesty are penalized, subject to the appeal process, and that "Penalties may range from requiring the student to repeat the work in question to failure in the course" (72-73). No other use of any other electronic/computer media is allowed during class time.*

Academic Integrity: Students are expected to abide by the SDSMT policies of academic integrity (with regard to cheating, plagiarism, etc.), as outlined in the Course Catalog.

Tentative Course Schedule:

Date	Topic	Reading	Due
Jan 16	Introduction		
Jan 19	No Class – Martin Luther King, Jr. Day		
Jan 21	Basic Concepts in Thermodynamics	K 1.1-1.5	
Jan 23	Basic Concepts in Thermodynamics	K 1.1-1.5	
Jan 26	Phase Diagrams for Pure Substances	K 1.6	
Jan 28	Phase Diagrams for Pure Substances	K 1.6	HW 1
Jan 30	Property Tables and the Ideal Gas Law	K 1.7-1.8	
Feb 2	Property Tables and the Ideal Gas Law	K 1.7-1.8	
Feb 4	First Law of Thermodynamics – Closed Systems	K 2.1-2.4, 2.7	HW 2
Feb 6	First Law of Thermodynamics – Closed Systems	K 2.1-2.4, 2.7	
Feb 9	First Law of Thermodynamics – Closed Systems	K 2.1-2.4, 2.7	
Feb 11	First Law of Thermodynamics – Closed Systems	K 2.1-2.4, 2.7	HW 3
Feb 13	Heat Effects	K 2.6	
Feb 16	No Class – President's Day		
Feb 18	Heat Effects	K 2.6	
Feb 20	HOURLY EXAM #1		
Feb 23	First Law of Thermodynamics – Open Systems	K 2.5, 2.8	
Feb 25	First Law of Thermodynamics – Open Systems	K 2.5, 2.8	HW 4
Feb 27	First Law of Thermodynamics – Open Systems	K 2.5, 2.8	
Mar 2	First Law of Thermodynamics – Reactive Systems	FR Chap. 9	
Mar 4	First Law of Thermodynamics – Reactive Systems	FR Chap. 9	HW 5
Mar 6	First Law of Thermodynamics – Reactive Systems	FR Chap. 9	
Mar 9-13	No Class - Spring Break		
Mar 16	First Law of Thermodynamics – Reactive Systems	FR Chap. 9	
Mar 18	Introduction to Thermodynamic Cycles	K 2.9	
Mar 20	HOURLY EXAM #2		
Mar 23	Entropy and The Second Law of Thermodynamics	K 3.1-3.7	
Mar 25	Entropy and The Second Law of Thermodynamics	K 3.1-3.7	HW 6
Mar 27	Entropy and The Second Law of Thermodynamics	K 3.1-3.7	
Mar 30	Entropy and The Second Law of Thermodynamics	K 3.1-3.7	
Apr 1	Power Cycles	K 3.9	HW 7
Apr 3	Power Cycles	K 3.9	
Apr 6	Refrigeration Cycles	K 3.9	
Apr 8	Refrigeration Cycles	K 3.9	HW 8
Apr 10	No Class - Easter		
Apr 13	No Class - Easter		
Apr 15	Intermolecular Forces	K 4.1-4.2	HW 9
Apr 17	Equations of State	K 4.3-4.4	
Apr 20	Equations of State	K 4.3-4.4	
Apr 22	Equations of State	K 4.3-4.4	HW 10
Apr 24	HOURLY EXAM #3		
Apr 27	Thermodynamic Property Relationships	K 5.1-5.3	
Apr 29	Thermodynamic Property Relationships	K 5.1-5.3	
May 1	Thermodynamic Property Relationships, Review		HW 11,Project
May 5	FINAL EXAM (1:00-2:50 pm)		