Syllabus

Course Administration

	Section 3
Lecturer:	Issam Lakkis
Office	Bechtel 410
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Office hours	Wednesday 10 AM - 2 PM
Lectures	Tuesdays and Thursdays 11 AM – 12 PM Bechtel 539
Problem Solving Session	TBD
Teaching Assistant	TBD

Welcome to MECH 310!

This course is an introduction to classical thermodynamics. It primarily covers the first and second laws of thermodynamics.

Educational objectives

The objectives of this course are to

1. learn the laws of thermodynamics with focus on the meaning and application of these laws in engineering.

2. acquire strong problem solving skills and analysis techniques.

3. develop the proper analytical and critical mindset for tackling problems of more advanced nature.

Textbook

The suggested textbook is *Fundamentals of Thermodynamics*, Borgnakke and Sonntag, Wiley, 8th Edition.

Electronic Mail and Moodle

We expect to use email for course announcements. If you are not on the mailing list, notify the teaching assistant. Course handouts, Problem Set solutions, Exams solutions and additional material will be available in "pdf" format on Moodle in a timely fashion.

Problem sets, exams and grading

The final grade in the course will be based upon analytical homework assignments, two quizes, a final exam, and class performance weighted as follows:

- 8 % Pop up quizzes and in-class participation. Drop quizzes are mostly picked from the recommended problems.
- 25 % Quiz 1: November 15, 2010. 90 minutes. Closed book. Date: ..., Place....
- 30 % Quiz 2: January 3, 2010. 90 minutes. Closed book. Date: ..., Place....
- 37 % Final: 120 minutes. Closed book.

Office Hours

Your are encouraged (and even expected) to come by and see me to ask any questions you have. There is a signup sheet posted on my door. Just put your name next to the (15 mins) time slot convenient for you. Please be advised that I will not be able to answer or discuss course related questions outside these time slots.

Collaboration and honesty rules

AUB regulations are applicable.

Approach

The course will be presented as a series of lectures accompanied by visual aids when convenient. Reading material is assigned mainly from the textbook. Example problems will be solved in class. Separate problem solving sessions will be held when necessary. The Problem Sets are an essential part of the course and the student is therefore expected to spend sufficient time in solving the problems. In addition to the Problem Sets, solving additional problems from the textbook is recommended.

From experience, students who do not spend enough time on the Problem Sets end up not doing well in the class.

Course outline

1. Introduction: the nature of conservation laws in physics with focus on thermal and fluid sciences. Forms of energy storage and modes of energy transfer. Are all energy storage forms and energy transfer modes similar when useful work extraction is the objective. Motivation to the second law. Continuum hypothesis. Microscopic vs macroscopic properties. Thermodynamics processes and cycles. Properties: specific volume, temperature, pressure, energy. Units. [Chapters 1 and 2]

2. First law expressed in terms of conservation of energy of a system. Choice of systems for thermodynamic analysis: control mass and control volume. Concept of system boundary and environment. Isolated systems. Definition of energy as a property of the system. Types of energy: kinetic, potential, thermal, etc. Types of energy transfers across system boundary: work, heat, and flow. Definition of state of a system and its unique identification in terms of thermodynamic properties. The concept of thermodynamic equilibrium and its implications on the thermodynamic properties. Pure substance and multi-phase pure substance and the minimum number of thermodynamic properties (basis) required to uniquely identify a thermodynamic equilibrium (TE) state of these systems. [Chapters 4, 5 and 6]

3. (TE) State equations relating properties of a particular material such as ideal gas or incompressible liquid. Limitations of state equations. Thermodynamic processes and cycles. Static processes and Quasi-static processes. Adiabatic process. Isothermal Process. Isobaric process. Isochoric process. Polytropic process. Thermodynamic equilibrium state charts and tables. [Chapter 3]

4. Specification of the energy of a system. The constant volume and constant pressure specific heat. Internal energy and enthalpy. Kinetic energy. Potential energy. [Chapter 3]

5. Interactions across system boundary: work, heat and flow. Definition of work and type of work interactions. Work done by (on) fluid system on (by) a solid boundary. Work done by (on) a control volume on (by)

fluid flow across control surface. Definition of heat with introduction to nature of heat transfer by conduction. [Chapter 4]

6. First Law of thermodynamics for a system and control volume. Integral and differential forms. The concept of energy flux and its relevance to the control volume. Special cases: steady state, uniform flow. [Chapter 6]

7. Introduction to second law of thermodynamics. Why do we need another law of thermodynamics? What are the "preferred" forms energy in terms of conversion to work? The concept of available energy (exergy) of a system and its relevance to engineering applications. The concept of unavailable energy and irreversibility with focus on major sources of irreversibilities: irreversible heat transfer across a finite temperature difference, friction and its origins, irreversible work and sudden expansion. Internal irreversibility vs. external irreversibility. The concept of a thermal reservoir. [Chapters 7, 8, 9]

8. Statements of the second law of thermodynamics and their equivalence. Available energy (exergy). Second law analysis of system interacting with one reservoir. Second law analysis of a system interacting with two reservoirs. The Carnot cycle. [Chapters 7, 8, 9, 10]

9. Entropy definition and relation to second law. Entropy balance for control mass and control volume. Entropy and internally reversible processes. Isentropic processes and isentropic efficiencies. . [Chapter 10]

10. Exergy analysis for control mass and control volume. [Chapter 7]

References

1. *Fundamentals of Engineering Thermodynamics* by Michael Moran and Howard Shapiro, Sixth Edition (John Wiley, 2007).

2. *Thermodynamics: an Engineering Approach*, Cengel and Boles, McGraw-Hill, 2005.

If you are interested in deeper understanding of thermodynamics, check these references:

1. *Understanding Thermodynamics*, Ness, Dover, 1983.

2. *Thermodynamics: Foundations and Applications*, Gyftopoulos and Berreta, Dover, 2005.