
16.001 / 16.002
Unified Engineering

Fall 2008

Lecture U1 – Introduction

Faculty



Prof. Zolti Spakovszky
Thermodynamics & Propulsion
Course Coordinator



Prof. Paul Lagace
Materials and Structures



Prof. Paulo Lozano
Fluids
Systems / Labs

Faculty



Prof. Eytan Modiano
Signals & Systems



Prof. Moe Win
Signals & Systems

Graduate TFs



Amanda Jason



Jon Gibbs

Staff Roles

- Faculty:
 - Define subject learning objectives
 - Set policy
 - Lectures
 - Recitations
 - Office hours
 - Develop homework, quizzes, systems problems
 - Assess student achievement of subject learning objectives
- Graduate TFs:
 - Manage grading
 - Assist in lectures
 - Office hours
 - Manage web page
- Undergraduate TAs:
 - Grade homework
 - Help run labs

Registration Considerations

- All students in Unified must
 - Have completed 8.01, 8.02, 18.01, 18.02 (or have an approved petition)
 - Have completed 18.03, or register for and remain registered for 18.03
- Unified is a 24 unit subject
 - Expect to budget 24 hours per week to Unified (Class + Prep)
 - Schedule other classes accordingly
- **Unified forms the core of our undergraduate curriculum**

Exploratory Subject

- If you elect Unified as Exploratory, designate both 16.001 and 16.002 as Exploratory
- After Drop Date and no later than Registration Day of the succeeding term, students will be allowed to forfeit either or both of the grades assigned in Unified.
- If a student forfeits the grade assigned in both 16.001 and 16.002 and opts for Listener status, then the student cannot elect an Exploratory subject in the Spring Term.
- If a student forfeits only one of the grades assigned in Unified 16.001-16.002, then the student has a remaining Exploratory option to elect in the Spring Term.
- If a student elects 16.001-002 as Exploratory and does NOT forfeit either grade, he/she has a remaining Exploratory option to exercise in the Spring Term.
- Students are strongly advised to consult with the Unified subject coordinator if they have questions about grading policies in Unified Engineering

Structure of Unified – Fall Term

- Two subjects: 16.001, 16.002
- Four disciplines:
 - Fluid Mechanics (F)
 - Materials and Structures (M)
 - Thermodynamics and Propulsion (T)
 - Signals and Systems (S)
- Systems Problems
- Labs

Typical Week

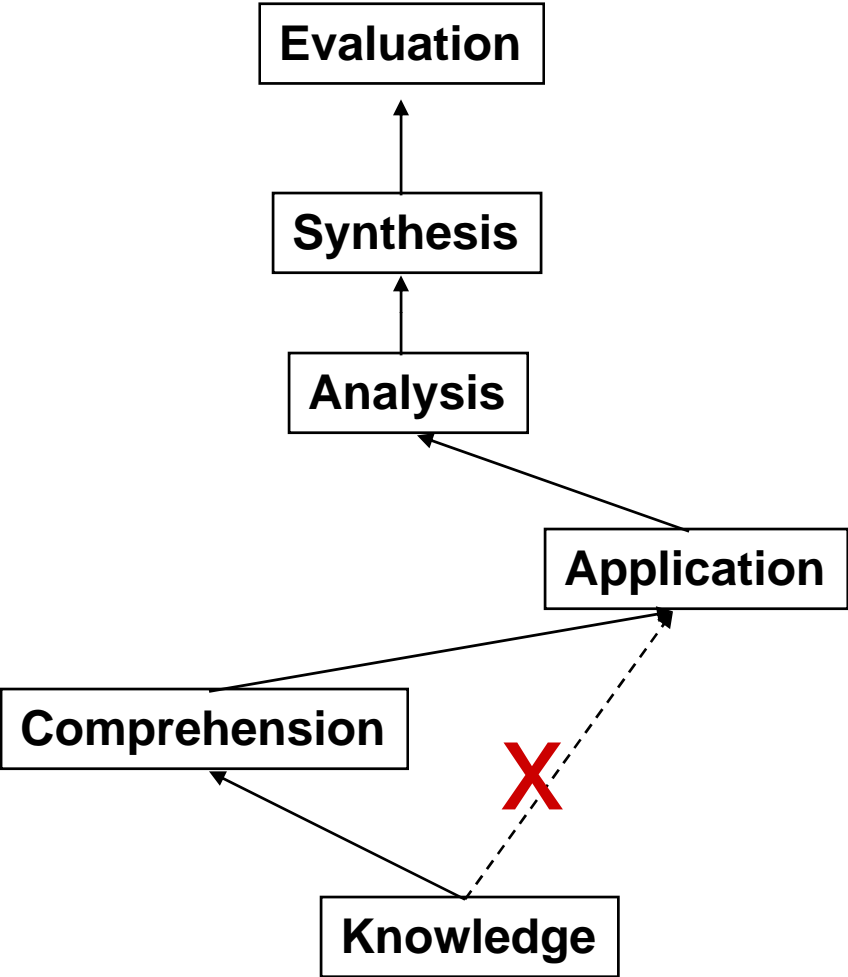
- 7-8 Lectures
- 2 Recitations
- System Problem or Lab Lecture
- Office hours
- Assignments:
 - Problem Set
 - System Problem
 - Quiz

Unified Schedule – Fall Term

Week 1						Week 2					Week 3					Week 4							
M	T	W	TH	F		M	T	W	TH	F		M	T	W	TH	F		M	T	W	TH	F	
9/1	9/2	9/3	9/4	9/5		9/8	9/9	9/10	9/11	9/12		9/15	9/16	9/17	9/18	9/19		9/22	9/23	9/24	9/25	9/26	
9-10			U1	U	F1	F2	F	F3	T	T5	F5	F	T0	T	T7	Stu-dent	Q	QFT1	F	T8			
10-11	Labor Day	Reg Day	U2	S/L1	T1	T2	T3	T4	S/L2	F4	M1	M2	F6	F7	M3	Hday	F8	QFT1	S/L4	M4			
11-12				U			F		T			F		T			Q		F				

Week 5					Week 6					Week 7					Week 8								
M	T	W	TH	F		M	T	W	TH	F		M	T	W	TH	F		M	T	W	TH	F	
9/29	9/30	10/1	10/2	10/3		10/6	10/7	10/8	10/9	10/10		10/13	10/14	10/15	10/16	10/17		10/20	10/21	10/22	10/23	10/24	
9-10	T9	M	T10	T	F10	T11	M	F11	F	S/L6	Colum-bus	Q	QFM2	M	T15	T16	M	T17	T	T18			
10-11	M5	F9	M6	S/L5	M7	M8	T12	M9	T13	M10	Day	M11	QFM2	T14	M12	M13	S1	M14	U3	M15			
11-12		M		T			M		F			Q		M			M		T				

Bloom's Taxonomy of Educational Objectives



Overall Course Learning Objectives

- To obtain a solid understanding of the fundamental disciplines of aerospace engineering (F, M, S and T) and to perceive the common intellectual threads in these disciplines
- To be able to apply the fundamental principles to solve basic engineering problems
- To acquire the fundamental skills, the basic knowledge and sensitivities of a successful engineer (technical knowledge, team work and communication skills, self-education, professionalism)

Active Learning

- What is Active Learning?
 - Teaching techniques that stress students' active involvement in their own learning
 - “. . . interactive engagement of students in heads-on (always) and hands-on (usually) activities which yield immediate feedback through discussions with peers and/or instructors.” [Hake]
- Why active learning?
 - Increased gain in understanding
 - Provides more feedback to instructors
 - More motivating to students
 - Accommodates different learning styles

Active Learning Methods

- Cooperative activities
 - Opening organizing discussion
 - Concept questions
 - Turn-to-your-partner discussions
- Individual activities
 - Opening questions on understanding
 - Muddiest part of the lecture
 - etc.

Concept Questions

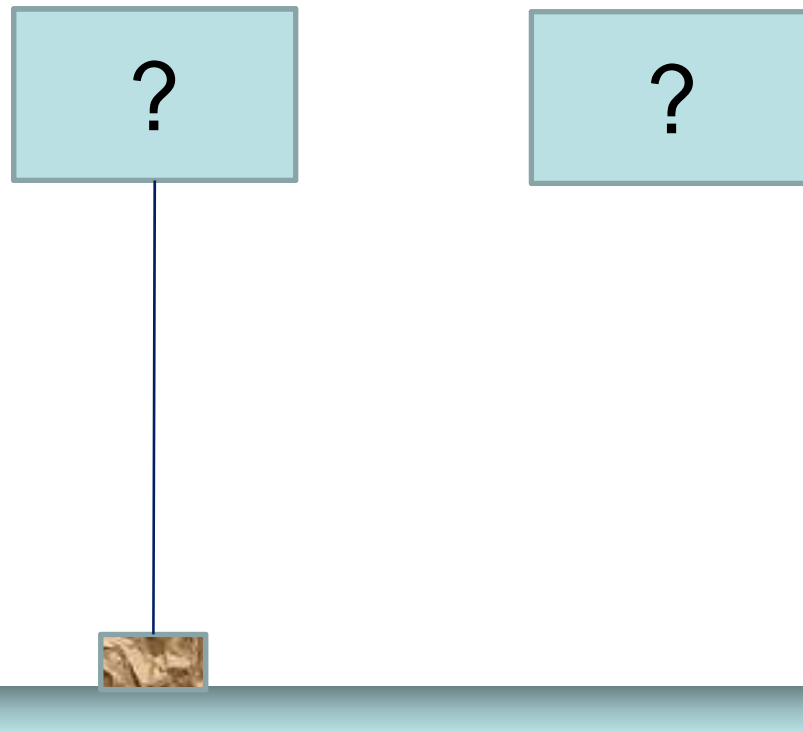
- Questions are
 - Conceptual
 - Multiple choice
 - Brief
 - Designed to surface misconceptions
- Use PRS (personal response system) to determine class response
- Benefits
 - Confidential
 - Simultaneous
 - Provides continual feedback to both students and teacher

What is a Concept Question?

- An example is given in the next slide
- The question is based on the direct application of a fundamental principle or characteristic
- The question has an answer which can be stated simply
- The answer can be reasoned without calculation
- The question and its answer serve as analogies, or springboards, to other situations or classes of problems
- The arguments (train of logic) by which you came to the answer involve some approximations so their validity has limitations
- You can articulate these approximations and the limits
- **You can define the concept(s) which the question illustrates**

Example: Magic Box

Consider a weight connected via a rope to a box of unknown content. Initially the weight is on the ground. Suddenly, the weight is drawn up into the box. Which of the statements is correct?

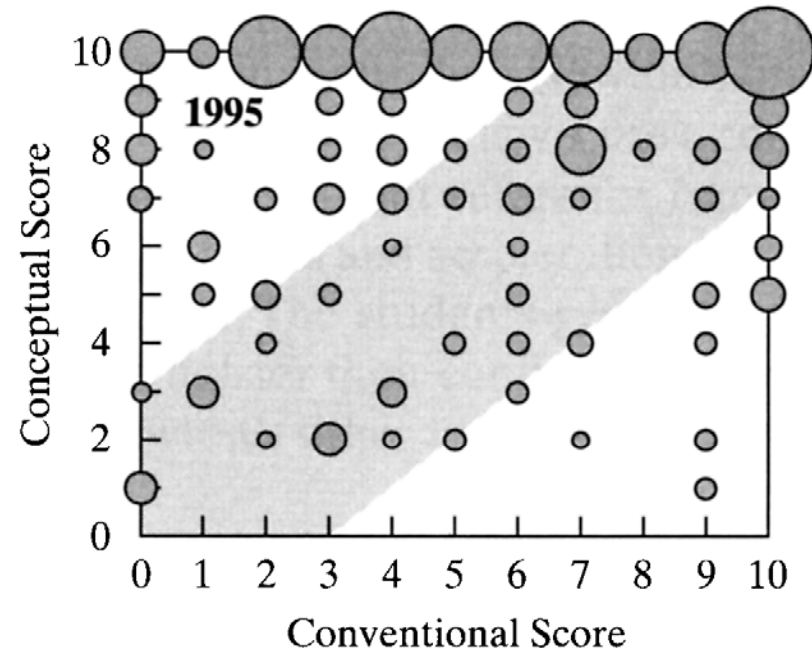
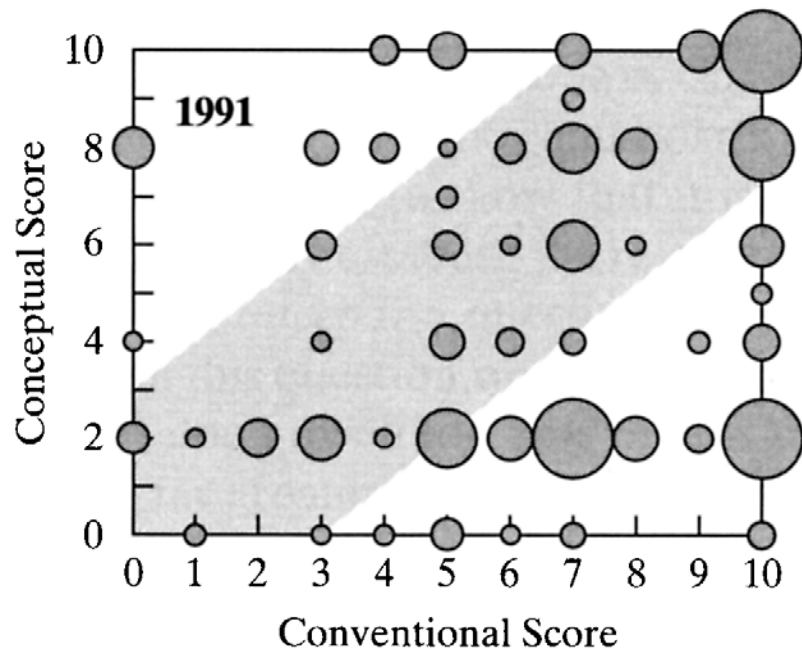


The energy in the box:

- 1) increases
- 2) stays the same
- 3) decreases

Effectiveness of Peer Instruction

- Data taken over a number of years generally show that Peer Instruction results in a better learning outcome
 - Equal or better performance on “conventional” problems
 - Better performance on conceptual problems



Muddiest Part of the Lecture

- Procedure:
 - Decide on question (e.g., “What was most confusing concept?” “What was most important concept?”)
 - Allow time at end of lecture for students to write responses
 - Collect responses
 - Respond at next class or through some other mechanism
- Benefits:
 - Gives instant feedback to instructor
 - Allows corrective action early
 - Allows reflective time for students
 - More effective than “are there any questions?”

Problem Solving in Engineering

- Define the problem; break it down, layout a sketch
- Identify critical elements, forces, flows, boundaries, known quantities
- State applicable assumptions and reasons they apply
- Identify the unknowns
- Apply fundamental principles
- Use auxiliary information as needed
- Solve for unknowns
- Discuss your results; validate your results
- Prepare a professional presentation

Resources

- Web site: web.mit.edu/16.unified/www
 - Course Facts
 - Syllabi
 - Learning objectives
 - Class notes
- Textbooks
 - See list in course facts
- Faculty and TFs

Grades

- Grades are based on:
 - Quizzes (70%)
 - Problem Sets and Systems Problems (25%)
 - Participation (5%)
- Grades are based on MIT definition of grades, not a curve
- For every assignment, we publish the middle “B” grade

Quiz Policy

- Absences from quizzes can be excused only under one of the following circumstances:
 - You have a verifiable, serious medical illness or serious personal emergency, confirmed by Counseling and Support Services. **You must notify us in advance of the quiz.**
 - If you have a foreseeable conflict for valid educational reasons. You must request permission to reschedule the Quiz **at least two weeks prior to the quiz** (or earlier if you need to make travel commitments). Requests are granted at the discretion of the course staff
- There are no make-up quizzes for unexcused absences.

Academic Honesty

- Please read Course Facts carefully
- Our guidelines allow collaboration (but not copying) on homework, so long as appropriate attribution is given
- Academic dishonesty is a serious breach of our rules, and will be treated as such

Responsible Learning – How to Do Well in Unified

- Take control of your learning [priority]
- Come to class
- Participate, remain active
- Work smart
- Read the textbook; read ahead of the lecture
- Maintain good physical and mental health
- Ask for assistance

Learning Tips

- ***Do the reading assignments*** and review lecture material on a regular basis; take notes in class to process the material
- ***Review the course notes / books / handouts*** after lecture to further digest the material and to acquire fluency in using concepts (reflect on what things mean rather than memorize equations)
- ***Do the homework in time*** ... It is crucial that you spend “soak” time with the material to internalize the concepts and their application
- We strongly suggest that you first try to solve the problems **by yourself** and then discuss challenges in **groups** or in **office hours** if necessary

Homework Solutions

- Please use separate sheets of paper for each problem
- Write your name on the sheets
- Clearly indicate who you worked with on every question you turn in
- You don't need to type up your solutions but please write legibly
- State your assumptions and display graphs and equations neatly
- Explain your solution clearly and interpret your results
 - Clearly identify intermediate results and their importance
 - Units must be explicitly worked and identified in all work and solutions
- Box your final answer
- Summarize the concepts you have used to solve the problem on the top of the page

The grading weight between numerical results and conceptual results may vary from problem to problem

Sample Homework

The sample homework problem given here is meant to illustrate the proper way to write up a problem solution; you will see the concepts relevant for this problem in lecture later.

Problem 1

During a reversible process executed by a closed system, the pressure increases from 345 kPa to 1,380 kPa in accordance with $pV = C$, and the internal energy increases by 22,575 J. The initial volume is $V_1 = 85$ l. Find the heat transferred.

Sample Homework Solution

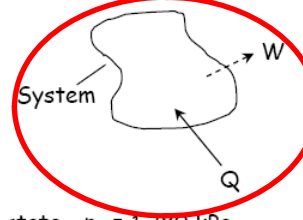
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Problem 1

Tim Target

Concepts used to solve problem:

- 1st law of thermodynamics for a control mass
- Work and heat
- State changes



Known: Initial state $p_1 = 345 \text{ kPa}$

Final state $p_2 = 1,380 \text{ kPa}$

$$V_1 = 85 \text{ l} = 0.085 \text{ m}^3$$

Find: Heat transfer Q given a known change in internal energy $\Delta U = 25,575 \text{ J}$

Using 1st law of thermodynamics and neglecting potential and kinetic energies yields $\Delta U = Q - W$, where Q is the heat transfer to the system and W is the work done by the system. So the heat transfer becomes

$$Q = \Delta U + W$$

The work done by the system is: $W = \int_1^2 p dV$ (note that work is path dependent)

Knowing that $pV = C$ or $p = C/V$, the work becomes: $W = C \int_1^2 \frac{dV}{V} = C \ln(V_2/V_1)$

The constant C can be found from the initial state $p_1 V_1 = C$, and the volume ratio can be expressed in terms of the pressure ratio as $V_2/V_1 = p_1/p_2$ such that

$$W = p_1 V_1 \ln(p_1/p_2)$$

From 1st law one can thus find the heat transfer $Q = \Delta U + p_1 V_1 \ln(p_1/p_2)$

$$Q = -15,078 \text{ J}$$

The negative sign indicates that heat is rejected by the system.

What can you expect from us?

- Commitment to effective teaching
- Technical excellence
- Highest professional standards
- Intensive engagement with you in the teaching-learning process
- Trust and mutual respect

What do we expect from you?

- Responsibility and commitment to learning
- Achievement of learning objectives
- Highest professional standards
- Intensive engagement with us in the teaching-learning process
- Trust and mutual respect
- Feedback – what works, what doesn't work

What can you expect from Unified?

- Expect to be challenged
- Expect to work hard
- Expect to learn a lot
- Expect to have fun