

Thermodynamics I

Course Number: ENGR 3012, Spring 2008
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Office Hours: M,W 2:45 to 3:45 PM
Classes: M,W 4:00 to 5:15 PM, Room NC1511
Text: Thermodynamics, An Engineering Approach,
by Y. Cengel and M. Boles, 6th edition¹.

WHAT THIS COURSE IS ABOUT

Thermodynamics is about ENERGY. It is about energy storage, transformation and transport. And its about how we use material (working fluids) to store, transport and convert energy from one form to another. Engineers use thermodynamics to design and analyze energy conversion systems like aircraft propulsion systems, fuel cells, submarines, sports cars, refrigeration systems, chemical processes, solar cells and electricity generating systems such as nuclear and thermal powerplants.

This course will cover the first law of thermodynamics (that energy is conserved) and the second law (real processes produce entropy and dissipate the *value* of energy). The second-law of thermodynamics imposes the upper limit on the performance of energy conversion processes. Although the second-law is most often applied to energy conversion systems, it applies in general to all processes that occur in nature including living systems and processes like photosynthesis. The second law of thermodynamics is one of the most profound and well established laws of physics.

Topics Covered:

Properties, State Relationships, Forms of Energy – chapters 1, 2, and 3

1st Law of Thermodynamics: Energy is conserved, it is neither created or destroyed² - **chapter 4,5**

2nd Laws of Thermodynamics: Real processes create entropy (a measure of disorder) and dissipate the value of energy – **chapters 6 and 7**

¹ The 4th and 5th editions can be used although you may need to get the assignment questions from someone with the 6th edition.

² Except in processes such as nuclear fission or fusion, or particle accelerator experiments, where mass is converted to energy or vice versa according to Einstein's relation $E = mc^2$. With these nuclear processes it is the combination of energy and mass that is conserved.

Thermodynamic cycles for heat engines, gas turbines, and steam turbines, refrigeration, and heat pumps – **chapters 9, 10 and 11**

Approximately eight assignment sets will be assigned and usually due after a week and a half. Your lowest homework mark will be discarded and will not be included in your homework average – the average will be computed from the seven highest marks. Late homework must be turned in before the answers are reviewed in class and the following penalties apply to late submissions:

If due on a Monday: -10% for Tues., -15% for Wed before class
If due on a Wednesday: -10% for Thur., -15% for Fri, and -25% for the following Monday before class

There will be a midterm and final, and the final will be comprehensive. On tests you are responsible for all the material covered in class as well as the material covered in the homework assignments and any reading assignments (if given). There will be no extra credit problems.

	Option I	Option II
Grading: Assignments	30%	30%
Midterm	25%	35%
Final	45%	35%

Your Maximum of options I or II will automatically be calculated and selected for you – you do not have to specify a choice.

References:

- G. N. Hatsopoulos and J. H. Keenan, *Principles of General Thermodynamics*, Academic Press, 1965.
- J. Kestin, *A Course in Thermodynamics*, Vol. I and Vol. II, Blaisdell, 1966.
- A. Bejan, *Advanced Engineering Thermodynamics*, John Wiley and Sons NY, 2nd edition, 1997.
- K. Wark and D. E. Richards, *Thermodynamics*, 6th edition, McGraw Hill NY, 1999.
- H. B. Callen, *Thermodynamics and Introduction to Thermodynamics*, 2nd edition, Wiley, 1985.
- P. Pippard, *The Elements of Classical Thermodynamics*, Cambridge U.P., 1960.

ENGR 3012 Spring 2008 Tentative Schedule (Jan 22nd)

Class #	Day of Week	Date	Assignments			Topics
			Assign	Due	Review	
1	W	23-Jan				Introduction to course
2	M	28-Jan				ch 1: Basic Concepts (units, T, P, ρ, v , systems, state, equilibrium)
3	W	30-Jan	#1			chapter 1 ($\rho g h$, hydraulics)
4	M	4-Feb				chapter 1 (manometers, barometers, problem solving)
5	W	6-Feb				ch 3: Property Relations and Tables (phases, processes, diagrams)
6	M	11-Feb	#2	#1		chapter 3 (property tables, compressibility charts, Van der Waals)
7	W	13-Feb			#1	Chapter 4 sections 4-3 to 4-5 (U, H, C_p and C_v)
8	M	18-Feb				Energy Transfer (Forms of energy, heat, work, 1st law)
9	W	20-Feb	#3	#2		chapter 2 (Forms of energy, heat, work, 1st law)
10	M	25-Feb			#2	chapter 4 (4-1 boundary work)
11	W	27-Feb				chapter 5 (5-1 Mass transfer, 5-2 flow work and energy in a fluid)
12	M	3-Mar	#4			First Law of Thermodynamics (4-2 For closed systems)
13	W	5-Mar		#3		chapter 5 (closed and open systems)
14	M	10-Mar			#3	chapter 5 (steady flow, and unsteady systems)
15	W	12-Mar		#4		chapter 5 (steady flow, and unsteady systems)
16	M	17-Mar		#4	#4	Review for midterm
17	W	19-Mar	#5			Midterm
No Class	M	24-Mar				<i>Spring Break</i>
No Class	W	26-Mar				<i>Spring Break</i>
18	M	31-Mar				ch 9: Otto Cycle (Spark Ignition Engine)
19	W	2-Apr	#6	#5		ch 9: Brayton (Gas Turbine)
20	M	7-Apr				No Class
21	W	9-Apr			#5	Finish Brayton and start ch. 6/7 Second Law and Entropy
22	M	14-Apr	#7	#6		chapter 6/7
23	W	16-Apr				chapter 6/7, Start ch. 10 Rankine (Steam Power Plant)
24	M	21-Apr			#6	Rankine (ch. 10)
25	W	23-Apr				ch 11: Refrigeration and Heat Pump Cycles
26	M	28-Apr	#8	#7		Refrigeration/Heat Pump
27	W	30-Apr			#7	Refrigeration/Heat Pump
28	M	5-May				Review Class #1
29	W	7-May		#8	#8	Review Class #2
Final Exam: ?? to ?? PM NC1511						