2015 May Term

ME 2331 Thermodynamics
(co-listed as CEE 2331)

By Prof. J. L. Lage
Department of Mechanical Engineering
SMU

Course Description

Classical Thermodynamics is the study of energy interactions between a domain and its surroundings. Human fascination for energy can be traced back to the primordial times, when fire was discovered as a defense weapon and as a warming and lighting mechanism. The discovery of steam, over two-thousand years ago by the Greeks, attracted again the human attention to the use of thermal energy. The 19th hundreds, in particular, marked an epoch of great advances in Thermodynamics guided primarily by the potential of useful work production. The advent of the First and the Second Laws of Thermodynamics during this period are now the pillars for the design, operation, and the economic as well as engineering feasibility determination of all energy systems.

Guided by the contemporary need for energy conservation, optimization, alternative energy sources, and the minimization of environmental impact, the course introduces both, First and Second Laws of Thermodynamics concurrently to the students. With these two concepts hand-in-hand, the students perform complete analyses of energy systems by learning to formulate the energy conservation equation (First Law, energy quantity), and the entropy conservation equation (Second Law, energy quality), applicable to any energy process. The mastering of the First and Second Laws is accomplished by considering, throughout the course, many practical engineering systems executing simple processes, such as the pressuring of a tire or the boiling of water (for cooking), or executing complex processes, such as the power producing by an internal combustion engine or the production of electricity to feed an entire city by a nuclear power plant.

Instructor

Lage is an accomplished, internationally recognized Professor of Mechanical Engineering at SMU, where he started his career in 1991, immediately after obtaining his PhD from Duke University. He is the author of several book chapters and over two-hundred articles, a registered Professional Engineer in the State of Texas, a Fellow of the American Society of Mechanical Engineers (ASME), and a Member of the International Centre for Heat and Mass Transfer Scientific Council. He currently serves as the Associate Editor of the Journal of Heat Transfer (ASME) and as an Editorial Board Member of the International Journal of Mechanics and Thermodynamics.

He has over twenty years of experience developing research projects and teaching thermo-fluid courses, including Thermodynamics, at the undergraduate and graduate levels. At SMU, he has in the past few years brought together his academic experiences as a student and as a Professor into a new strategy for teaching Thermodynamics, one in which theory and practice are presented side-by-side, and the developing analytical skills (mathematics) becomes rooted in a strong physics understanding of the subject. A consequence of his efforts has been the production of a *blitzkrieg* strategy to Thermodynamics learning, which paves the way for mastering the most cumbersome concepts of the subject in a very efficient and rapid way. This engaging, very efficient teaching strategy fits very well with the fast-pace May-term concept.

Benefits/Learning outcomes

At the end of the course students will:

- be able to identify and analyze energy processes in the framework of classical Thermodynamics;
- be able to determine initial and final states, identify common energy forms, such as kinetic, potential, internal thermal, heat and work, and forecast the efficiencies of energy processes;
- know how the various energy forms interact, and predict their variations through the energy conservation equation (First Law);
- be able to apply the conservation of entropy equation (Second Law) to predict the feasibility and irreversibility of a process, and the degree of lost useful work, which essentially relates to energy quality;
- be able to identify, simulate and predict the performance of: (a) practical devices commonly used in the energy industry, such as: heat exchangers, boilers, condensers, evaporators, diffusers, turbines, open feed-water heaters, pumps, compressors, and expansion valves; and, (b) complex systems, such as: power plants (e.g., heat engines, internal combustion engines), refrigerators, and heat-pumps.

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ME/CEE 2331
Thermodynamics
Room: TBD
Mo/Fr: 8 am to noon (May 14 – May 29)

May-Term - 2015

Objectives: Demonstrate ability to perform energetic and entropic analysis of energy processes (e.g., compressing, heating), devices (e.g., boilers, turbines, pumps, heat exchangers) and systems (e.g., heat engines, refrigerators/heat pumps) running simple substances (e.g., water, ammonia, helium).

Catalogue: The first and second laws of thermodynamics and thermodynamic properties of ideal gases, pure substances, and gaseous mixtures are applied to power production and refrigeration cycles.

Prerequisite: MATH2339, CHEM1303, ME/CEE2310

Textbook: *Fundamentals of Thermodynamics*, C. Borgnakke, R.E. Sonntag 8th Ed, Wiley, 2012.

Topics:

- Applications of Thermodynamics, macroscopic vs. microscopic view, continuum concept
- Fundamentals: Control Mass vs. Control Volume; Property, State & Process
- Thermal equilibrium; Zeroth law; Temperature scales; P-v and T-S diagrams; Steam tables; Definition of h, u, C_p and C_v
- Constitutive Equations: Ideal Gases; Incompressible Substances
- Balance Equations: First Law - Work & Heat; Second law - Entropy, Entropy Generation
- Non-cyclic, Flow, Cyclic Processes
- Gas Mixtures: Psychometry

Grading:

Attendance	10%
In-class quizzes	30%
Test 1 (May 21)	30%
Test 2 (May 29)	30%
Total:	**100%**

A ≥ 3.8	C+ ≥ 2.8
A- ≥ 3.6	C ≥ 2.6
B+ ≥ 3.4	C- ≥ 2.4
B ≥ 3.2	D+ ≥ 2.2
B- ≥ 3.0	D ≥ 2.0
	F ≥ 0.0

Course Policies:

2. Class attendance is mandatory: grade "F" if less than 75% attendance (waived if tests averaged > 85/100)
3. Deadlines are strictly enforced – no extensions
4. Use of name card is mandatory during lectures
7. The SMU Honor Code is strictly enforced

Course outcomes: Students will attain ability to …
- apply knowledge of mathematics, science, and engineering in solving thermodynamics problems
- identify, formulate, and solve thermodynamics problems

Disability Accommodations: Students needing academic accommodations for a disability must first be registered with Disability Accommodations & Success Strategies (DASS) to verify the disability and to establish eligibility for accommodations. Students may call 214-768-1470 or visit http://www.smu.edu/alec/dass.asp to begin the process. Once registered, students should then schedule an appointment with the professor to make appropriate arrangements.
Religious Observance: Religiously observant students wishing to be absent on holidays that require missing class should notify their professors in writing at the beginning of the semester, and should discuss with them, in advance, acceptable ways of making up any work missed because of the absence. (See University Policy No. 1.9.)
Excused Absences for University Extracurricular Activities: Students participating in an officially sanctioned, scheduled University extracurricular activity should be given the opportunity to make up class assignments or other graded assignments missed as a result of their participation. It is the responsibility of the student to make arrangements with the

instructor prior to any missed scheduled examination or other missed assignment for making up the work. (University Undergraduate Catalogue)