AME 20231–Thermodynamics
Spring 2013

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Office hours: W: 9:00-11:00 AM		

TA's affiliated with the T-Th 20231 session: Xufei Wu, Xin Mu

Office hours for TA pool: 364 Fitzpatrick
M: 3-5 PM, Kathryn Gordon
Tu: 10-12 AM, Na Yu
W: 5:30-7:30 PM, Xufei Wu
Th: 4-6 PM, Xin Mu

Course web site: http://www.nd.edu/~powers/ame.20231

Listserver address: ame20231-01-sp13@acadlist.nd.edu. When e-mail is sent to this address, the entire class will receive a copy of the mail.

Lecture time and location: MWF, 11:45 AM-12:35 PM, 102 DeBartolo Hall
Optional discussion session: Mondays, 7-8 PM, 138 DeBartolo; Tuesday, 7-8 PM, 155 DeBartolo

Prerequisites: Calculus III. Though not required, Mechanics I will be useful.

Catalog description: "Basic concepts of thermodynamics. The First Law of Thermodynamics. Work, heat, properties of substances and state equations. The Second Law of Thermodynamics. Applications to engineering systems."

Comments: The course will consider the fundamental science of classical thermodynamics and its practical applications. Problem solving will be emphasized, including problem formulation, analytic, and computational solutions.

Topics:

- Some introductory comments: some definitions, some history, some philosophy, relevance of thermodynamics to engineering applications,

- Concepts: property, state, system, process, temperature, pressure, density, volume, energy, units, zeroth law of thermodynamics,

- Properties of a pure substance: vapor/liquid/solid phase equilibrium, independent properties, thermal equation of state, tables of properties, ideal gas limit, some non-ideal state equations, interpolation,

- Work and heat: some mathematics, simple compressible systems, work, heat,

- The first law of thermodynamics: classical formulation of the first law, internal, kinetic, and potential energy, enthalpy, constant pressure and constant volume specific heats, tables of energy and enthalpy, constant and temperature-dependent specific heats for ideal gases, time-dependency,

- First law analysis for a control volume: detailed derivations, control volume mass conservation, first law formulation for control volume, steady-state processes, transient processes, devices, introduction to the Rankine cycle,

- The second law of thermodynamics: statements of the second law, heat engines and refrigerators, reversible processes, absolute temperature scale, Carnot cycles,

- Entropy: theoretical development, second law in terms of entropy, the Gibbs equation, entropy for ideal gases, entropy change for reversible and irreversible processes, tabulation of entropy, adiabatic reversible processes for ideal gases, entropy of mixing, probabilistic approach,

- Second law analysis for a control volumes: irreversible entropy production, Bernoulli's principle, steady state and transient formulation, efficiency of components,

- Cycles: Rankine, Brayton, refrigeration,

- Mathematical foundations: Maxwell relations, Legendre transformations, heat capacity, real gas behavior and non-ideal equations of state, adiabatic sound speed, introduction to compressible flow.

Course notes

J. M. Powers, Lecture Notes on Thermodynamics, `http://www.nd.edu/∼powers/ame.20231/notes.pdf`

Texts available in Bookstore

C. Borgnakke and R. E. Sonntag, 2009, *Fundamentals of Thermodynamics*, Seventh Edition, John Wiley.

H. C. von Baeyer, 1998, *Warmth Disperses and Time Passes: The History of Heat*, Modern Library.

Required Work and Grading

A student who wish to insure his or her privacy can elect to put his or her Notre Dame ID on their submitted written work in place of their name. A student can also elect to put his or her name on their work. Students can also elect to put both on their work!

Exams will be open book, closed notes and held in class. The final exam will be comprehensive.

Homework will be assigned weekly, and generally due at the beginning of class on Friday. All homework will be graded and returned. Homework must be done on *one side only* of 8 1/2" by 11" *engineering* paper with no frayed edges. Multiple pages must be stapled. You should briefly restate the problem, give a sketch if helpful, give all necessary analysis, and place a box around your final answer. All plots must be computer generated, trimmed, and taped to engineering paper. Label all axes. Raw `mathematica` output will not be graded. Neatness and effective communication are considered in grading as well as the final answer itself.

Short closed book, closed notes quizzes will be given on a regular basis. Generally these will be on Friday, but they may be given without prior announcement at the instructor's discretion.

Two short (one page maximum) critical reviews of works from the literature will be required. The first will be a review of the von Baeyer book. The second review must consider an article on thermodynamics from the technical journal *Nature* and consider some aspect of thermodynamics related to energy. Detailed technical articles should be studied, not news summaries. The reviews are required to be written in a LaTeX format and will be checked primarily for style, format, grammar, and content.

I will make arrangements for a tour of the Notre Dame power plant. Attendance will be required.

Attendance in class is expected.

An Office of Student Affairs-approved written excuse will be required in order for any consideration to be given for any required work (for example, examinations, quizzes, or homework) which is not completed at

the expected time. The instructor reserves the right to require all work to be completed to receive a passing grade.

Grades will be assigned based on students' performance on examinations, quizzes, homework, and papers. Pertinent information is as follows:

Exam I	15	Tuesday, 12 February 2013, 8:00-9:15 AM, Location: 129-131 DeBartolo Hall
Exam II	15	Tuesday, 9 April 2013, 8:00-9:15 AM, Location: 129-131 DeBartolo Hall
Final Exam	40	Thursday, 9 May 2013, 7:30-9:30 PM, 127 Nieuwland Hall
Quizzes	15	generally on Fridays
Homework	13	generally on Fridays
Reviews	2	Friday, 22 February 2013;
		Friday, 12 April 2013
Total	**100**	

Honesty Policy

Academic honesty is expected. When confronted with an apparent violation, I will enforce the appropriate University regulations to the best of my ability. I will also try to make my expectations clear. By and large, though, these issues are out of my control and as such I do not seek out violations. Instead, I depend upon your basic integrity to prevent any problems.

In brief my expectations are as follows. I encourage you to freely discuss the homework amongst one another as you formulate your solutions *individually*. *Your* written work should represent *your* understanding of the problem. In practice this means copying (in whole or in part) another student's homework, exam, computer program, or paper is *not* permitted. Copying homework from web-based answer keys is also considered to be an honor code violation. If you choose to discuss your work with a colleague, it should be a discussion in which one teaches another or both work to a mutual understanding. As a counter-example, it is not acceptable to give a friend your homework five minutes before class so that friend can copy your work. I also consider it unacceptable to copy work from a student who was in the class in a previous year. In your written reports, be careful to correctly use quotation marks for words that did not originate with you. Paraphrasing should be held to a minimum, but if used, the paraphrased section should be specifically identified and unambiguously cited. It is not sufficient to simply list a reference but not indicate where a specific quotation or paraphrase was employed. In addition all sources used should be fully cited. As is done in the scientific literature, you should *briefly* acknowledge in writing any significant discussions or interactions you had regarding the work you submit. As a general principle, I do not accept the justification that you were not sure of my intentions. If you feel you may be in an ethical grey area, then you should consult with me *before* acting.