AME 20231: Thermodynamics

Spring Semester 2011
MWF 8:30-9:20 am
DeBartolo Hall 136

Instructor: Frank P. Incropera (fpi@nd.edu)
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Office Hours:

Incropera, MWF 10:00-11:30 am, Fitzpatrick 361
Ardekani, Tu 4:45-6:00 pm, Th3:30-4:45 pm, Fitzpatrick 369
Assistants, W 1:00-5:00 pm, Fitzpatrick 364
Th, 9:00-11:00 am, 3:00-5:00 pm, Fitzpatrick 364

Course Description

Of the problems to be encountered by today's engineering students *throughout their careers*, none is more important than that of shaping a *sustainable energy future*. The supply of nonrenewable fossil fuels, which currently provides more than 80% of the world's *primary energy,* is being depleted, and it is problematic whether other sources, such as nuclear and renewable energy, can be developed at *scales* sufficient to meet growing world demand. The challenge is great, but it can be met through engineering innovation, large capital investments, and reexamination of consumption patterns commensurate with achieving an acceptable standard of living.

The subject of *thermodynamics* is central to the study of energy conversion and utilization, as well as to the development of related technologies. In fact, the subject itself evolved from efforts to understand the essence of energy and the laws of nature that govern the use of energy. This course therefore provides an essential foundation for dealing with energy conversion processes and systems. It does so by introducing the thermodynamic properties of matter used to characterize energy systems and by developing a theoretical framework for predicting system performance.

Learning Objectives

Students completing this course are expected to:

- understand the nature and role of the following *thermodynamic properties of matter*: *internal energy*, *enthalpy*, *entropy*, *temperature*, *pressure* and *specific volume*;
- be able to access thermodynamic property data from appropriate sources;
- be able to chart *thermodynamic processes* on appropriate *thermodynamic diagrams*, such as a temperature-entropy or pressure-volume diagrams;
- be able to represent a thermodynamic system by a *control mass* or *control volume*, distinguish the system from its *surroundings*, and identify *work* and/or *heat interactions* between the system and surroundings;
- recognize and understand the different forms of energy and restrictions imposed by the *First Law of Thermodynamics* on conversion from one form to another;
- be able to apply the First Law to a control mass or control volume at an *instant of time* or over a *time interval*;
- understand implications of the *Second Law of Thermodynamics* and limitations placed by the Second Law on the performance of thermodynamic systems;
- be able to use *isentropic processes* to represent the *ideal behavior* of a system;
- be able to quantify the behavior of power plants based on the *Rankine cycle*, including the effect of enhancements such as *superheat*, *reheat* and *regeneration*;
- be able to quantify the performance of power plants and turbojet engines based on the *Brayton cycle*, including the effects of enhancements such as *reheat*, *regeneration* and *intercooling*;
- be able to quantify the performance of *refrigeration* and *heat pump systems*;
- understand the basic principles of *combustion* and be able to apply conservation of mass and the First Law to combustion processes;
- understand the nature and role of advanced power production options such as *ultra supercritical pulverized coal* (USCPC), *combined heat and power* (CHP), *oxy-fuel combustion* (OFC), *combined cycle* (CC), and *integrated gasification and combined cycle* (IGCC) systems.

Textbook: *Fundamentals of Engineering Thermodynamics*, 7th Edition, by M.J. Moran, H. N. Shapiro, D.D. Boettner and M.B. Bailey. John Wiley and Sons, 2011.

Student Evaluation: Grades will be based on the following point distribution:

- homework problems and quizzes (15),
- three, hour-long examinations (50), and
- final examination (30).

Academic Code of Honor: ***As a member of the Notre Dame community, I will not participate in academic dishonesty.***

- Although collaborative study has educational value and is encouraged, all submitted homework must be that of the student.

    - A student may not copy another student’s homework solution and may not draw on accessible solution manuals.
    - Written work that plagiarizes or paraphrases the work of others is not acceptable. A student must be the sole author of submitted essays.
- A student may not give or receive unauthorized aid on a quiz or exam, whether administered in class or taken at home.
- If you become aware of an Honor Code violation, you must notify either the instructor or the Honesty Committee of the department within which the course is taught.