ME 311-Thermodynamics: Lecture 1

1. (a) Introduce instructor (setting office hours)
   (b) Check student registration (pre-requisites; e-mail contacts)

2. Set class rules including:
   (a) Grading policy
   (b) Requirements on homework & quizzes
   (c) Use of text book
      - Thermodynamics I
      - Thermodynamics II

3. What is "thermodynamics" and typical applications
   (a) Hydraulic turbine (potential energy into kinetic energy; then into shaft work)
   (b) Car engine (chemical energy into heat; then expansion work into shaft work)
   (c) Steam power plant (heat into work; then into kinetic energy; then into electric energy)
   (d) Air conditioning system (work into reduced "heat" – reversed cycle)

4. Forms of Energy and thermodynamics laws
   (a) Forms of energy
      - Potential energy (gravity-defined)
      - Kinetic energy (organized velocity related: linear; rotation; vibrating of macro-scaled matter)
      - Internal energy
         • randomly velocity related: linear; rotation; vibrating of micro-scaled matter such as molecules and electrons
         • molecular bonding (realized from chemical reactions – change of molecules)
         • nuclear bonding (realized from nuclear reactions of fission or fusion – change of nuclear matter or element)
      - Work
         • mechanical work (shaft work; spring work; elastic tension; or into raising or accelerating a body)
         • non-mechanical work (electrical, magnetic or polarization work)
   
   (b) Thermodynamics laws
      - zeroth law (define temperature)
      - first law (general energy conservation)
      - second law (define energy transfer direction: from higher entropy to lower entropy for an isolated system)
      - third law
         • absolute temperature is unreachable; or
• energy cannot be transformed into work with 100% efficiency; or
• define exergy: energy that can be transformed into work

5. Energy transfer and course arrangements
(a) Thermodynamics (overall energy transfer in quasi-equilibrium process):
   - entire system is always uniform;
   - stationary;
   - energy transferred instantly;
   - transfer intensity without material limit
(b) Heat Transfer (non-uniformity; finite transfer rate and transfer intensity)
(c) Fluid Mechanics (simple compressible work in form of pressure into kinetic energy and potential energy of fluid):
(d) Advanced application-oriented subjects:
   - Combustion
   - HVAC (heating, ventilating, air conditioning & refrigeration)
   - Turbine machinery

6. Basic thermodynamic properties and units (SI & English)
   - Mass and Weight
     • kg
     • lbm; slug (=32.174 lbm)
     • Weight = mg:
       - Weigh of 1 kg mass = 9.8 N
       - Weight of 1 lbm mass = 1 lbm × 32.174 ft/s² = 1 lbf
   - Length, area and volume
     • m; m²; m³
     • ft; ft²; ft³
   - Temperature
     • relative temperature: °C; F
     • absolute temperature: K; R
     • T(K) = T(°C)+273.16
     • T(R) = T(F)+459.67
     • T(F) = 1.8T(°C)+32
   - Force
     • 1 N = 1 kg × 1 m/s²
     • 1 lbf = 1 slug × 1 ft/s²
   - Pressure (force per unit area)
     • absolute pressure: Pa; atm; bar; mmHg; mmH2O; psi
     • relative pressure: psig
       - gauge pressure = P – atm
       - vacuum pressure = atm – P
       - manometer pressure = P₁-P₂
       - Pascal's law: hydraulic pressure at the same height in a static fluid system is the same
* Ex 1-6; Ex 1-7

- Work, heat, and power (work per unit time)
  - $1 \text{ J} = 1 \text{ N} \times 1 \text{ m}$
  - $1 \text{ Btu} = $ energy for 1 lbm (of water) to increase 1 F
  - $1 \text{ calorie} = $ energy for 1 g (of water) to increase 1 °C

- Heat
  - sensible heat
  - latent heat

7. First Law of Thermodynamics
   - Isolated System; Closed System; and Open System
   - Energy conservation
   - Examples
     - energy conversions (Ex 2-8; Ex 2-9)
     - energy conservation (Ex 2-10; Ex 2-12; Ex 2-16)

Homework Assignment-1 (Due on Jan 25)

1-85; 1-94; 1-111; 1-114; 2-32; 2-37; 2-77; 2-123