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B.TECH
ME-102

Second Semester Examination – 2015

BASIC THERMAL ENGINEERING

BRANCH: EEE/ETC

Time: 3 Hours

Max marks: 50

Answer any five.

The figures in the right hand margin indicate marks.

1. a) Define gauge pressure, vacuum and absolute pressure with a sketch. [3]
   b) With suitable example differentiate between intensive and extensive properties. [2]
   c) Cite engineering applications where nozzle and compressors are used. [2]
   d) A sample of steam is at 5 bar, 0.7 quality and occupies a volume of $4m^3$. Calculate the mass of this sample of steam. [3]
2. a) What is point function and path function? Give two examples for each kind. [4]
   b) A mass of air is initially at 260°C and 700 kPa, and occupies 0.028 m^3. The air is expanded at constant pressure to 0.084 m^3. A polytropic process with n = 1.5 is then carried out followed by a constant temperature process which completes a cycle. All the processes are reversible.
   i) draw the *p-v* diagram.
   ii) find the heat received and rejected in the cycle.
   iii) find the efficiency of the cycle. [6]

3. a) State the Steady Flow Energy Equation (SFEE) for throttling process. [2]
   b) Steam flows through a small turbine at the rate of 5000 kg/Hr. entering at 15 bar, 300°C and leaving at 0.1 bar with 4% moisture. Steam enters at 80m/sec at a point 2 m above the discharge and leaves at 40m/sec. Compute the power output assuming that the device is adiabatic but considering the changes in KE and PE. How much error would be made, if these terms were neglected? Calculate the inlet diameter. [8]

4. a) A fluid is confined in a cylinder by a spring loaded frictionless piston so that the pressure in the fluid is a linear function of the volume (p = a + bV). The internal energy of the fluid is given by the following equation:

$$U = 34 + 3.15\,pV$$

Where U is in kJ, p in kPa and V in m^3.

If the fluid changes from an initial state of 170 kPa, 0.03m^3 to a final state of 400 kPa, 0.06m^3, with no work other than that done on the piston, find the direction and magnitude of the work and heat transfer. [5]

b) 1.5 kg of liquid having a constant specific heat of 2.5 kJ/kg K is stirred in a well insulated chamber causing the temperature to rise by 15^{0}C. Find the ΔE and W for the process. [5]

5. Classify Internal Combustion engines on the basis of (i) Working cycles and (ii) Number of strokes. Explain with neat sketches (a) Working principle of 4-stroke petrol engine and (b) Working principle of two stroke petrol engine. (c) Mention significant differences. [2+3+3+2]

6. a) State and explain Clausius Inequality and entropy increasing principle. [5]
b) A heat engine used to drive a heat pump. The heat transfers from the heat engine and from the heat pump are used to heat the water circulating through the radiators of a building. The efficiency of the heat engine is 27% and the COP of the heat pump is 4. Evaluate the ratio of the heat transfer to the circulating water to the heat transfer to the heat engine. [5]

7. One kg of ice at -5°C is exposed to the atmosphere which is at 20°C. The ice melts and comes into thermal equilibrium with atmosphere.
a) determine the entropy increase of the universe.
b) what is the minimum amount of work necessary to convert the water back into ice at -5°C.
Take C_p of ice is 2.093 kJ/kg-K and the latent heat of fusion of ice is 333.3 kJ/kg. [10]