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B.TECH
ME-102

otal Number of Pages: 2

First Semester Examination – Dec.,2014

BASIC THERMAL ENGINEERING

BRANCH: CSE/IT

Time: 3 Hours

Max marks: 50

Answer any five.

The figures in the right hand margin indicate marks.

1. a) A manometer using mercury as the manometric fluid gives a reading of 2 cm when attached to a vessel containing a gas. If the local atmospheric pressure is 1 bar, what are the gauge and absolute pressure of the gas in the vessel? [2]

   b) A rigid vessel of volume $10m^3$ contains steam at 8 bar, 80 % dry. Additional steam is now introduced into the vessel and the steam finally becomes dry and saturated at 12 bar. What is the mass of steam introduced into the vessel? [6]

   c) Calculate the entropy change when 5 kg of saturated water is heated at 5 bar to get saturated vapor. [2]

2. a) Calculate R, C_p and C_v of carbon dioxide gas in SI units, given adiabatic index as 1.33. [5]

   b) A mixture of gases expands at a constant pressure from 1 MPa, $0.04m^3$ to $0.08\ m^3$ with 100 kJ heat transfer into the system. There is no work other than that done on the piston. Find the change in internal energy of the gaseous mixture. Also find the change in internal energy, work done and heat transfer for the process if the same mixture expands through the same path while 25 kJ of work is done on the system instead of the heat transfer. [5]

3. a) State the Steady Flow Energy Equation (SFEE) for a Nozzle considering ideal conditions. [2]

   b) Air enters a frictionless adiabatic nozzle with a velocity of 30 m/sec and at a state of 5 bars, 180° C and leaves at a pressure of 1 bar. Determine the velocity of air at the nozzle exit. [3]

   c) Steam enters the nozzles of a turbine with negligible velocity at 3MPa, 350°C and leaves the nozzles at 1.6 MPa with a velocity of 550 m/s. The rate of flow of steam is 0.5 kg/s. Calculate the condition for steam at nozzle exit and also the nozzle exit area. [5]

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 kg of air at 7 bar, 90°C undergoes a polytropic process which may be represented by $pv^{1.1}$ = constant, till the pressure falls to 1,4 bar. Find out:

(a) The final temperature.

(b) The final specific volume.

(c) The work done.

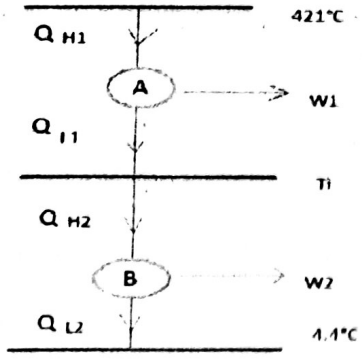
(d) The heat transferred.

(e) The changes in internal and enthalpy. [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) Prove the equivalence between Kelvin-Plank's statement and Clausius statement. [5]
(b) Air expands isothermally from 6 bar, 300K to 1 bar. For 10 kg of this air, determine the change in entropy. Derive any formula you use. Assume air to be ideal gas. [5]

7. a) Two reversible heat engines A and B are arranged in series as shown in the figure. Engine A receives 200KW of heat from a reservoir at 421°c and engine B rejects heat to a reservoir at 4.4°c.The power output of A is 3 times the power output of B. Find the following:



i) The intermediate temperature

ii) Efficiency of the two engines

iii) Heat rejection rate Q_{L2} for engine B. [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]