S.E (MECHANICAL ENGG) (SEM III) (CBSGS) 26th November, 2014
Thermodynamics 2.30 pm to 5.30 pm

QP Code : 14568

(3 Hours) **[Total Marks : 80**

NB:- i) Question no. 1 is compulsory

ii) Answer any three questions from remaining

iii) Use of steam table & Mollier chart is permitted.

1) Write a short note on any four of the following (5X4)

a) Zeroth law and its significance

b) Absolute thermodynamic temperature scale

c) Principle of entropy increase and its applications

d) Joule- Thomson porous plug experiment

e) Reheat Rankine cycle

2) a) State and prove Clausius Theorem (8)

b) A power washer is being used to clean the walls of house. Water at the rate of 0.1 kg/s enters at 20 °C and 1atm, with the velocity 0.2 m/s. The jet of water exits at 23 °C, 1 atm with a velocity 50 m/s at an elevation of 5m. At steady state the magnitude of the heat transfer rate from power unit to the surrounding is 10% of the power input. Determine the power input to the motor in kW. (12)

3) a) Prove that the difference in heat capacities is $C_p - C_v = \frac{TV\beta^2}{K_T}$ Where β is volume Expansivity and K_T is isothermal compressibility. (10)

b) A household refrigerator is maintained at a temperature of 2°C. Every time the door is opened, warm material is placed inside introducing an average of 420 kJ, but making only a small change in the temperature of the refrigerator. The door is opened 20 times a day and the refrigerator operates at 15% of the Ideal COP. The cost of the work is 4 rupees per kWh. What is the monthly bill for this refrigerator? The atmosphere is at 30°C. (10)

4) a) The swept volume of an engine working on duel cycle is 0.0053 m^3 & clearance volume is 0.00035 m^3. The maximum pressure is 65 bar. Heat addition ends at 5% of the stroke. The temperature & pressure at the beginning of compression are 80 °C & 0.9 bar respectively. Determine i) work done ii) Mean effective pressure iii) air standard efficiency. (10)

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b) A steam turbine is supplied with dry saturated steam at 20 bar . The exhaust takes place at 0.3 bar. For a flow rate of 10 kg/s. Calculate
i) Quality of steam at the end of expansion ii) Power required to drive the pump
iii) Turbine power iv) The Rankine efficiency v) The heat flow in the condenser (10)

5) a) What is an irreversibility? State it's types and causes (6)

b) Air enters a compressor in a steady flow at 140 KPa, 17° C & 70 m/s and leaves at 350 KPa, 127 °C & 110 m/s. The environment is at 100 KPa, 7°C. Calculate per kg of air-
(i)The actual amount of work required (ii)The minimum work required
(iii)The irreversibility of the process (10)

c) Calculate the enthalpy, volume and entropy of 2 kg of steam at a pressure of 1.9 MPa having the dryness fraction of 0.85. (4)

6) a) Prove that the entropy is the property of system (4)

b) 1 Kg of Nitrogen gas at 1 bar and 300K is compressed to 5bar and 400K. Find i) Index of process ii) Work Transfer iii) Heat transfer iv) Change in internal Energy (6)

c) Liquid octane C_8H_{18} at 25°C is used as a fuel. Air used is 140 % of theoretical air & is supplied at 25°C. Assume a complete combustion & the product leaves the combustion chamber at 1500 K. Find the transfer per kg mole of fuel. Use the following data: (10)

substance	h_f^0 (MJ/K mol)	h_{298K} (MJ/K mol)	h_{1500k} (MJ/K mol)
C_8H_{18} (Liquid)	-250	-	-
O_2	-	8.68	49.29
N_2	-	8.67	47.07
H_2O (gas)	-241.8	9.90	57.99
CO_2	-393.5	9.36	71.078