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BT-3/DX

THERMODYNAMICS

Paper : ME-201(E)

Time : Three Hours] [Maximum Marks : 100

Note : Attempt *five* questions and at least *one* question from each unit. Steam Table, Mollier diagram and Calculator is allowed.

UNIT–I

1. (a) Define a quasistatic process and state its salient characteristics. 8

   (b) The pressure volume correlation for a non-flow rev. process is given by $p = (8.4v)$ bar where v is in m^3. If 150 kJ of work is supplied to the system, determine the final pressure and volume of the system. Take initial volume = 0.6 m^3. 12

2. (a) State and explain Gibbs Dalton Law. 10

   (b) Two vessels A and B both containing nitrogen are connected by a valve which is opened to allow the contents to mix and achieve an equilibrium temp. of 27°C. Before mixing the following information is known about the gases in two vessels.

Vessel A	**Vessel B**
p = 1.5 MPa	p = 0.6 MPa
t = 50°C	t = 20°C
Contents = 0.5 kg. mol	Contents = 2.5 kg. mol.

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Calculate final equilibrium pressure and the heat transferred to the surroundings. If the vessel had been perfectly insulated, calculate the final temperature and pressure which would have been reached Take $\gamma = 1.4$. 10

UNIT–II

3. (a) State the first law for a closed system undergoing a cycle. 5

   (b) What is PMM2 ? Explain. 5

   (c) A heat engine operating between two reservoirs 1000K and 300 K is used to drive a heat pump which extracts heat from the reservoir at 300 K, at a rate twice that at which the engine rejects heat to it. If the efficiency of engine is 40% of the max. possible value and cop of heat pump is 50% of max. possible, make calculations for the temp. of the reservoir to which the heat pump rejects heat. Also workout the rate of heat rejection from heat pump if the rate of heat supply to engine is 50kW. 10

4. (a) A centrifugal pump delivers 2750 kg of water per min. from initial pressure of 0.8bar absolute to a final pressure of 2.8 bar absolute. The suction is 2m below and delivery is 5m above the centre of pump. If suction and delivery pipes are 15cm and 10cm diameter respectively, make calculations for the power required to run the pump. 10

   (b) Show that polytropic specific heat is given by the expression : 10

$$C_n = - C_V \frac{\gamma - n}{n - 1}$$

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UNIT–III

5. (a) Explain Clausius Inequality. 8

   (b) Three identical finite bodies of constant heat capacity are at temp. 300 K, 300 K and 100 K. If no work or heat is supplied from outside, what is the highest temp. to which any one of the bodies can be raised by the operation of heat engines or refrigerators. 12

6. (a) Set up expression for availability of a closed system. 10

   (b) 20 kg of water at 90°C is mixed with 30 kg of water at 30°C, the pressure remains constant during the mixing operation. Calculate the decrease in available energy. The surroundings are at temperature of 10°C and for water C_p = 4.18 kJ/kg. K. 10

UNIT–IV

7. Derive Maxwell's equations of state and their importance in thermodynamics. 20

8. (a) Steam at 1000 kPa and 300°C enters an engine and expands to 20 kPa. If the exhaust steam has dryness fraction of 0.9, make calculations for the drop in enthalpy and change in entropy. 5

   (b) What do you understand by Triple point ? 5

   (c) Draw the phase diagram for pure substance on p–T coordinates. Why does fusion line for water have negative slope ? 10

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