Mech III

Seat No. : _____

7020

December-2008

(MA-303) Thermodynamics

Time : 3 Hours] **[Max. Marks : 100**

(2 : 30 P.M. to 5 : 30 P.M.)

Instructions : (1) Answer both the section in separate answer book.
(2) Figures to the right indicates full marks.
(3) Assume suitable data, if required.
(4) Use of steam table is permitted.

SECTION – I

1. Answer ANY **THREE** **18**

(a) (i) Explain quasi-static process with p-V diagram

(ii) Explain thermodynamic equilibrium.

(b) (i) Explain point function and path function.

(ii) Explain flow work, shaft work and paddle-wheel work transfer.

(c) Prove that entropy is a thermodynamic property.

(d) Define first law of thermodynamics. Also define internal energy of the system and show that the internal energy is a property of the system.

2. (a) State and explain the Clausius Inequality and prove it. **16**

(b) Carnot cycle is not practical. Justify.

(c) Steam enters a nozzle at a pressure of 7 bar and 20 °C and leaves at a pressure of 2 bar. The initial velocity of steam at the entrance is 50m/s and exit velocity from the nozzle is 750 m/s. The mass flow rate through the nozzle is 1500 kg/h. The heat loss from the nozzle is 12000 kJ/h. Determine the final enthalpy of the steam and nozzle area if the specific volume is 1.25 m^3/kg. Take initial enthalpy 2850kJ/kg.

OR

(a) What is irreversibility ? State various types of irreversibility and explain them. **16**

(b) Explain the second law of thermodynamics.

(c) A heat engine receives 999 kW of heat at constant temperature of 286 °C. The heat is rejected at 6 °C. The possible heat rejected are :

(a) 850 kW

(b) 490kWand

(c) 400 kW.

3. (a) Prove the equivalence of Clausius and Kelvin statements. **16**

(b) Derive Maxwell's equation from basics.

(c) A fluid undergoes a reversible adiabatic compression from 1 MPa and 0.3 m^3 to 0.05 m^3 according to the law $pv^{1.3}$ = constant. Determine the change in enthalpy, internal energy, entropy, heat transfer and work transfer.

OR

(a) Explain the Joule-Kelvin effect with various diagrams. **16**

(b) To get maximum work from two finite bodies at temperature T1 and T2, derive the relevant equation.

(c) Gas enters a nozzle at 15 bar and 1500 K with a velocity of 30 m/s. The pressure at the exit of nozzle is 5 bar. If the nozzle efficiency is 90%, calculate the actual exit velocity. Neglect changes in PE and heat exchange between nozzle and surrounding. Take Cp=1.005 kJ/kgK.

SECTION – II

4. (a) How actual vapour cycle differs from and ideal vapour cycle. Explain in detail. **18**

(b) Explain reheat vapour power cycle with necessary diagrams.

(c) Steam at 20 bar and 360 °C is expanded, in a steam turbine to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. : Assuming ideal process find, per kg of steam the new work and the cycle efficency.

5. (a) Derive an air-standard efficiency expression for Brayton cycle in terms of r_p and y. **5**

(b) Derive an air-standard efficiency expression for Otto cycle in terms of r_k and y. **5**

(c) An engine works on the dual combustion cycle, the compression ratio being 11. The pressure at the commencement of compression is 1 bar and the temperature is 90 °C. The maximum pressure in the cycle is 50bar and the constant pressure heat reception continues for $1/20^{th}$ of the stroke. Calculate: **6**

(1) Workdone per kg of the air and

(2) Ideal thermal efficiency.

OR

(c) The Tata Nano "650" car has a four stroke cylinder in-line diesel engine with compression ratio 16:1 and expansion ration 11:1. Calculate the cut-off ratio and air-standard efficiency.

6. (a) Explain enthalpy of reaction. **5**

(b) Explain bomb calorimeter with line diagram. **5**

(c) Calculate the stoichiometri air required for the complete combustion of 1 kg of normal heptane C_7H_{16} Also, calculate the percentage analysis of the products on a mass and a molal basis. **6**

OR

(c) A petrol engine uses a fuel C7H16. Determine the air-fuel ratio which would just suffice of theoretical combustion.