(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 1260 Roll No. | | | | | | | | | | |

B. Tech.

(SEM. III) ODD SEMESTER THEORY EXAMINATION 2013-14

THERMODYNAMICS

Time : 3 Hours *Total Marks : 100*

SECTION—A

1. Attempt **all** questions parts : **(10×2=20)**
   (a) Distinguish between microscopic and macroscopic approaches of thermodynamics.
   (b) Explain shaft work and electric work.
   (c) Write the limitations of First law of thermodynamics.
   (d) Explain PMM-1 and PMM-2.
   (e) In van der Waals' Equation $\left(P+\frac{a}{v^2}\right)(v-b)=RT$.
   Explain the term $\frac{'a'}{v^2}$ and 'b'.
   (f) Explain critical point and triple point.
   (g) Explain reversible process with an example.
   (h) Derive a relationship between COP of heat pump and refrigerator.
   (i) What is Second law efficiency ?
   (j) Prove : entropy of an isolated system always increases.

SECTION—B

2. Attempt any **three** questions from this section : **(10×3=30)**

(a) A piston and cylinder machine containing a fluid system has a stirring device in the cylinder. The piston is frictionless and it is held against the fluid due to the atmospheric pressure of 101.325 kPa. The stirring device is turned 10,000 revolutions with an average torque against the fluid 1.275 N-m. Meanwhile the piston of 0.6 m diameter moves out 0.8 m. Find the net work transfer for the system.

(b) A cylinder contains 0.5 m^3 of an ideal gas at 1 bar and 90°C. The gas is compressed to a volume of 0.125 m^3, the final pressure being 60 bar. Determine (a) mass of gas, (b) the value of index n for compressions, (c) the heat received or rejected by the gas during compression. (Y = 1.4, R = 0.294 kJ/kgK)

(c) What is dryness fraction ? Explain the measurement of dryness fraction of steam by combined separating and throttling calorimeter.

(d) Write Kelvin Planck and Clausius statements. Establish the equivalence of above statements.

(e) What is available and unavailable energy ? Explain availability of a closed and open system.

SECTION—C

Attempt **all** questions : **(10×5=50)**

3. Attempt any **one** part : **(10×1=10)**

(a) Derive expressions for the expansion (or compression) work when a gas undergoes expansion (or compression) from an initial state P_1, V_1 to a final state P_2, V_2. If the P-V relationship during the process is : (a) PV^n = constant, (b) PV = constant.

(b) Explain :

(i) Intensive and extensive properties

(ii) Restrained and unrestrained processes

(iii) Diathermal and adiabatic wall

(iv) State and cycle

(v) Heat and work.

4. Attempt any **one** part : **(10×1=10)**

(a) What is unsteady flow processes ? Explain filling and evacuation process of a vessel.

(b) 0.8 kg/sec of air flows through a compressor under steady state conditions. The properties of air at entry are, pressure 1 bar, velocity 10 m/s, specific volume 0.95 m^3/kg and internal energy 30 kJ/kg. The corresponding values at exit are 8 bar, 6 m/s, 0.2 m^3/kg, 124 kJ/kg. Neglecting the change in potential energy, determine the power input and pipe diameter at entry and exit.

5. Attempt any **one** part : **(10×1=10)**

(a) Derive the relation of van der Waals' equation in terms of critical properties. Explain compressibility factor.

(b) Steam at 0.8 MPa, 250°C and flowing at the rate of 1 kg/sec passes into pipe carrying wet steam at 0.8 MPa, 0.95 dry. After adiabatic mixing the flow rate is 2.3 kg/sec and pressure is 0.8 MPa. Determine the condition of steam after mixing. The mixture is now expanded in a frictionless nozzle isentropically to a pressure of 0.4 MPa. Determine the velocity of steam leaving the nozzle. Neglect the velocity of steam in the pipeline.

6. Attempt any **one** part : **(10×1=10)**

(a) Explain working of Carnot and reversed Carnot Cycle.

(b) A reversible heat engine operates between two reservoirs at 827°C and 27°C. Engine drives a Carnot refrigerator maintaining –13°C and rejecting heat to reservoir at 27°C. Heat input to the engine is 2000 kJ and the net work available is 300 kJ. Determine the heat transferred to refrigerator and total heat rejected to reservoir at 27°C.

7. Attempt any **one** part : **(10×1=10)**

(a) Deduce two T-ds relations. A metal block of 5 kg and 200°C is cooled in a surrounding of air which is at 30°C. If the specific heat of metal is 0.4 kJ/kgK, calculate :

(i) Entropy change of block.

(ii) Entropy change of surrounding.

(iii) Entropy change of universe.

(b) Two blocks of metal, each of mass 'm' and specific heat 'c', initially at temperatures T_H and T_L, respectively are brought to the same final temperature by means of a reversible process. Show that the work obtained is given by :

$$W_{REV} = mC\left[T_H + T_L - 2\sqrt{T_H\ T_L}\right].$$