ENGINEERING & MANAGEMENT EXAMINATION, JUNE - 2008

MECHANICAL SCIENCE

SEMESTER - 2

Time : 3 Hours] [Full Marks : 70

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : 10 × 1 = 10

i) Which of the following is an intensive thermodynamic property ?

a) Volume b) Temperature

c) Mass d) Energy. ☐

ii) For an irreversible process, change in entropy is

a) greater than dQ/T b) less than dQ/T

c) zero d) equal to dQ/T. ☐

iii) During throttling, which of the following quantity does not change ?

a) Internal energy b) Entropy

c) Pressure d) Enthalpy. ☐

iv) Work done in a free expansion is

a) Positive b) Negative

c) Zero d) Maximum. ☐

v) A cycle with constant volume heat addition and constant volume heat rejection is

a) Otto cycle b) Diesel cycle

c) Joule cycle d) Rankine cycle. ☐

vi) Triple point of a pure substance is a point at which

a) liquid and vapour coexist

b) solid and vapour coexist

c) solid and liquid coexist

d) all three phases coexist. ☐

vi) Bernoulli's equation deals with the conservation of

a) Mass b) Momentum

c) Energy d) Work. [ ]

vii) Continuity equation is based on the principle of conservation of

a) Mass b) Momentum

c) Energy d) Entropy. [ ]

viii) A Pitot tube is used for measuring

a) State of fluid b) Velocity of fluid

c) Density of fluid d) Viscosity of fluid. [ ]

ix) Dynamic viscosity has dimensions of

a) MLT^{-2} b) $ML^{-1}T^{-1}$

c) $ML^{-1}T^{-2}$ d) $M^{-1}L^{-1}T^{-1}$ [ ]

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. State the first law of thermodynamics for a closed system undergoing a cyclic process.

3. Explain thermodynamic equilibrium.

4. The fluid flow is given by $\vec{V} = x^2 y \hat{i} + y^2 z - (2xyz + yz^2)\hat{k}$. Show that this is a case of possible steady incompressible flow. Calculate the velocity and acceleration (2, 1, 3).

5. Draw a block diagram of vapour compression refrigeration cycle and also show the corresponding P-V and T-S plots.

6. Derive Bernoulli's equation form first principles, stating the assumptions.

7. Explain PMM-1 and PMM-2.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

8. a) Which is a more effective way of increasing the efficiency of a Carnot engine to increase source temperatue (T_1), keeping sink temperature (T_2) constant or to decrease T_2 keeping T_1 constant.

   b) State Clausius inequality.

   c) A mass of m kg of liquid (specific heat = C_p) at a temperature T_1 is mixed with an equal mass of the same liquid at a temperature T_2 ($T_1 > T_2$) and the system is thermally insulated. Show that the entropy change of the universe is given by $2mC_p \ln\left(\frac{T_1 + T_2}{\sqrt{T_1 T_2}}\right)$ and prove that this is necessarily positive. 3 + 2 + 10

9. a) Derive the expression for efficiency of an Otto cycle and show the process on p-V and T-s planes.

   b) For the same compression ratio, explain why the efficiency of Otto cycle is greater than that of Diesel cycle.

   c) In a diesel engine the compression ratio is 13 : 1 and fuel is cut off at 8% of the stroke. Find the air standard efficiency of the engine. Take γ for air = 1.4.

   5 + 3 + 2 + 5

10. a) A gas occupies 0.024 m^3 at 700 kPa and 95°C. It is expanded in the non-flow process according to the law $pv^{1.2}$ = constant to a pressure of 70 kPa after which it is heated at a constant pressure back to its original temperature. Sketch the process on the *p-V* and *T-s* diagrams and calculate for the whole process the work done and the heat transferred. Take C_p =1.047 and C_v = 0.775 kJ/kg K for the gas.

    b) A rigid closed tank of volume 3 m^3 contains 5 kg of wet steam at a pressure of 200 kPa. The tank is heated until the steam becomes dry saturated. Determine the pressure and the heat transfer to the tank. 8 + 7

11. a) Write the steady flow energy equation for a single steam entering and single steam leaving a control volume and explain the various terms.

b) At the inlet to a nozzle, the enthalpy of the fluid passing is 3000 kJ/kg and velocity is 60 m/s. At the exit, the enthalpy is 2762 kJ/kg. The nozzle is horizontal and there is negligible heat loss.

i) Find the velocity at the nozzle exit

ii) The inlet area is 0.1 m^2 and the specific volume at inlet is 0.187 m^3/kg. Find the mass flow rate.

iii) If the specific volume at the nozzle exit is 0.498 m^3/kg, find the exit area of the nozzle. 9

12. a) Derive Euler's equation of motion along a streamline.

b) A venturimeter has inlet and throat diameters of 300 mm and 150 mm. Water flows through it at the rate of 0.065 m^3/s and the differential gauge is deflected by 1.2 m. The specific gravity of the manometric liquid is 1.6. Determine the coefficient of discharge of the venturimeter.

c) A jet of water from a 25 mm diameter nozzle is directed vertically upwards. Assuming that the jet remains circular and neglecting any loss of energy, what will be the diameter of the jet at a point 4.5 m above the nozzle, if the jet leaves the nozzle with a velocity of 12 m/s ? 5 + 5 + 5

13. a) A circular disk of diameter d is slowly rotated in a liquid of viscosity μ at a small distance h from a fixed surface. Derive an expression for the torque necessary to maintain an angular velocity ω.

b) Distinguish between the follow :

i) laminar and turbulent flow

ii) compressible and incompressible fluid

iii) static pressure and stagnation pressure

iv) viscous and inviscid fluid. 7 + 3

14. Write short notes on any *three* of the following : 3 × 5

a) Pitot tube

b) Orifice meter

c) Point function and path function

d) Streamline, streakline and pathline.

END