



ENGINEERING & MANAGEMENT EXAMINATIONS, 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. | <input type="checkbox"/> |
- 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 . | <input type="checkbox"/> |
- iii) During throttling, which of the following quantity does not change ?
- | | | |
|--------------------|--------------|--------------------------|
| a) Internal energy | b) Entropy | |
| c) Pressure | d) Enthalpy. | <input type="checkbox"/> |
- iv) Work done in a free expansion is
- | | | |
|-------------|-------------|--------------------------|
| a) Positive | b) Negative | |
| c) Zero | d) Maximum. | <input type="checkbox"/> |
- 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. | <input type="checkbox"/> |
- 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. | | <input type="checkbox"/> |



- 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 x 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 $\vec{V} = x^2y\hat{i} + y^2z - (2xyz + yz^2)\hat{k}$. Show that this is a possible steady incompressible flow. Calculate the velocity and acceleration at (2, 1, 3).
5. Draw a block diagram of vapour compression refrigeration cycle and also show corresponding P-V and T-S plots.
6. Derive Bernoulli's equation from 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 × 15 = 45

8. a) Which is a more effective way of increasing the efficiency of a Carnot engine to increase source temperature (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 $pv^{1.2} = \text{constant}$ 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 $C_v = 0.775 \text{ kJ/kg K}$ 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.
- Find the velocity at the nozzle exit
 - The inlet area is 0.1 m^2 and the specific volume at inlet is $187 \text{ m}^3/\text{kg}$. Find the mass flow rate.
 - If the specific volume at the nozzle exit is $0.498 \text{ m}^3/\text{kg}$, find the exit area of the nozzle.
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 $0.065 \text{ m}^3/\text{s}$ 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 + 3 = 8
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 :
- laminar and turbulent flow
 - compressible and incompressible fluid
 - static pressure and stagnation pressure
 - viscous and inviscid fluid.
14. Write short notes on any three of the following : 3 x 5 = 15
- Pitot tube
 - Orifice meter
 - Point function and path function
 - Streamline, streakline and pathline.

END