



**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.     |

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. |

**II-222833 (3)**



- vii. Continuity equation is based on the principle of conservation of

- 23) A Pitot tube is used for measuring

- 1.) Dynamic viscosity has dimensions of

- GROUP - B**

**( Short Answer Type Questions )**

Answer any three of the following.

3 x 5 = 15

- State the first law of thermodynamics for a closed system undergoing a cycle process.
- Explain thermodynamic equilibrium.
- 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 possible steady incompressible flow. Calculate the velocity and acceleration at (2, 1, 3).
- Draw a block diagram of vapour compression refrigeration cycle and also show corresponding P-V and T-S plots.
- Derive Bernoulli's equation from first principles, stating the assumptions.
- Explain PMM-1 and PMM-2.

**D-221333 (S)**



**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  $\gamma$  for air = 1.4. 5 + 3 + 2 + 5
10. a) A gas occupies  $0.024 \text{ m}^3$  at 700 kPa and  $95^\circ\text{C}$ . 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  $3 \text{ m}^3$  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

**II-222833 (3)**



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  $0.1 \text{ m}^2$  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 + 5 = 10
13. a) A circular disk of diameter  $d$  is slowly rotated in a liquid of viscosity  $\mu$  at a small distance  $h$  from a fixed surface. Derive an expression for the torque necessary to maintain an angular velocity  $\omega$ .
- 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 × 5 = 15
- Pitot tube
  - Orifice meter
  - Point function and path function
  - Streamline, streakline and pathline.

END

**U-2223-3 (3)**