Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH (OLD)/SEM-2/ME-201/2011

2011
MECHANICAL SCIENCE

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : $10 \times 1 = 10$

i) Latent heat of vaporization of the critical point is
   a) equal to zero b) less than zero
   c) greater than zero d) none of these.

ii) In an adiabatic process (symbol has the usual meaning)
   a) Q = constant b) W = constant
   c) P = constant d) V = constant

iii) Which of the following is not the property of the system ?
   a) Pressure b) Temperature
   c) Heat d) Specific Volume.

iv) A thermal power plant works on
   a) Carnot cycle b) Rankine cycle
   c) Joule cycle d) Otto cycle.

v) Which of the followings is an intensive property ?

a) volume b) entropy

c) pressure d) internal energy.

vi) Dynamic viscosity has dimension as

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

c) $ML^{-1}T^{-1}$ d) $M^{-1}L^{-1}T^{-1}$.

vii) For pipes, laminar flow occurs when Reynold's number is

a) less than 2000

b) between 2000 and 3000

c) between 3000 and 4000

d) more than 4000.

viii) Bernoulli's equation deals with the law of conservation of

a) mass b) momentum

c) work d) energy.

ix) Euler equation is written as

a) $dp/\rho + v^2dv + gdz = 0$ b) $dp/\rho + vdv + gdz = 0$

c) $dp/\rho + v^2dv + g^2dz = 0$ d) $dp/\rho^2 + v^2dv + gdz = 0$.

x) A venturimeter is a device used to measure

a) pressure in a fluid

b) velocity at a point

c) flow rate

d) temperature of the fluid.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Derive Euler's equation of motion along a streamline.

3. a) State newton law of viscosity. What is Newtonian and what is non newtonion fluid?

   b) A plate, at $0 \cdot 25$ mm distance from a fixed plate, moves 60 cm/s and required a force of 2 N per unit area to maintain this speed. Determine the fluid viscosity between the plate. 2 + 3

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

5. a) What is the basic difference between a process and a cycle ?

   b) State the first law of thermodynamics for a closed system undergoing a cycle and a process.

6. a) Write the Kelvin-Planck statements of second law of thermodynamics.

   b) A Carnot engine is operated between two reservoirs at T_H and T_L. The work output of the engine is $0 \cdot 6$ times the heat rejected. The difference in temperature between source and the sink is $200^{\circ}C$. Calculate the thermal efficiency, source temperature and sink temperature.

GROUP – C

(Long Answer Type Questions)

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

7. a) A mass of 8 kg of gas expands within a flexible container so that the P-V relationship is of the form $PV^{1.3}$ = constant. The initial pressure is 1000 kPa and the initial volume is 1 m^3. The final pressure is 5 kPa. If the specific internal energy is decreased by 40 kj/kg, find the heat transfer in magnitude and direction.

   b) Two reversible heat engines are operating in series between temperature T_1 and T_2 such that heat rejected by one is fed directly to the other. Prove that

      i) The intermediate temperature is the arithmetic mean of T_1 and T_2 if the work outputs from the two engines are same.

      ii) The intermediate temperature is the geometric mean of T_1 and T_2 if the efficiency of the two engines is same. 8 + 7

8. a) Define :

      i) Streamline

      ii) Streak line

b) A 20 cm × 10 cm venturimeter is inserted in a vertical pipe carrying oil of sp. gr. $0 \cdot 8$, the flow of oil is in upward direction. The difference of levels between the throat and inlet section is 50 cm. The oil mercury differential manometer gives reading of 30 cm of mercury. Find the discharge of oil. Neglect losses.

c) A Pitot tube is inserted in a pipe of 300mm diameter. The static pressure in pipe is 100 mm of mercury (vacuum). The stagnation pressure at the centre of the pipe recorded by the Pitot tube is $0 \cdot 981 \text{N/m}^2$. Calculate the discharge of water through pipe, if the mean velocity of flow is $0 \cdot 85$ times the central velocity. (Take $C_v = 0 \cdot 98$). $\left(1\frac{1}{2} \times 2\right) + 6 + 6$

9. a) An ideal gas is heated at a constant vol. until its temperature is double and then cooled at constant pressure until it is returned to the original temperature. Finally the gas is allowed to expand at constant temperature until it is returned to the original volume. Determine the expression for net work done by the gas.

b) A compressor receives air at 100kpa and 20°C. The air is compressed adiabatically to 800kpa. The power input in the compressor is 400 kw. Determine the mass flow rate. The changes in kinetic and potential energies are negligible.

c) If the thermal effincy of a carnot engine is 1/6, calculate the coefficient of performance of

i) a carnot heat pump.

ii) a carnot refrigerator. 5 + 5 + 5

10. a) A cyclic heat engine operates between a source temperature of 800°C and a sink temp of 30°C. What is the least heat rejection per kW net output of the engine ?

b) A nozzle is a device for increasing the velocity of a steadily flowing stream. At the inlet of a certain nozzle, the enthalpy of the fluid passing is 3000 kJ/kg and the velocity is 60 m/sec. At the discharge end, the enthalpy is 2762 kJ/kg and the nozzle is horizontal and there is negligible heat loss from it.

i) Find the velocity at exit of the nozzle

ii) the inlet area is $0 \cdot 1\ m^2$ and the specific volume at inlet is $0 \cdot 187\ m^3/kg$, find the mass flow rate.

iii) if the specific volume at the nozzle exit is $0 \cdot 498\ m^3/kg$, find the exit area of the nozzle.

c) A vertical pipe of 1 m diameter and 10 m length has a pressure head of 5 m of water at the upper end. When water flows through the pipe at an average velocity of 5 m/s, the head loss due to friction is 1 m of water column. Find the pressure head at the lower end of the pipe, when the flow is

i) upward

ii) downward 4 + 6 + 5

11. a) Obtain an expression for continuity equation for a two dimensions flow.

b) A diffuser consists of two parallel circular plates of 20 cm diameter $0 \cdot 5$ cm apart and connected to a 3 cm pipe as shown in the figure. If the streamline are assumed to be redial in the diffuser, what mean velocity in the pipe will correspond to an exit velocity of $0 \cdot 5$ m/s ?

c) A body weighing 1000 N slides down at a uniform speed of 1 m/s along a lubricated inclined plane making 30° with the horizontal. The viscosity of lubricant is $0 \cdot 1$ kg/ms and contact area of the body is $0 \cdot 25 \text{m}^2$. Determine the lubricant thickness assuming linear velocity distribution. 5 + 5 + 5