Name : ANKUSH DAS

Roll No. : 09109003018

Invigilator's Signature : C. G. C. Sil

CS/B.TECH/SEM-2/ME-201/2010

2010

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) The study of thermodynamics provides answer to the following, *except*

a) whether a process is feasible or not

b) how much energy is required for a process to take place

c) rate or speed with which a process occurs

d) extent to which a reaction/process takes place.

ii) For an irreversible process entropy change is

a) greater than $\frac{\delta Q}{T}$ b) equal to $\frac{\delta Q}{T}$

c) less than $\frac{\delta Q}{T}$ d) equal to zero.

iii) The work done in a steady flow process is given by

a) $\int p\,dv$ b) $\int -p\,dv$

c) $\int v\,dp$ d) $\int -v\,dp$.

iv) Extensive property of a system is one whose value

a) depends on mass of the system

b) is independent of mass of the system

c) is always constant

d) is dependent on the path followed, not on the state.

v) Idea of temperature scale is obtained from

a) Zeroth law of Thermodynamics

b) First law of Thermodynamics

c) Second law of Thermodynamics

d) none of these.

vi) A stagnation point is a point in a fluid where

a) total energy is zero

b) velocity of the flow is zero

c) total ennergy is maximum

d) pressue is zero.

vii) A pitot tube is used for the measurement of

a) flow b) pressure

c) discharge d) velocity.

viii) Streamline is a line

a) which is along the path of particle

b) which is always parallel to the main direction of flow

c) across which there is no flow

d) on which a tangent drawn at any point gives the direction of velocity.

ix) Stroke is the unit of

a) Surface tension b) Dynamic viscosity

c) Kinematic viscosity d) none of these.

x) Absolute pressure can be obtained from a pressure gauge,

a) $P_{gauge} + P_{atm}$ b) $P_{gauge} - P_{atm}$

c) $P_{gauge} \times P_{atm}$ d) P_{gauge} / P_{atm}.

GROUP – B

(Short Answer Type Questions)

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

2. The fluid flow is given by $V - x^2 yi + y^2 zj - (2xyz + yz^2) k$. Show that this is the case of possible steady incompressible flow. Calculate the velocity and acceleration at (2, 1, 3).

3. A 150 mm diameter shaft rotates at 1500 r.p.m. in a 200 mm long journal bearing with an internal diameter 150·5 mm. The uniform annular space between the shaft and the bearing is filled with oil of dynamic viscosity 0·8 poise. Calculate the power required to rotate the shaft.

4. A gaseous system undergoes three quasi-static processes in sequence. The gas initially at 5 bar & 0·01 m^3 is expanded at constant pressure. It is then further expanded according to the relation $PV^2 = C$ to 2 bar & 0·025 m^3. The gas is then returned to its initial state during which process $PV = C$.

   i) Sketch the cycle in the P-V plane

   ii) Calculate the net work for the system. 2 + 3

5. State the 2nd law of thermodynamics. Show that the efficiency of a reversible engine operating between two given constant temperatures is the maximum. 2 + 3

6. Classify various types of fluid with the help of Rheological diagram.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) A reversible heat engine takes in heat from a reservoir at 840°C and rejects heat to a reservoir at 60°C. The heat engine drives a reversible heat pump which takes in heat from a reservoir at 5°C and delivers heat to a reservoir at 60°C. The reversible heat engine also drives the machine that absorbs 30 kW. If the heat pump extracts 17 kJ/s from a 5°C reservoir, determine

   i) the rate of heat supply from 840°C source

   ii) the rate of heat rejection to 60°C sink.

b) Calculate the entropy change of 1 kg of water at 27°C, when it is converted to ice at – 20°C. Specific heats of ice and water are 2·18 kJ/kg-K and 4·18 kJ/kg-K respectively and latent heat of fusion of ice at 0°C is 335 kJ/kg. 10 + 5

8. a) What is an air standard cycle ? Derive an expression for the efficiency of a diesel cycle.

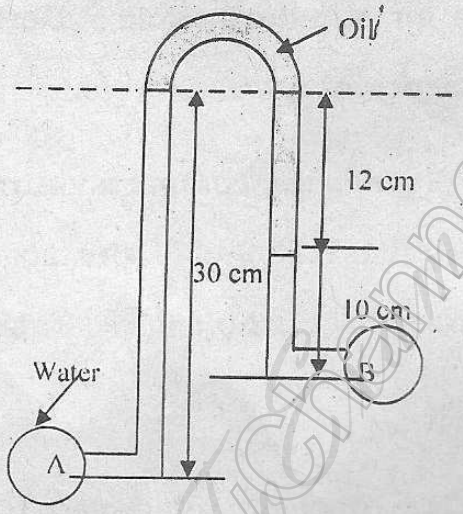
b) In a diesel engine, the compression ratio is 13 : 1 and the fuel is out off at 8% of the stroke. Find the air standard efficiency of the engine. Take γ of air = 1·4.

9 + 6

9. a) Why does the viscosity of a gas increase with the increase in temperature while that of a liquid decrease with increase in temperature ?

b) The space between two large flat and parallel walls, 25 mm apart is filled with a liquid of absolute viscosity of 0·7 N-s/m ^{2}. Within this space, a thin flat plate 250 mm × 250 mm is towed at a velocity of 150 mm/s at a distance of 6 mm from one wall, the plate and its movement being parallel to the walls. Assuming linear variations of velocity between the plate and the walls, determine the force exerted by the liquid on the plate.

c) What is flowing through two different pipes to which an inverted differential manometer having an oil of sp. gr. 0·8 is connected. The pressure head in the pipe *A* is 2 m of water. Find the pressure in pipe *B* for the manometer readings as shown in figure below.



2 + 6 + 7

10. a) What is orifice meter ? Prove that the discharge through the orifice meter is given by the relation

$$Q = Cd \frac{a_1 a_0}{\sqrt{a_1^2 - a_0^2}} \sqrt{2gh}$$

where a_1 is area of the pipe orifice meter fitted, a_0 is the area of the orifice.

b) What is Euler's equation of motion. Prove the Euler's equation of motion. How you can obtain the Bernoulli's equation from it ? 2 + 6 + 7

11. a) A mass of air is initially at 260°C and 700 kPa and occupies 0·028 m^3. The air is expanded at constant pressure to 0·084 m^3. A polytropic process $PV^{1.5}$ is then carried out followed by a constant temperature process which completes the cycle. All the processes are reversible. Find the efficiency of the cycle.

b) State first law of Thermodynamics for a closed system undergoing a cycle. Why is the value of specific heat at constant pressure greater than specific heat at constant volume ?

12 + 3