Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B. TECH (NEW)/SEM-2/ME-201/2012

2012

ENGINEERING THERMODYNAMICS AND FLUID MECHANICS

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 any *ten* of the following: $10 \times 1 = 10$

i) During throttling process

a) internal energy remains constant

b) entropy remains constant

c) enthalpy remains constant

d) pressure remains constant.

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

a) Volume b) Energy

c) Mass d) Temperature.

iii) Newton's law of viscosity relates to

a) pressure velocity and viscosity

b) shear stress and rate of angular deformation in a fluid

c) shear stress, temperature, viscosity and velocity

d) pressure, viscosity and rate of angular deformation.

iv) Stoke is the unit of

a) surface tension b) viscosity

c) kinematic viscosity d) none of these.

v) The first law of thermodynamics furnishes the relationship between

a) heat, work and properties of the system

b) heat and internal energy

c) various thermodynamic properties of the system

d) heat and properties of the system.

vi) Entropy change depends on

a) change of temperature b) mass transfer

c) thermodynamic state d) heat transfer.

vii) The increase in temperature

a) increase the viscosity of the liquid

b) decrease the viscosity of the liquid

c) increase the viscosity of the gas

d) both (b) and (c).

viii) A stream line is a line

a) which is along the path of a particle

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

c) across which there is no flow

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

ix) For the same compression ratio and heat rejection, the efficiency of Otto cycle is

a) greater than diesel cycle

b) less than diesel cycle

c) equal to diesel cycle

d) none of these.

x) A refrigerator and a heat pump operate between the same temperature limits. If the COP of the refrigerator is 4, the C.O.P. of the heat pump would be

a) 3 b) 4

c) 5 d) none of these.

xi) Work done in a free expansion process is

a) positive b) negative

c) zero d) maximum.

xii) A stagnation point is a point in a fluid flow where

a) pressure is zero

b) velocity of flow is zero

c) total energy is zero

d) total energy is maximum.

xiii) An inventor claims that his heat engine has the following specifications. Power developed 50 kW, Fuel burned per hour 3 kg, heating value of fuel 75000 kJ per kg. Temperature limits 627°C. His engine is

a) reality b) impossible

c) costly d) none of these.

xiv) A flow of viscous fluid with $\mu = 1{\cdot}0\ \text{Ns/m}^2$ has a velocity distribution given by $u = 0{\cdot}90y - y^2$. The shear stress at $y = 0{\cdot}45$ m is

a) $0{\cdot}90\ \text{Ns/m}^2$ b) zero

c) infinity d) none of these.

xv) For irrotational flow

a) V = constant b) $\nabla \times V = f(t)$

c) $\nabla \times V = 0$ d) $\nabla \times V = V(x, y, t)$

xvi) Reynold's number is expressed as

a) $\rho\, VD/\mu$ b) $V^2\, D/\rho$

c) $V\rho^2 S/\gamma$ d) $V^2 D^2/\gamma$

GROUP – B

(Short Answer Type Questions)

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

2. a) Draw the rheological diagram for Newtonian and non-Newtonian fluids. 2

b) Show the pressure decreases exponentially with elevation for an isothermal compressible fluid at rest. 3

3. a) What is the basic difference between a process and a cycle ? 2

b) Show that the work done in isothermal process from the state 1 to state 2 is given by
$W_{1-2} = p_1\, v_1\, (\log_e\ p_1 - \log_e\ p_w)$ 3

4. Show that the two dimensional flow described by the equation $\psi = x + 2x^2 - 2y^2$ is irrotational.

5. a) State Newton's law of viscosity. 2

   b) What are the causes of viscosity ? 2

   c) What is no-slip condition ? 1

6. 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.

GROUP – C

(Long Answer Type Questions)

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

7. a) What is PMM2 ? Why is it impossible ? What is its difference from PMM1 ? 5

   b) Show that the COP of a heat pump is greater than the COP of a refrigerator by unity. 4

   c) A carnot heat engine draws heat from a reservoir at temperature T_A and rejects heat to another reservoir at temperature T_B. The carnot forward cycle again drives a carnot reversed cycle engine or carnot refrigerator, which absorbs heat from reservoir at temperature T_C and rejects heat to reservoir at temperature T_A. Derive an expression for the ratio of heat absorbed from reservoir at temperature T_B, such that heat supplied to engine Q_A is equal to heat absorbed by refrigerator Q_C. Determine efficiency and cop (Co-efficient of performance) of carnot refrigerator. 6

8. a) A simple U-tube manometer containing mercury is connected to a pipe in which a fluid of specific gravity 0·9 and having vacuum pressure is flowing. The other end of the manometer is open to atmosphere. Find the vacuum pressure in pipe, if the difference in mercury level in the two limbs is 50 cm and the height of fluid in the left limb from the centre of pipe is 10 cm below. Assume any other data required. 5

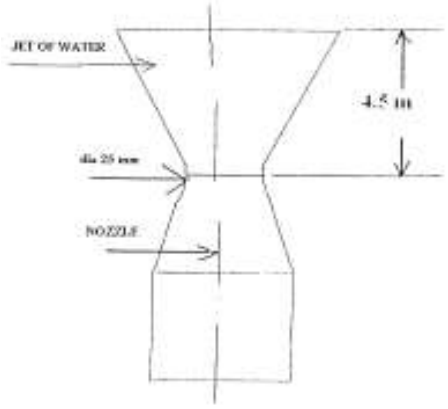
b) The velocity vector in a fluid flow is give by
$V = 2x^3 i - 5x^2 yj + 2tk$

Find the velocity and acceleration of a fluid particle at (2, 1, 3) at time t = 1. 10

9. a) Derive the expression for continuity equation for a three-dimensional steady incompressible flow. 5

b) Describe the steady flow and unsteady flow. 2

c) A jet of water from a 25 mm dia nozzle is directed vertically upwards, assuming that jet remains steady and neglecting any loss of energy. What will be the dia at a point 4·5 m above the nozzle, if the velocity with which jet leaves the nozzle is 12 m/s ? 8



10. a) An engine working on Otto cycle has an air standard cycle efficiency of 56% and rejects 544 kJ/kg of air. The pressure and temperature of air at the beginning of compression are 0·1 Mpa and 60°C respectively. Calculate

    i) the compression ratio of the cycle

    ii) Work done/kg of air

    iii) the pressure and temperature at the end of compression

    iv) maximum pressure of the cycle. 8

    b) Find the pressure at an elevation of 3000 m above the sea level by assuming

    i) an isothermal condition of air

    ii) an isentropic condition of air.

    Pressure and temperature at sea level are 101·32 kN/m^2 and 293·15 K. Consider air to be an ideal gas with R = 287J/kgK and γ = 1·4. 7

11. a) Determine the quantity of heat required to produce 1 kg of steam at a pressure of 6 bar at a temperature of 25°C under the following conditions.

    i) when the steam is wet having a dryness fractions 0·9

    ii) when the steam is dry saturated

    iii) when it is superheated at a constant pressure at 250°C.

    Assume the mean specific heat of superheated steam to be 2·3 kJ/kg. 7

b) Two bodies, each of equal mass *m* and heat capacity Cp are at temperature T1 and T2 respectively (T1>T2). The first body is used as a source of heat for reversible engine and the second body as the sink. Show that the maximum work obtainable from such an arrangement is $mC\ p(\sqrt{T_1}-\sqrt{T_2})^2$. 8