MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

Paper Code : ME-201

ENGINEERING THERMODYNAMICS & 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 the following : $10 \times 1 = 10$

i) The absolute zero pressure will be

a) when molecular momentum of the system becomes zero

b) at sea level

c) at the temperature of – 273 K

d) under vacuum conditions.

ii) The specific volume of water when heated at 0°C

a) first increases and then decreases

b) first decreases and then increases

c) increases steadily

d) decreases steadily.

iii) Internal energy of a perfect gas depends on

a) temperature, specific heats and pressure

b) temperature, specific heats and enthalpy

c) temperature, specific heats and entropy

d) temperature only.

iv) 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)

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) A stagnation point is a point in fluid flow where

a) pressure is zero

b) velocity of flow is zero

c) total energy is zero

d) total energy is maximum.

vii) For irrotational flow

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

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

viii) Newton's law of viscosity states that

a) shear stress is directly proportional to the velocity

b) shear stress is directly proportional to the velocity gradient

c) shear stress is directly proportional to shear strain

d) shear stress is directly proportional to the viscosity.

ix) The standard atmospheric pressure is 101.32 kPa. The local atmospheric pressure at a location was 91.52 kPa. If a pressure is recorded as 22.48 kPa (gauge), it is equivalent to

a) 123.80 kPa (abs) b) 88.84 kPa (abs)

c) 114.00 kPa (abs) d) 69.04 kPa (abs).

x) If heat engine attains 100% thermal efficiency, it violets

a) Zeroth law of thermodynamics

b) 1st law of thermodynamics

c) 2nd law of thermodynamics

d) none of these.

GROUP – B

(Short Answer Type Questions)

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

2. Derive an expression for displacement work in process where pV^n = constant.

3. What is a Carnot cycle ? What are the four processes which constitute the cycle ? Why is the Carnot cycle on *T-s* plot a rectangle ? 1 + 2 + 2

4. The water flowing through a pipe having diameter 20 cm and 10 cm at section 1 and 2 respectively. The rate of flow through pipe is 35 liters/s. The section 1 is 6m above datum line and section 2 is 4m above the datum. If the pressure at section 1 is 39.24 N/cm^2, find the intensity of pressure at section 2. Assume frictionless flow.

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

6. Steam enters and engine at a pressure of 12 bar with a 67°C of superheat. It is exhausted at a pressure 0.15 bar and 0.95 dryness fraction. Find the drop of enthalpy of steam C_p = 2.04 kJ/kg.

Pr (bar)	h_f (kJ/kg)	h_{fg} (kJ/kg)
12	797.4	1984.3
0.15	226	2373.2

GROUP – C
(Long Answer Type Questions)

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

7. a) Derive an expression for the discharge through a venturimeter ?

   b) An orificemeter with orifice diameter 20 cm is inserted in a pipe of 40 cm diameter. The pressure of the upstream and downstream of the orificemeter are 20 N/cm^2 and 9.81 N/cm^2 respectively. Find the discharge through the pipe if Cd = 0.6.

   c) A pitot-tube is inserted in a pipe of 40 cm diameter. The static pressure in pipe is 100 mm of mercury (vacuum). The stagnation pressure at the centre of the pipe is 1 N/cm^2. Calculate discharge through pipe. C_v = 0.98. 5 + 7 + 3

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8. a) Write the steady flow energy equation for a single steam entering and a single steam leaving a control volume and explain the various terms in it.

   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.

      i) Find the velocity at the nozzle exit.

      ii) The inlet area is 0.1 m^2 and the specific volume at inlet is 0.187 m^3 / kg. Find the mass flow rate.

      iii) If the specific volume at the nozzle exit is 0.498 m^3 / kg, find the exit of the nozzle.

   5 + 10

9. a) Derive the expression for the efficiency of an Otto cycle and show the process on *P-V* & *T-S* plots.

   b) In an air standard diesel cycle, the compression ratio is 16 and at the beginning of isentropic compression, the temperature is 15°C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of the constant pressure process is 1480°C. Calculate :

      i) the cut-off ratio

      ii) the heat supplied per kg of air

      iii) the cycle efficiency

      iv) the m.e.p. 5 + 10

10 a) A space 25 mm wide between two large plane surface is filled with a liquid of dynamic viscosity 0.785 N-s/m^2. What force is required to drag a very thin plate 0.75 m^2 in area between the surfaces at a speed of 0.5 m/s.

i) if this plate remains equidistant from two surfaces

ii) if it is at a distance 10 mm from one of the surfaces ?

b) A pipeline 60 cm in diameter bifurcates at a junction into two branches 40 cm and 30 cm in diameter. If the rate of flow in the main pipe is 1.5 m^2/s and the mean velocity of flow in the 30 cm pipe is 7.5 m/s, determine the rate of flow in the 40 cm pipe.

c) Derive the Euler's equation of motion along a streamline. 6 + 3 + 6

11. a) Draw the p-v and T-s diagram for a rankine cycle.

b) Why is Carnot cycle not practicable for a steam power plant ?

c) A U-tube differential manometer is used to measure the pressure difference between two points in a horizontal pipeline carrying oil of relative density 0.8. The manometric fluid is mercury (relative density of 13.56) and the difference of mercury levels in the two limbs in 60 mm. Determine the pressure difference between the two points. 5 + 5 + 5