Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(AUE-OLD)/SEM-3/AUE-302/2011-12

2011

FLUID MECHANICS AND MACHINERY

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 × 1 = 10

   i) A fluid in equilibrium cannot sustain

   a) Tensile stress b) Compressive stress

   c) Shear stress d) Bending stress.

   ii) Falling drop of water becomes spherical due to the property called

   a) Adhesion b) Cohesion

   c) Viscosity d) Surface tension.

iii) Pitot tube is used to measure

a) discharge

b) average velocity

c) velocity at a point

d) pressure at a point.

iv) When a venturimeter is inclined, then for a given flow it will show

a) lesser reading b) same reading

c) more reading d) inaccurate reading.

v) Rotameter is used for measuring

a) density of fluids

b) velocity of fluids in pipes

c) discharge of fluids

d) viscosity of fluids.

vi) For an irrotational flow $\frac{\partial \phi}{\partial x^2} + \frac{\partial \phi}{\partial y^2} = 0$ is the equation given by

a) Cauchy-Riemann b) Reynolds

c) Laplace d) Bernoulli.

vii) Continuity equation can take the form

a) $Q = \rho AV$ b) $\rho_1 A_1 = \rho_2 A_2$

c) $A_1 V_1 = A_2 V_2$ d) $\rho_1 A_1 V_1 = \rho_2 A_2 V_2$

viii) Air vessels in reciprocating pump are used to

a) smoothen flow

b) reduce acceleration to minimum

c) increase pump efficiency

d) save pump from cavitation

e) increase pump head.

ix) The specific speed (N_s) of a turbine is given by

a) $N_s = N\sqrt{P}/H^{3/4}$ b) $N_s = N\sqrt{Q}/H^{3/4}$

c) $N_s = N\sqrt{P}/H^{5/4}$ d) $N_s = NP^{5/4}/\sqrt{H}$.

x) Ratio of inertia force to elastic force is known as

a) Mach number b) Froude number

c) Reynolds number d) Weber's number.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. A tank of dimension 1 m × 1 m × 1 m contains water and a liquid of specific gravity 0·9. The height of water layer is 0·4 m and that of a liquid layer is 0·6 m. Calculate (i) the total thrust on one side of the tank (ii) the position of the centre of pressure.

3. Develop an expression for the differential form of two dimensional continuity equation.

4. Calculate the kinetic energy correction factor α for the velocity distribution $\frac{u}{u_m}=\left(1-\frac{r}{r_0}\right)$ in a circular pipe radius r_0.

5. With a neat sketch describe the principle of operation of a gear pump.

6. A uniform film of oil 0·13 mm thick separates two discs each of 200 mm diameter mounted coaxially. Calculate the torque necessary to rotate one disc relative to the other at a speed of 7rps if the oil has a viscosity of 0·14 Ns/m^2.

GROUP – C

(Long Answer Type Questions)

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

7. a) Derive an expression for the force exerted on a submerged inclined surface by the static liquid and locate the position of centre of pressure.

   b) A 30 cm × 15 cm venturimeter is provided in a vertical pipeline carrying oil of specific gravity 0·9, the flow being upward. The difference in elevations of the throat section and entrance section of the venturimeter is 30 cm. The differential *U*-tube manometer shows a gauge deflection of 25 cm. Calculate —

      (i) the discharge of oil

      (ii) the pressure difference between the entrance section and the throat section.

   (Take co-efficient of the manometer as 0.9 and specific gravity of Hg as 13.6) 8 + 7

8. a) Derive from first principles Bernoulli's equation for fluid motion along a streamline.

   b) A 45° reducing pipe bend (in a horizontal plane) tapers from 600 mm diameter at inlet to 300 mm diameter at

outlet. The pressure at inlet is 140 kN/m^2 and the rate of flow of water through the bend is 0.425 m^3/s. Neglecting friction, calculate the resultant force exerted by water on the bend.

8 + 7

9. a) Wooden block in the form of a rectangular prism floats with its shortest axis vertical. The block is 40 cm long, 20 cm wide and 15 cm deep with a depth of immersion of 12 cm. Calculate the position of metacentre and comment on the stability of the block.

b) A lawn sprinkler has two identical nozzles of diameter 7.5 mm each provided at the ends of the sprinkler rotor. One nozzle discharges water vertically upward while the other nozzle discharges water in the downstream direction. The velocity of flow from each nozzle is 10 m/s and nozzles are at a radial distance of 20 cm and 15 cm from the centre of rotor.

(i) Determine the torque to be exerted so as to hold the system in stationary position

(ii) Also determine the constant speed of rotation of the arm if it is free to rotate. 7 + 8

10. a) The impeller of a centrifugal pump is single inlet type, having inlet and outlet diameters 700 mm and 1200 mm respectively. At outlet, the width is 200 mm, relative flow angle 25° and absolute flow angle 10·5°. The pump runs at 480 rmp with an efficiency of 77%. Considering 5% blockage at outlet, calculate the pump discharge, head and specific speed.

    b) With diagram describe the working principle of a centrifugal pump. 10 + 5

11. Write short notes on any *three* of the following : 3 × 5

    a) Draft Tube

    b) Skin friction drag & pressure drag

    c) Positive displacement pump

    d) Buckingham's theorem

    e) Cavitation.