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10ME/AU46B

Fourth Semester B.E. Degree Examination, June 2012
Fluid Mechanics

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***
2. ***Missing data may be assumed suitably with proper reasoning.***

PART - A

1 a. Distinguish between the following :
i) Mass density and weight density
ii) Dynamic viscosity and kinematic viscosity.
iii) Ideal fluid and real fluid. **(06 Marks)**

b. Prove that an ideal gas undergoing an adiabatic process, the bulk modulus of elasticity (K) is γ time the pressure (P) where $\gamma = C_p/C_v$. **(04 Marks)**

c. Derive an expression for surface tension on a liquid jet. **(04 Marks)**

d. An oil film of thickness 1.5mm is used for lubrication between a square plate of size 0.9m × 0.9m and an inclined plane having an angle of inclination 20^0 with horizontal. The mass of the square plate is 40 kg and it slides down the plane with a uniform velocity of 0.2m/s. Find the dynamic viscosity of the oil. **(06 Marks)**

2 a. State and prove hydrostatic law. **(06 Marks)**

b. Find the pressure difference between A and B in kPa in meters of water for the fig.Q2(b). **(06 Marks)**

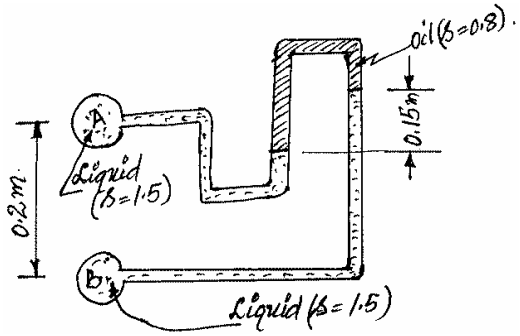

Fig.Q2(b)

c. A circular plate of 4.5m diameter is submerged in water with its greatest and least depths below the water surface being 3m and 1.5m respectively. Find i) the total pressure on the front face of the plate and ii) the position of centre of pressure. **(08 Marks)**

3 a. A hollow wooden cylinder (s = 0.6) has an outer diameter of 0.6m and an inner diameter of 0.3m. It is required to float in an oil of sp.gr. 0.9. Calculate i) the maximum length (height) of the cylinder so that it shall be stable when floating with its axis vertical ii) the depth to which it will sink. **(08 Marks)**

b. Distinguish between : i) Steady flow and uniform flow ii) Rotational flow and irrotational flow. **(04 Marks)**

c. In a two – dimensional flow field for an incompressible fluid, the velocity components are :
$u = y^3/3 + 2x - x^2y$ and $v = xy^2 - 2y - x^3/3$
i) Check for the continuity ii) Find an expression for the stream function. **(08 Marks)**

4 a. Derive Euler's equation of motion along a stream line. Also derive Bernoulli's equation from Euler's equation of motion and list the assumptions made for deriving Bernoulli's equation. **(10 Marks)**

b. A conical tube is fixed vertically with its smaller end upwards and it forms a part of pipe line. The velocity at the smaller end is 4.5m/s and at the large end is 1.5m/s. Length of the conical tube is 1.5m. The pressure at the upper end is equivalent to a head of 10m of water.

i) Neglecting the frictional loss, determine the pressure at the lower end of the tube.

ii) If head loss in the tube is $0.3\ (v_1 - v_2)^2/2g$, where v_1 and v_2 are the velocities at smaller and larger end respectively, determine the pressure at the larger end assuming flow downward. **(10 Marks)**

PART - B

5 a. Derive an expression for discharge through V – notch. **(06 Marks)**

b. A horizontal venturimeter with inlet diameter 20cm and throat diameter 10cm is used to measure the flow of water. The pressure at inlet is 147 kPa and vacuum pressure at the throat is 40cm of mercury. Find the discharge of water through venturimeter. Take $C_d = 0.98$. **(06 Marks)**

c. The shear stress (τ) in a pipe flow depends upon the diameter of the pipe (D), velocity (v) of the fluid, mass density (ρ) and dynamic visocity (μ) of the fluid and height of roughness of projection (k). Using dimensional analysis, obtain the relation for shear stress in a non – dimensional form. **(08 Marks)**

6 a. Derive Chezy's equation for loss of head due to friction in pipes. **(06 Marks)**

b. Water is to be supplied to the inhabitants of a college campus through a supply main. The following data is given :
Distance of the reservoir from the campus = 3km, Number of inhabitants = 4000, Consumption of water per day of each inhabitant = 180 litres, Loss of head due to friction = 18m, Coefficient of friction for the pipe, f = 0.007. If half of the daily supply is pumped in 8 hours, determine the size of the supply main. **(06 Marks)**

c. Three pipes of diameters 300mm, 200mm and 400mm, and length 450m, 255m and 315m respectively are connected in series. The difference in water surface levels in two tanks is 18m. Determine the rate of flow of water if co-efficient of frictions are 0.0075, 0.0078 and 0.0072 respectively. Neglect the minor losses. Also find the equivalent diameters of the pipe if the equivalent coefficient of friction is 0.0075. **(08 Marks)**

7 a. Show that the average velocity is equal to the half of the maximum velocity in a laminar flow through pipe. **(10 Marks)**

b. Determine i) the pressure gradient ii) the shear stress at the two horizontal plates iii) discharge per meter width for laminar flow of oil with a maximum velocity of 2m/s between two plates which are 150mm apart. Given $\mu = 2.5$ Pa-s. **(10 Marks)**

8 a. Differentiate between : i) Pressure drag and friction drag ii) Stream line body and bluff body iii) Lift and drag. **(08 Marks)**

b. Find the displacement thickness and momentum thickness for the velocity distribution in the boundary layer given by :

$$\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2.$$ **(08 Marks)**

c. Find the velocity of the bullet fired in standard air if the Mach angle is 30^0, Assume temperature of air as 15^0C. **(04 Marks)**

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