19.1.09

Ex/BESUS/AM-302/09

B.E. (CE) Part-II 3rd Semester Examination, 2009

Hydraulics-I

(AM-302)

Time : 3 hours **Full Marks : 70**

Use separate answerscript for each half.
Answer SIX questions, taking THREE from each half.
The questions are of equal value.
Take $g = 9.807\ m/s^2$.

FIRST HALF

1. a) The values of C_C and C_V for an orifice, on the wall of a tank are 0.62 and 0.98 respectively, under a particular high head of water above the orifice. If an external mouthpiece, of same diameter as the orifice, is attached to it, what would be the percentage change in discharge under the same head of water, if the mouthpicee runs full?

   b) In case of turbulent incompressible flow through pipe, deduce the Darcy-Weisbach equation from first principle and show that the friction factor is a function of Reynolds number and relative roughness of the pipe.

2. Oil of specific gravity 0.9 and kinematic viscosity 2 stokes flows through a 6 cm diameter inclined pipe. Compute the critical velocity of flow. The pressure gauges connected to sections 1 and 2 of the pipe, 10 m apart, give the values 280 kPa and 360 kPa respectively. Section 1 is 5 m vertically above section 2. Assuming the flow to be steady, laminar and incompressible, find : (i) the direction of flow through the pipe, (ii) the head loss between the sections, (iii) the average velocity of flow and discharge through the pipe, (iv) the friction factor for the pipe, and (v) the shear stress developed at the pipe wall.

3. a) Derive from first principle, the formula for discharge over a sharp crested rectangular notch with end contractions, taking velocity of approach into consideration.

   b) For a venturimeter, installed in a pipeline carrying an incompressible liquid and connected to a differential manometer, deduce the general expression for the head loss between the inlet and the throat sections, in terms of the manometer reading and other pertinent variables, with the aid of a neat sketch.

4. a) Explain :
(i) Hydraulic grade line, (ii) Energy grade line, (iii) Total energy line.

b) Two reservoirs, 48 km apart, have steady water surface level difference of 150 m and they were initially connected by a single pipe of diameter 54 cm. Subsequently, to increase the discharge into the lower reservoir by 100 litres/s, it is proposed to connect another pipe of same diameter to the first one, laid parallely with the former and leading to the lower reservoir. Find the required length of the second pipe to be connected.
Take f=0.028 for all pipes and neglect minor losses.

5. a) Explain with example: "dimensionally homogeneous equation". Give an example of dimensionally non-homogenous equation.

b) State Reynolds law associated with model analysis. Cite a few physical phenomena which are governed by this law.

c) Assume that the torque required to rotate a flat circular disc of diameter D at the speed of N r.p.m. within a fluid of dynamic viscosity μ and mass density ρ is givens as T. Using dimensional analysis, calculate the torque required to rotate a 24 cm diameter disc at 3000 r.p.m. in air, if 0.77 N-m of torque is required to rotate a 9 cm diameter disc in water.
Take $\rho_{air} = 1.2$ kg/m^3, $\mu_{air} = 1.81 \times 10^{-5}$ Pa-s, and $\mu_{water} = 1.01 \times 10^{-3}$ Pa-s.

SECOND HALF

6. a) Define compressibility. How it is related to bulk-modulus of elasticity?

b) Does the viscosity fo liquids and gases increase or decrease with temperature growth? Suggest reasons for the difference in behaviour.

c) A glass tube of 2 mm internal diameter is immersed in oil of mass density 950 kg/m^3 to a depth of 12 mm. If the oil has a surface tension of 0.036 N/m, what pressure is needed in the formation of a just related bubble.

7. a) A closed cylindrical tank 4 m high is partly filled with oil of density 800 kg/m^3 to a depth of 3 m. The remaining space is filled with air under pressure. A U-tube containing mercury (sp. gr. 13.6) is used to measure the air pressure, with one end open to atmosphere. Find the gauge pressure at the base of tank when the mercury deflection in the open limb of the U-tube is (i) 100 mm above and (ii) 100 mm below the level in the other limb.

b) Derive the expression for resultant force on one side of an inclined plane surface immersed in a static liquid and also its line of action.

8. a) An 80 mm diameter composite solid cylinder consists of an 80 mm diameter 20 mm thick metallic plate having specific gravity 4.0 attached at the lower end of an 80 mm diameter wooden cylinder of specific gravity 0.8. Find the limits of the length of the wooden portion so that the composite cylinder can float in stable equilibrium in water with its axis vertical.

   b) State and explain Newtons law of viscosity .

9. a) A reducer bend having an outlet diameter of 15 cm discharges freely. The bend connected to a pipe of 20 cm diameter, has a deflection of 60°and lies in the horizontal plane. Determine the magnitude and direction of the force on the anchor block supporting the pipe when a discharge of $0.3m^3/s$ passes though the pipe.

   b) Distinguish between (i) steady flow and unsteady flow, (ii) Uniform flow and non-uniform flow and (iii) laminar flow and turbulent flow.

10. a) Derive the Euler's equation of motion along a stream line and hence derive the Bernoullis' equation .

    b) A siphon consisting of a 3 cm diameter tube is used to drain water from a tank. The outlet end of the tube is 2.0 m below the water surface in the tank. Neglecting friction, calculate the discharge. It the summit of the siphon is 1.4 m above the water surface in the tank, estimate the pressure at the summit of the siphon.

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