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10ME/AU46B

Fourth Semester B.E. Degree Examination, June/July 2016
Fluid Mechanics

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Explain the following fluid properties with relevant equations:
(i) Bulk modulus (ii) Capillarity (iii) Kinematic viscosity (iv) Surface tension. **(08 Marks)**

b. What is cavitation? Explain the importance of cavitation in the study of fluid mechanics. **(04 Marks)**

c. A square plate of side 1 m and weight 350 N slides down an inclined plane with a uniform velocity of 2 m/s. The inclined plane is laid on a slope of 6 : 8 and has an oil film of 1 mm thickness. Calculate the viscosity of oil. **(08 Marks)**

2 a. Explain the terms: (i) Total pressure (ii) Centre of pressure (iii) Pressure at a point. **(06 Marks)**

b. A simple U-tube manometer containing mercury is connected to a pipe in which a fluid of sp.gr. 0.8 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 of mercury level in the two limbs is 40 cm and the height of fluid in the left from the centre of pipe is 15 cm below. **(04 Marks)**

c. A circular plate of 3.0 m diameter with a concentric circular hole of diameter 1.5 m is immersed in water in such a way that its greatest and least depth below the free surface are 4 m and 1.5 m respectively. Determine the total pressure on one face of the plate and position of the centre of pressure. **(10 Marks)**

3 a. A metallic body floats at the interface of mercury and water in such a way that 30% of its volume is submerged in mercury and 70% in water. Find the density of the metallic body. **(05 Marks)**

b. A wooden block of size $3m \times 2m \times 1m$ and of specific gravity 0.8 floats in water. Determine its meta centric height. **(05 Marks)**

c. A fluid flow is given by $V = 10x^3 i - 8x^3 yj$. Find the shear strain rate and state whether the flow is rotational or irrotational. **(05 Marks)**

d. The velocity potential is given by $\phi = x(2y-1)$. Calculate the value of stream function at a point (1, 2). **(05 Marks)**

4 a. State Bernoulli's theorem for fluid flow. Derive an expression for Bernoulli's equation from first principle. Also state the assumption made for such a derivation. **(10 Marks)**

b. A pipeline carrying oil of specific gravity 0.8 changes in diameter from 300 mm at a position A to 500 mm to a position B which is 5 m at a higher level. If the pressures at A and B are 1.962 bar and 1.491 bar respectively, and the discharge is 150 litres/s, determine the loss of head during the fluid flow. Also state the direction of the fluid flow. **(10 Marks)**

PART – B

5 a. When do you prefer orifice meter over a venturimeter? Why? **(02 Marks)**

b. An oil of specific gravity 0.9 is flowing in a venturimeter of size 20cm×10cm. The oil mercury differential manometer shows a reading of 20 cm. Calculate the flow rate of oil through the horizontal venturimeter. Take discharge coefficient of venturimeter as 0.98. **(06 Marks)**

c. A rectangular channel 2 m wide has a discharge of 0.25 m^3/s, which is measured by a right-angled V-notch weir. Find the position of the apex of the notch from the bed of the channel if maximum depth of water is not to exceed 1.3 m. Take $C_d = 0.62$. **(04 Marks)**

d. Show by Buckingham's π-theorem that the frictional torque T of a disc of diameter D rotating at a speed N in a fluid of viscosity μ and density ρ in a flow is given by,

$$T = D^5N^2\rho\phi\left[\frac{\mu}{D^2N\rho}\right].$$ **(08 Marks)**

6 a. Explain the terms HGL and TEL in case of flow through pipes. **(04 Marks)**

b. List out the various frictional and minor losses occurring in a flow through pipes. Also write down the expressions for the loss of head in each of the above cases. **(06 Marks)**

c. A horizontal pipe line 40 m long is connected to a water tank at one end and discharges freely into the atmosphere at the other end. For the first 25 m of its length from the tank, the pipe is 150 mm diameter and its diameter is suddenly enlarged to 300 mm. The height of water level in the tank is 8 m above the centre of the pipe. Determine the rate of flow considering all losses of head which occur. Take f = 0.01 for both sections of the pipe. **(10 Marks)**

7 a. Explain the terms the critical Reynold's number, velocity gradient and pressure gradient with respect to a viscous flow. **(06 Marks)**

b. Derive an expression for the velocity distribution for Hagen-Poiseuille flow occurring in a circular pipe. Hence prove that the maximum velocity is twice the average velocity of the flow. **(10 Marks)**

c. Determine (i) the pressure gradient (ii) the shear stress at the two horizontal parallel plates for the laminar flow of oil with a maximum velocity of 1.5 m/s between two horizontal parallel fixed plates which are 80 mm apart. Take the viscosity of oil as 1.962 NS/m^2. **(04 Marks)**

8 a. Explain the terms : (i) Boundary layer thickness (ii) Displacement thickness (iii) Momentum thickness (iv) Energy thickness. **(06 Marks)**

b. A flat plate 2m×2m moves at 40 km/hr in stationary air of density 1.25 kg/m^3. If the coefficient of drag and lift are 0.2 and 0.8 respectively, find (i) the lift force (ii) the drag force (iii) the resultant force and (iv) the power required to keep the plate in motion. **(04 Marks)**

c. Obtain an expression for velocity of the sound wave in a compressible fluid in terms of change of pressure and change of density. **(06 Marks)**

d. Calculate the Mach number and Mach angle at a point on a jet propelled aircraft which is flying at 900 km/hour at sea level where air temperature is 15°C. Take K = 1.4 and R = 287 J/kgK. **(04 Marks)**

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