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06ME46B

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

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting atleast TWO questions each from Part – A and Part - B.***

PART – A

1 a. Define the following terms and mention their S.I. units :
i) Specific gravity ii) Kinematic viscosity iii) Surface tension iv) Capillarity. **(06 Marks)**

b. The space between two square flat parallel plates is filled with oil. Each side of the plate is 60cm. The thickness of the oil film is 12.5mm. The upper plate, which moves at 2.5 meter per sec requires a force of 98.1N to maintain the speed. Determine : i) the dynamic viscosity of the oil in poise ii) the kinematic viscosity of the oil in stokes if the specific gravity of the oil is 0.95. **(06 Marks)**

c. Derive an expression for the force exerted on a submerged vertical plane surface by the static liquid and locate the position of centre of pressure. **(08 Marks)**

2 a. State and prove hydrostatic law. **(04 Marks)**

b. Explain the term meta – centric height and derive an expression for the meta – centric height of a floating body. **(08 Marks)**

c. A block of wood of specific gravity 0.7 floats in water. Determine the meta – centric height of the block if its size is - 2m × 1m × 0.8m. **(08 Marks)**

3 a. Obtain an expression for continuity equation for a three dimensional unsteady compressible flow. Deduce the same for steady and incompressible flow. **(10 Marks)**

b. Find the acceleration and the vorticity components at a point (1, 1, 1) for the following flow field. $U = 2x^2 + 2y$; $V = -2xy + 3y^2 + 3yz$; $W = \frac{-3}{2}z^2 + 2xz - 9y^2z$. **(06 Marks)**

c. Does a stream function ψ exist for a flow field described by $\overline{V} = 2y\hat{i} - 2x\hat{j}$? If so determine the stream function ψ. **(04 Marks)**

4 a. What do you mean by repeating variables? How are the repeating variables selected for dimensional analysis? **(04 Marks)**

b. State Buckingham's π theorem and explain dimensional homogeneity. **(04 Marks)**

c. An agitator of diameter D requires power P to rotate at a constant speed N in a liquid of density ρ and viscosity μ.
i) Show with the help of Buckingham 's π theorem that $P = \rho N^3 D5\ \phi\ (\rho ND^2/\mu)$
ii) An agitator of 225mm diameter rotating at 23rps in water requires a driving torque of 1.1Nm. Calculate the corresponding speed and the torque required to drive a similar agitator of 675mm diameter rotating in air.
($\mu air = 1.86 \times 10^{-5}$ Pas , $\mu water = 1.01 \times 10^{-3}$ Pas, $\rho air = 1.2$ kg/m^3, $\rho water = 1000$kg/m^3) **(12 Marks)**

PART – B

5 a. Name the different forces present in a fluid flow. For the Euler's equation of motion, which forces are taken into consideration? **(02 Marks)**

b. State Bernoulli's theorem for steady flow of an in compressible fluid. Derive an expression for Bernoulli's theorem from first principles and state the assumptions made for such a derivation. **(10 Marks)**

c. A 30cm × 15cm venturimeter is provided in a vertical pipe line carrying oil of specific gravity 0.9, the flow being upwards. The difference in elevation of the throat section and entrance section of the venturimeter is 30cm. The differential U - tube mercury manometer shows a gauge deflection of 25cm. Calculate : i) the discharge of oil and ii) the pressure difference between the entrance section and the throat section. Take the co-efficient of meter as 0.98 and specific gravity of mercury as 13.6. **(08 Marks)**

6 a. What is a pitot – tube? How will you determine the velocity at any point with the help of a pitot – tube? **(04 Marks)**

b. Derive Darcy's formula to calculate the frictional factor in a pipe. **(08 Marks)**

c. Find the diameter of a pipe of length 2000m when the rate of flow of water through the pipe is 200 litres/sec and the head loss due to friction is 4m. Take the value of C = 50 in Chezy's formula. **(04 Marks)**

d. Explain the terms hydraulic gradient line and total energy line. **(04 Marks)**

7 a. Describe Reynold's experiment to demonstrate laminar and turbulent flows. **(06 Marks)**

b. Derive an expression for the velocity distribution for viscous flow through a circular pipe. Also sketch the velocity distribution and shear stress distribution across a section of the pipe. **(08 Marks)**

c. Determine i) the pressure gradient ii) the shear stress at the two horizontal parallel plates and iii) the discharge per meter width for the laminar flow of oil with a maximum velocity of 2 m/s between two horizontal parallel fixed plates which are 100mm apart. Given $\mu = 2.4525$ Ns/m^2. **(06 Marks)**

8 a. Define the following :
i) Stream lined body ii) Boundary layer iii) Bluff body iv) Lift and drag. **(08 Marks)**

b. Calculate the diameter of a parachute to be used for dropping an object of mass 100 kg so that the maximum terminal velocity of dropping is 5m/s. The drag co-efficient for the parachute, which may be treated as hemispherical is 1.3. The density of air is 1.216kg/m^3. **(06 Marks)**

c. Find the energy thickness for the velocity distribution in the boundary layer given by

$$\frac{V}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2 .$$ **(06 Marks)**

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