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CBCS SCHEME

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15ME44

Fourth Semester B.E. Degree Examination, Jan./Feb. 2021
Fluid Mechanics

Time: 3 hrs. Max. Marks: 80

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Differentiate between Newtonian and non-Newtonian fluids. Give examples for each. **(04 Marks)**

b. Define surface tension of a liquid. Derive an expression for surface tension of a i) liquid droplet ii) hollow bubble. **(05 Marks)**

c. A 15cm diameter vertical cylinder rotates concentrically inside another cylinder of 15.1cm diameter. Both cylinders are 25cm high. The space between the cylinders is filled with a liquid whose viscosity is unknown. If a torque of 12N-m is required to rotate the inner cylinder at 100rpm, determine the viscosity of the fluid. **(07 Marks)**

OR

2 a. Derive an expression for the depth of centre of pressure from free surface of liquid of vertical plane surface submerged in the liquid. **(08 Marks)**

b. A solid cylinder of diameter 4m has a height of 4m. Find the metacentric height of the cylinder if the specific gravity of the material of the cylinder is 0.6 and it is floating in water with its axis vertical. State whether the equilibrium is stable or unstable. **(08 Marks)**

Module-2

3 a. Define the following :

i) Steady and unsteady flow
ii) Laminar and Turbulent flow. **(04 Marks)**

b. Derive the continuity equation in three dimensional Cartesian coordinate for a steady incompressible fluid flow. **(06 Marks)**

c. The velocity components in a two dimensional flow field for an incompressible fluid are expressed as $u = \frac{y^3}{3} + 2x - x^2 y$, $v = xy^2 - 2y - \frac{x^3}{3}$. Obtain an expression for velocity potential function. **(06 Marks)**

OR

4 a. With usual notations, show that the discharge through a venturimeter is given by $Q = C_d \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \sqrt{2gh}$. **(06 Marks)**

b. A pipeline carrying oil of specific gravity 0.9 changes in diameter from 20cm at a position A to 50cm at position B which is 5m at higher level. If the pressure at A and B are $10 N/cm^2$ and $6 N/cm^2$ respectively and discharge is 200litres/s, determine the loss of head and the direction of flow. **(10 Marks)**

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Module-3

5 a. Prove that the velocity distribution across the cross section of a circular pipe during viscous fluid flow is parabolic in nature. Also prove that the maximum velocity is in the centre of the pipe and is equal to twice the average velocity. **(10 Marks)**

b. Water at 15ºC flows between two large parallel plates at a distance of 1.6mm apart. Determine : i) the maximum velocity ii) the pressure drop per unit length iii) the shear stress at the walls of the plates if the average velocity is 0.2m/s. The viscosity of water at 15ºC is given as 0.01 poise. **(06 Marks)**

OR

6 a. Derive an expression for loss of head due to sudden enlargement of a pipe. **(08 Marks)**

b. An oil of specific gravity 0.9 and viscosity 0.06 poise is flowing through a pipe of diameter 200mm at the rate of 60 liters/s. Find the head loss due to friction for a 500m length of the pipe. Find the power required to maintain this flow. **(08 Marks)**

Module-4

7 a. Find the displacement thickness and the momentum thickness for the velocity distribution in the boundary layer given by $\frac{u}{U\infty} = \frac{y}{\delta}$, where u is the velocity at a distance y from the plate and $u = U_\infty$ and $y = \delta$, where δ = boundary layer thickness. Also calculate the ratio of displacement thickness to momentum thickness. **(08 Marks)**

b. Experiments were conducted in a wind tunnel with a wind speed of 50km/h on a flat plate 2m long and 1m wide. The density of air is $1.15 kg/m^3$. The plate is kept at such an angle that the coefficient of lift and drag are 0.75 and 0.15 respectively. Determine :
i) lift force ii) drag force iii) resultant force iv) power exerted by air stream on the plate. **(08 Marks)**

OR

8 a. Explain the following terms :
i) Geometric similarity ii) Kinematic similarity iii) Dynamic similarity. **(06 Marks)**

b. A partially submerged body is towed in water. The resistance R to its motion depends on the density ρ, the viscosity μ of water, length ℓ of the body, velocity v of the body and the acceleration due to gravity g. By using Buckingham's π-theorem, show that the resistance to the motion can be expressed in the form

$$R = \rho \ell^2 v^2 \phi \left[\frac{\mu}{\rho v L}, \frac{\ell g}{v^2} \right]$$ **(10 Marks)**

Module-5

9 a. From fundamentals, show that the velocity of a sound wave in a compressible fluid is given by $C = \sqrt{\frac{dp}{d\rho}}$. Further, show that this sonic velocity for an isentropic medium is given by $c = \sqrt{rRT}$, where r = ratio of specific heats, R = Gas constant ; T = Temperature. **(08 Marks)**

b. Define Mach number. Explain its significance in compressible flow. **(04 Marks)**

c. Compute the velocity of a bullet fired in still air and Mach number when the mach angle is 30º. Take R = 0.28714kJ/kg K and r = 1.4. Assume air temperature to be 15ºC. **(04 Marks)**

OR

10 a. Define and write the expression for : i) Stagnation enthalpy ii) Stagnation temperature iii) Stagnation pressure. **(06 Marks)**

b. Mention the advantages, disadvantages and limitation of CFD. **(10 Marks)**

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