CBCS SCHEME

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18ME43

Fourth Semester B.E. Degree Examination, June/July 2023
Fluid Mechanics

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Define the following properties of fluids and write their SI units:
(i) Specific weight (ii) Kinematic viscosity (iii) Specific volume **(06 Marks)**

b. Define surface tension of a fluid. Derive an expression for surface tension of a :
(i) liquid droplet (ii) Liquid jet **(06 Marks)**

c. The dynamic viscosity of an oil used for lubrication between a shaft and sleeve is 6 poise. The shaft is of diameter 0.4 m. It rotates at 190 rpm. Calculate the power lost in the bearing for a sleeve length of 90 mm. The thickness of the oil film is 1.5 mm. **(08 Marks)**

OR

2 a. State and prove Pascal's law. **(06 Marks)**

b. Derive an expression for total pressure and depth of centre of pressure for a vertical surface submerged in water. **(06 Marks)**

c. Determine the total pressure and centre of pressure on an isosceles triangular plate of base 4 m and altitude 4m when it is immersed vertically in an oil of specific gravity 0.9. The base of the plate coincides with the free surface of oil. **(08 Marks)**

Module-2

3 a. Define:
(i) Buoyancy (ii) Centre of Buoyancy
(iii) Meta centre (iv) Meta centric height **(08 Marks)**

b. Explain the method to find the metacentric height experimentally. **(06 Marks)**

c. A block of wood of specific gravity 0.7 floats in water. Determine the metacentric height of the block if its size is 2m × 1m × 0.8m. **(06 Marks)**

OR

4 a. Differentiate between:
(i) Steady and unsteady flow
(ii) Laminar and turbulent flow
(iii) Compressible and incompressible flow **(06 Marks)**

b. Derive the continuity equation in three dimensional Cartesian coordinates for a steady, incompressible fluid flow. **(08 Marks)**

c. The diameter of a pipe at sections 1 and 2 are 10 cm and 15 cm respectively. Find the discharge through the pipe if the velocity of water at section 1 is 5 m/s. Determine also the velocity at section 2. **(06 Marks)**

Module-3

5 a. Derive Euler's equation of motion along a stream line. Deduce Bernoulli's equation from Euler's equation. State the assumptions made. **(10 Marks)**

b. A pipe line carrying oil of specific gravity 0.87 changes in diameter from 200 mm at a position A to 500 mm at a position B which is 4 m at higher level. If the pressure at A and B are 10 N/cm^2 and 6 N/cm^2 respectively and the discharge is 200 litres/s. determine the loss of head and the direction of fluid flow. **(10 Marks)**

OR

6 a. Derive Hagen-Posseuille's equation for laminar flow through a circular pipe. **(12 Marks)**

b. Water at 15°C flows between two parallel plates at a distance of 1.6 mm apart. Determine: (i) Maximum velocity (ii) Pressure loss per unit length (iii) Shear stress at the plate if the average velocity is 0.2 m/s. Viscosity of water at 15°C is 0.01 Poise. Take unit width of the plate. **(08 Marks)**

Module-4

7 a. Define the following with respect to boundary layer:
(i) Boundary layer thickness (ii) Displacement thickness
(iii) Momentum thickness (iv) Energy thickness **(08 Marks)**

b. Define Drag and Lift. **(04 Marks)**

c. A flat plate 2m × 2m movers with a velocity of 50 km/hr in air of density 1.15 kg/m^3. If the coefficient of list and drag are 0.75 and 0.15 respectively, calculate:
(i) Drag force (ii) Lift force
(iii) Resultant force (iv) Power exerted on the plate **(08 Marks)**

OR

8 a. Explain the following similarities:
(i) Geometric similarity
(ii) Kinematic similarity
(iii) Dynamic similarity **(10 Marks)**

b. 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 turbulent flow is given by $T = \rho N^2 D^5 \phi\left[\frac{\mu}{\rho N D^2}\right]$. Prove this by using Buckingham's π - theorem method. **(10 Marks)**

Module-5

9 a. Define Mach number. Explain the significance of Mach number in compressible fluid flow. **(06 Marks)**

b. Derive an expression for the velocity of a sound wave in a compressible fluid in terms of change of pressure and change of density. **(08 Marks)**

c. A projectile travel in air of pressure 10.1043 N/cm^2 at 10°C at a speed of 1500 km/hr. Find the Mach number and Mach angle. Take $\gamma = 1.4$ and R = 287 J/kgK. **(06 Marks)**

OR

10 a. Define stagnation temperature and stagnation pressure. Derive the relation between them in terms of Mach number. **(08 Marks)**

b. What is CFD? Mention the applications of CFD. **(06 Marks)**

c. List any six limitations of CFD. **(06 Marks)**

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