

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/cm² and 6 N/cm² 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-Poiseuille'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 moves with a velocity of 50 km/hr in air of density 1.15 kg/m³. If the coefficient of lift 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/cm² 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)
