CBCS SCHEME

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18AE/AS35

Third Semester B.E. Degree Examination, Jan./Feb. 2023
Mechanics of Fluids

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Define Mass Density , Specific gravity , Viscosity and Surface tension, with their S.I. Units. **(08 Marks)**

b. A cubical block of sides 1m and weighing 350N slides down on inclined plane with a uniform velocity of 1.5m/s. The inclined plane is laid on slope of 5 vertical to 12 horizontal and has an oil film of 1.0mm thickness. Calculate the dynamic viscosity of oil in poise. **(08 Marks)**

c. Determine the specific gravity of a fluid having viscosity 0.05 poise and kinematic viscosity 0.035 stokes. **(04 Marks)**

OR

2 a. State and prove Pascal's law. **(07 Marks)**

b. An open tank contains water upto a depth of 2m and above it an oil of specific gravity 0.9 for a depth of 1m. Find the pressure intensity i) At the interface of the two liquids
ii) At the bottom of the tank. **(05 Marks)**

c. A rectangular plane surface 3m wide and 4m deep lies in water in such a way that its plane makes an angle of 30° with the free surface of water. Determine the total pressure force and position of centre of pressure, when the upper edge is 2m below the free surface. **(08 Marks)**

Module-2

3 a. Derive an expression for continuity equation in three dimensions, for steady incompressible fluid flow. **(10 Marks)**

b. The stream function for a 2 – D flow is given by $\Psi = 8xy$. Calculate the velocity at a point P(4, 5). Find also the velocity potential function. **(10 Marks)**

OR

4 a. Explain types of particles motion with neat sketches. **(10 Marks)**

b. For the finite control volume fixed in space, derive momentum equation in integral form. **(10 Marks)**

Module-3

5 a. Derive Bernoulli's equation from Euler's equation. State the Bernoulli's theorem and the assumptions made. **(08 Marks)**

b. The water flowing in a horizontal pipe line whose discharge is measured by a venturimeter. If the ratio of upstream diameter to that of throat is 2:1, upstream diameter is 300mm. The difference of pressure between the throat and upstream is equal to 3m head of water and loss of head through meter is one eighth of the throat velocity head. Calculate discharge in the pipe in litres/sec. **(12 Marks)**

OR

6 a. Using Buckingham's π - theorem, show that the discharge Q consumed by an oil ring is given by

$$Q = Nd^3 \ \phi\left[\frac{\mu}{\rho Nd^2}, \frac{\sigma}{\rho N^2 d^3}, \frac{W}{\rho N^2 d}\right] \text{ where}$$

d is the internal diameter of the ring ; N is the rotational speed ; ρ is the density ; μ is the viscosity ; σ is the surface tension and W is the specific weight of the oil. **(10 Marks)**

b. Define Reynold's number. Derive an expression for Reynold's number. **(05 Marks)**

c. A pipe of diameter 1.5m is required to transport an oil of specific gravity 0.90 and viscosity 3×10^{-2} poise at the rate of 3000 litres/S. Test were conducted on a 15cm diameter pipe using water at 20°C. Find the velocity and rate of flow in the model. Viscosity of water at 20°C = 0.01 poise. **(05 Marks)**

Module-4

7 a. Derive an expression for drag and lift with a neat sketch. **(08 Marks)**

b. A jet plane which weighs 29.43 kN and having a wing area of $20m^2$ flies at a velocity of 950 km/hour, when the engine delivers 7357.5 kW power. 65% of the power is used to overcome the drag resistance of the wing. Calculate the co-efficients of lift and drag for the wing. The density of atmosphere air is 1.21 kg/m^3. **(08 Marks)**

c. Explain Boundary layer concept with neat sketch. **(04 Marks)**

OR

8 a. Obtain an expression for Vo Karman Momentum integral equation. **(12 Marks)**

b. Define Displacement thickness and Momentum thickness. Derive an expression for the Momentum thickness. **(08 Marks)**

Module-5

9 a. Derive an expression for velocity of sound wave in a fluid in terms of bulk modulus. **(10 Marks)**

b. Define Mach Number. Explain types of flow based on Mach number. **(04 Marks)**

c. An Airplane is flying at an altitude of 15km, where the temperature is -50°C. The speed of the plane corresponds to Mach number of 1.6. Assume K = 1.4 and R = 287 J/kg K for air. Find the speed of the plane in km/hour and Mach angle α. **(06 Marks)**

OR

10 a. Explain Propagation of pressure waves in a compressible fluid. **(10 Marks)**

b. Find the Mach Number when an Aeroplane is flying at 1100 km/hour through still air having a pressure of $7N/cm^2$ and temperature -5°C. Wind velocity may be taken as zero. Take R = 287.14 J/kg K. Calculate the Pressure , Temperature and Density of air at stagnation point on the nose of the plane. Take K = 1.4. **(10 Marks)**

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