CBCS SCHEME

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15AE35

Third Semester B.E. Degree Examination, Jan./Feb. 2021
Mechanics of Fluids

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Explain the different types of fluids. **(06 Marks)**

b. If the velocity profile of a fluid over a plate is a parabolic with the vertex 20 cm from the plate, where the velocity is 120 cm/sec. Calculate the velocity gradients and shear stresses at a distance of 0, 10 and 20 cm from the plate, if the viscosity of the fluid is 8.5 poise. **(10 Marks)**

OR

2 a. A circular plate 3.0 m diameter is immersed in water in such a way that its greatest and least depth below the free surface are 4m and 1.5m respectively. Determine the total pressure on one face of the plate and position of the centre of pressure. **(08 Marks)**

b. A circular opening, 3m diameter, in a vertical side of a tank is closed by a disc of 3m diameter which can rotate about a horizontal diameter. Calculate:

(i) The force on the disc, and

(ii) The torque required to maintain the disc in equilibrium in the vertical position when the head of water above the horizontal diameter is 4m. **(08 Marks)**

Module-2

3 a. Obtain the relation between stream function and velocity potential function. **(04 Marks)**

b. Derive the velocity potential function stream function. **(12 Marks)**

OR

4 Derive the differential and integral form of the energy equation through control volume approach. **(16 Marks)**

Module-3

5 a. The water is flowing through a taper pipe of length 100 m having diameters 600 mm at the upper end and 300 mm at the lower end, at the rate of 50 litres/s. The pipe has a slope of 1 in 30. Find the pressure at the lower end if the pressure at the higher level is 19.62 N/cm^2. **(08 Marks)**

b. A 30 cm × 15 cm 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 30 cm. The differential U-tube mercury monometer shows a gauge deflection of 25 cm. Calculate:

(i) The discharge of oil

(ii) The pressure difference between the entrance section and the throat section. Take the coefficient of meter as 0.98 and specific gravity of mercury as 13.6. **(08 Marks)**

OR

6 a. The resisting force R of a supersonic plane during flight can be considered as dependent upon the length of the aircraft ℓ, velocity V, air viscosity μ, air density ρ and bulk modulus of air k. Express the functional relationship between these variables and the resisting force using Rayleigh's method. **(08 Marks)**

b. Using Buckingham's π-theorem, shown that the discharge Q consumed by an oil ring is given by $Q = Nd^3\phi\left[\frac{\mu}{\rho Nd^2}, \frac{\sigma}{\rho N^2 d^3}, \frac{\omega}{\rho N^2 d}\right]$ where d is the internal diameter of the ring, N is rotational speed, ρ is density, μ is viscosity, σ is surface tension and ω is the specific weight of oil. **(08 Marks)**

Module-4

7 Explain Laminar boundary layer and Turbulent boundary layer. Also, derive Boundary Layer Thickness (δ), Momentum thickness and Energy thickness. **(16 Marks)**

OR

8 a. Derive Von Karman momentum integral equation on a flat plate due to boundary layer. **(10 Marks)**

b. Air is flowing over a flat plate 500 mm long and 600 mm wide with a velocity of 4 m/s. The kinematic viscosity of air is given as 0.15×10^{-4} m^2/s. Find:

(i) The boundary layer thickness at the end of the plate
(ii) Shear stress at 200 mm from the leading edge
(iii) Drag force on one side of the plate.

Take the velocity profile over the plate as $\frac{u}{U} = \sin\left(\frac{\pi}{2}.\frac{y}{\delta}\right)$ and density of air 1.24 kg/m^3. **(06 Marks)**

Module-5

9 a. Derive the Bernoulli's equation for isothermal process and adiabatic process. **(08 Marks)**

b. Derive the expression for velocity of sand wave in a fluid. **(08 Marks)**

OR

10 Obtain the expression for stagnation pressure (P_s), stagnation density (ρ_s) and stagnation temperature (T_s). **(16 Marks)**

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