CBCS SCHEME

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21ME43

Fourth Semester B.E. Degree Examination, June/July 2024
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. Derive an expression for Total hydrostatic pressure and centre of pressure from free liquid surface of a vertical plane surface submerged in water. **(08 Marks)**

b. A stream function is given by, $\psi = 3x^2t + 4xy + 2t$, find the velocity field and determine its magnitude and direction at a point defined by the position vector, $r = 1i + 2j + 3k$ when time $t = 5$. **(06 Marks)**

c. Prove that a stream line and potential lines are orthogonal. **(06 Marks)**

OR

2 a. Derive continuity equation for a 3-dimensional steady incompressible fluid flow in Cartesian coordinates with usual notations, also mention the assumptions made. **(12 Marks)**

b. A differential manometer is connected at two points A and B. The pressure at A is 1 Bar while pressure at B is 1.8 Bar. The pipe A carries fluid of specific gravity 1.5, while pipe B carries fluid of specific gravity 0.9. Determine the deflection in the level of Mercury in manometer. If the centre of Pipe A is 3 meter above centre of pipe B. While the level of mercury in Pipe B is 2 meter below centre of pipe B. Also show the diagrammatic representation of differential manometer as per the above data. **(08 Marks)**

Module-2

3 a. Derive an expression for Euler's momentum equation and deduce Bernoulli's equation, state the assumptions made. **(10 Marks)**

b. A $30cm \times 15cm$ 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. If the pressure difference between the entrance section and the throat section is 0.35 bar, determine the actual discharge of oil in litres per minute and the differential U-tube mercury manometer gauge deflection in millimeters of mercury. **(10 Marks)**

OR

4 a. With a neat sketch, explain the parts of a venturimeter and derive an expression for theoretical discharge with usual notations. List its advantages and limitations. **(10 Marks)**

b. The water is flowing through a pipe having diameters 20 cm and 10 cm at section 1 and section 2 respectively. The rate of flow through pipe is 35 litres per second. The section 1 is 6 m above datum and section 2 is 4 m above datum. If the pressure at section 1 is 40 N/cm^2, find the intensity of pressure at 2. Also determine the percentage drop in discharge if a 10% loss of difference in velocity head is considered for the same pressure difference. **(10 Marks)**

Module-3

5 a. Derive an expression to prove drop in pressure in a flow of viscous fluid through a circular pipe. $P_1 - P_2 = \frac{32\mu\bar{u}L}{D^2}$. **(12 Marks)**

b. The two fixed parallel plates kept at 80 mm apart have laminar flow of oil between them with a maximum velocity of 1.5 m/s, taking dynamic viscosity of oil to be 19.62 poise. Calculate

(i) The discharge per meter width.
(ii) The shear stress at the plates wall.
(iii) The pressure difference between two points 25 meter apart.
(iv) The velocity and fluid at a distance of 20 mm from plate. **(08 Marks)**

OR

6 a. Derive an expression for loss of head due to friction, "Darcy Weisback equation". **(10 Marks)**

b. Three pipes of diameter 300 mm, 200 mm and 400 mm having lengths of 450 meter, 225 meter and 315 meter respectively are connected in series between two tanks. The water flows from tank 1 to tank 2 through pipes as per the above given order, determine the rate of flow of water. If surface level of tank 2 is to be maintained 18 meters below the surface level of tank 1. Assume the co-efficient of friction of all the pipes as 0.0075. **(10 Marks)**

Module-4

7 a. Define the following and write their mathematical expressions :

(i) Drag force. (ii) Lift force
(iii) Displacement thickness (iv) Momentum thickness
(v) Energy thickness **(10 Marks)**

b. The pressure drop in an aeroplane model of size $\frac{1}{10}$ of its prototype is 100 N/cm^2. The model is tested in water. Find the corresponding pressure drop in the prototype. Take the density of air as 1.1 kg/m^3 and the viscosity of water as 0.01 poise, while the viscosity of air is 0.00018 Poise. **(06 Marks)**

c. Define similitude and its types. **(04 Marks)**

OR

8 a. The power generated by a Turbo machine P depends on the following, discharge Q, specific input energy gH density fluid ρ, dynamic viscosity μ, Diameter of Rotor D, Speed of the Rotor N. Prove that $P = \rho N^3 D^5 \left(\frac{gH}{N^2D^2}, \frac{\theta}{ND^3}, \frac{\rho VD}{\mu} \right)$, using Buckingham π theorem. **(12 Marks)**

b. A Kite weighing 20 N and having an area of 1 m^2, makes an angle of 7° to the horizontal when flying in a wind of 36 km/hr. If pull on the string attached to the kite is 49 Neutons and it is inclined to the horizontal at 45°, calculate the lift and drag coefficients take density of air = 1.2 kg/m^3. **(08 Marks)**

Module-5

9 a. Derive an expression for velocity of sound in a compressible fluid when the compression is,

(i) Adiabatic in nature. (ii) Isothermal process
(iii) In terms of Bulk Modulus (K),

If velocity of sound $C = \sqrt{\frac{dP}{d\rho}}$, where P is pressure ρ is density. **(10 Marks)**