CBCS SCHEME

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17AU42

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. Describe the phenomenon of capillarity. Obtain expression for capillary rise of a liquid. **(06 Marks)**

b. Distinguish between the following:
i) Mass density and specific weight.
ii) Newtonian and Non-newtonian fluid.
iii) Absolute and kinematic viscosity.
iv) Surface tension and vaccum pressure. **(08 Marks)**

c. Calculate the dynamic viscosity of an oil, which is used for lubrication between a square plate of size 0.8m × 0.8m and inclined plane having a inclination of 30°. The weight of the square plate is 300 N and it slides down the inclined plane with a uniform velocity of 0.3 m/s. The thickness of the oil film is 1.5 MN. **(06 Marks)**

OR

2 a. Derive an expression for the total pressure for an inclined force and depth of center of pressure for an inclined surface submerged in water. **(10 Marks)**

b. Determine the total pressure on a circular plate of diameter 1.5 m which is placed vertically in water in such a way that the center of the plate is 3 m below the free surface of water. Find the position of center of pressure also. **(06 Marks)**

c. State (i) Pascal's law (ii) Hydrostatic law. **(04 Marks)**

Module-2

3 a. Define : i) Buoyancy ii) Metacentre iii) Metacentric height iv) centre of buoyancy. **(10 Marks)**

b. A cylindrical buoy 2m in diameter and 1.5m in height weighs 12kN and floats in salt water of density 1020kg/m^3. Centre of gravity of buoy is 0.65m from bottom. If a load of 2kN on its top symmetrically. Find the maximum height of the centre of gravity of the load above the bottom, if the buoy is to remain in stable equilibrium. **(10 Marks)**

OR

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

b. Define : i) Steam line ii) Velocity potential. **(04 Marks)**

c. The velocity potential in a 2-d flow field for an incompressible fluid is given by $\phi = x(2y - 1)$. Determine the velocity potential at x = 3 and y = 4. Determine also the stream function Ψ at that point. **(10 Marks)**

Module-3

5 a. Derive Bernoulli's equation from Euler's equation with assumptions and limitations. **(08 Marks)**

b. A pipe line carrying oil of specific gravity 0.8 changes in diameter from 300mm at position. A to 500mm diameter at position B. Which is 5m at a higher level. If the pressure at A and B are $20N/cm^2$ and $15N/cm^2$ respectively and discharge is 150lit/sec. determine the loss of head and direction of flow. **(12 Marks)**

OR

6 a. What is venturimeter? Derive an expression for discharge through the venturometer. **(10 Marks)**

b. A venturimeter is to be installed in a 180mm pipe line horizontally at a section where the pressure is 110KPa (gauge). If the maximum flow rate of water in the pipe is $0.15m^8/s$, find the least diameter fo the throat so that pressure at the throat does not fall below 80KPa (vaccum). Assume that 4% of the differential heat is lost between inlet and the throat. **(10 Marks)**

Module-4

7 a. Using Buckingham's π theorem, show that the velocity through a circular orifice is given by $V = \sqrt{2gH} \cdot \phi \left[\frac{D}{H}, \frac{\mu}{\rho VH}\right]$ where 'H' is the head causing flow, 'D' is the diameter of the orifice, μ is the coefficient of viscosity, ρ is the mass density and 'g' is the acceleration due to gravity. **(10 Marks)**

b. Explain the following terms: (i) Geometric similarity (ii) Kinematic similarity **(04 Marks)**

c. Determine the expression for the power P, developed by a pump, when 'P' depends upon the head 'H' ; the discharge 'Q' and specific weight 'W' of the fluid. **(06 Marks)**

OR

8 a. Develop Darcy-Weisbach equation for loss of head in a pipe due to friction. **(10 Marks)**

b. Find the head lost due to friction in a pipe of diameter 300 mm and length 50 m, through which water is flowing at a velocity of 3 m/s using (i) Darcy formula (ii) Chezy's formula for which C = 60. Take γ for water = 0.01 stoke. **(10 Marks)**

Module-5

9 a. Starting from Hagen – Poiseuille equation show that for a circular pipe coefficient of friction is f = 16/Re. **(10 Marks)**

b. A smooth wrought pipe of iron 20cm in diameter carries crude oil at a velocity 2.5m/s. What is the loss of heat per 100m length of pipe? What is the power required to maintain the flow? Assume kinematic viscosity of oil $0.4cm^2/s$ and specific gravity 0.9, and f = 0.01. **(10 Marks)**

OR

10 a. Define : i) Boundary layer thickness ii) Drag force and lift force iii) Mach number iv) Supersonic and subsonic flow. **(10 Marks)**

b. A man weighing 981N descends to the ground from an aeroplane with the help of a parachute against the resistance of air. The parachute is hemispherical in shape, 2m diameter. Find the velocity of the parachute with which it comes down. Assume $C_d = 0.5$ density and kinematic viscosity of air respectively, 0.00125gm/cc and 0.015 stoke. **(05 Marks)**

c. Determine the velocity of a bullet fired in air at mach angle 30°. For air, temperature is 22°C, density $1.2 kg/m^3$, $\nu = 1.4$ and R = 287.4 J/kg K. **(05 Marks)**

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