CBCS SCHEME

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18AU42

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Fluid Mechanics

Time: 3 hrs. Max. Marks: 100

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

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Define surface tension. Prove that the relationship between surface tension and pressure inside a droplet of liquid in excess of outside pressure is given by $P = \frac{4\sigma}{d}$. **(06 Marks)**

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

c. A 15 cm diameter vertical cylinder rotates concentrically inside another cylinder of diameter 15.10 cm. Both cylinders are 25 cm high. The space between the cylinders is filled with a liquid whose viscosity is unknown. If a torque of 12 Nm is required to rotate the inner cylinder at 100 rpm. Determine the viscosity of the fluid. **(08 Marks)**

OR

2 a. Obtain an expression for pressure variation in a fluid at rest. **(06 Marks)**

b. Explain U-tube differential manometer with sketch and relation. **(06 Marks)**

c. A circular plate 3m diameter is immersed in water in such a way that its greatest and least depths below the free surface are 4m and 1.5 m respectively. Determine the total pressure on one face of the plate and position of the centre of pressure. **(08 Marks)**

Module-2

3 a. Derive an expression for the metacentric height of a floating body analytically. How will you determine the metacentric height of a floating body experimentally? Explain with sketch. **(12 Marks)**

b. With neat sketches, explain the conditions of equilibrium for floating and submerged bodies. **(08 Marks)**

OR

4 a. Distinguish between :
(i) Steady flow and unsteady flow
(ii) Laminar and Turbulent flow **(04 Marks)**

b. Obtain an expression for continuity equation for a three dimensional steady incompressible flow. **(08 Marks)**

c. Prove that for potential flow, the stream function satisfy the Laplace equation. **(08 Marks)**

Module-3

5 a. Derive an expression for Bernoulli's theorem from first principle and state the assumptions made for such a derivation. **(10 Marks)**

b. A pump has a tapering pipe running full of water. The pipe is placed vertically with the diameters at the base and top being 1.2 m and 0.6 m respectively. The pressure at the upper end is 240 mm of Hg vacuum, while the pressure at the lower end is 15 kN/m^2. Assume the head loss to be 20% of difference of velocity head. Calculate the discharge, the flow is vertically upwards and difference of elevation is 3.9 m. **(10 Marks)**

OR

6 a. Derive the expression for the rate of flow of fluid through venturimeter. **(08 Marks)**
b. Derive an expression for discharge through a triangular notch. **(08 Marks)**
c. What is difference between pitot-tube and pitot-static tube? **(04 Marks)**

Module-4

7 a. The efficiency η of a fan depends on density ρ dynamic viscosity μ of the fluid, angular velocity ω, diameter D of the rotor and the discharge Q. Express η in terms of dimensionless parameters. **(10 Marks)**
b. What is similitude? Explain types of similarities. **(06 Marks)**
c. Define: (i) Reynolds number (ii) Mach number **(04 Marks)**

OR

8 a. How will you determine the loss of head due to friction in pipes by using:
(i) Darcy formula (ii) Chezy's formula **(12 Marks)**
b. Obtain expression for head loss in a sudden expansion in the pipe. **(08 Marks)**

Module-5

9 a. Derive an expression for the velocity distribution for viscous flow through a circular pipe. **(08 Marks)**
b. Prove that the velocity distribution for viscous flow between two parallel plates when both plates are fixed across a section is parabolic in nature. Also prove that maximum velocity is equal to one and a half times the average velocity. **(12 Marks)**

OR

10 a. Prove that the momentum thickness for boundary layer flows is given by $\theta = \int_0^\delta \frac{u}{U}\left(1 - \frac{u}{U}\right)dy$. **(06 Marks)**
b. Derive an expression for velocity of sound wave in a fluid. **(08 Marks)**
c. Explain propagation of pressure waves in a compressible fluid. **(06 Marks)**

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