CBCS SCHEME

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17AE/AS35

Third Semester B.E. Degree Examination, Dec.2023/Jan.2024
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. Explain the terms:
(i) Specific weight (ii) Specific gravity (iii) Viscosity
(iv) Surface tension (v) Buoyancy **(10 Marks)**

b. Explain the phenomenon of capillarity. Obtain an expression for capillary rise and fall. **(10 Marks)**

OR

2 a. Derive an expression for hydrostatic force on an inclined submerged plane surface and depth of centre of pressure. **(10 Marks)**

b. Calculate the capillary rise in a glass tube of 2.5 mm diameter when immersed vertically in (i) water and (ii) mercury. Take surface tensions σ = 0.0725 N/m for water and σ = 0.52 N/m for mercury in contact with air. The specific gravity for mercury is given as 13.6 and angle of contact = 130°. **(05 Marks)**

c. A differential manometer is connected to the two points A and B as shown in Fig.Q2(c). At B air pressure is 9.81 N/cm^2 (abs), find the absolute pressure at A.

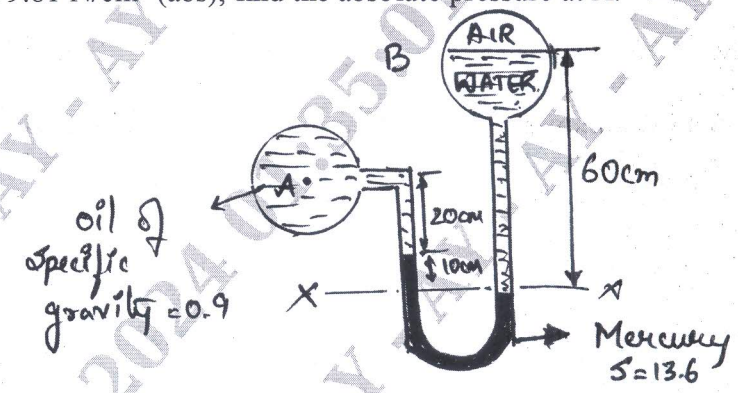

Fig.Q2(c) **(05 Marks)**

Module-2

3 a. Derive the general three-dimensional continuity equation and then reduce it to continuity equation for steady, two dimensional in compressible flow. **(10 Marks)**

b. Derive the Navier-Stokes equation by control volume approach. **(08 Marks)**

c. Mention the applications of continuity, momentum and energy equations. **(02 Marks)**

OR

4 a. At point P(0.5, 1) is situated in the flow field of a doublet of strength 5m^2/s. Calculate the velocity at this point and also the value of the stream function. **(10 Marks)**

b. Show that the stream lines and equipotential lines are orthogonal to each other. **(05 Marks)**

c. Obtain an equation of stream function and potential function. Draw streamline and potential lines for source flow. **(05 Marks)**

Module-3

5 a. Derive Euler's equation of motion for ideal fluids and hence deduce Bernoulli's equation of motion. State the assumption made. **(10 Marks)**

b. A horizontal venturimeter with inlet diameter 20 cm and the throat diameter 10 cm is used to measure the flow of water. The pressure at inlet is 17.658 N/cm^2 and the vacuum pressure at the throat is 30 cm of mercury. Find the discharge of water through venturimeter. Take $C_d = 0.98$. **(10 Marks)**

OR

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

b. The efficiency η of a fan depends on the density ρ, the dynamic viscosity μ of the fluid, the angular velocity ω, diameter 'D' of the rotor and discharge Q. Express η in terms of dimensionless parameters. **(10 Marks)**

Module-4

7 a. Derive the expression for the following:
(i) Displacement thickness (δ^*)
(ii) Momentum thickness (θ)
(iii) Energy thickness (δ^{**}) **(15 Marks)**

b. With a neat sketch, briefly explain boundary layer theory. **(05 Marks)**

OR

8 a. For the velocity profile for laminar boundary layer flows is given as $\frac{u}{U} = 2(y/\delta) - (y/\delta)^2$ find an expression for boundary layer thickness (δ), shear stress (τ_0) and coefficient of drag (C_D) in terms of Reynold number. **(15 Marks)**

b. With a neat sketch, explain the airfoil characteristics. **(05 Marks)**

Module-5

9 a. Derive an expression for:
(i) Velocity of sound in terms of Bulk modulus
(ii) Velocity of sound in isothermal process
(iii) Velocity of sound for adiabatic process **(12 Marks)**

b. Find the Mach number when an aeroplane is flying at 1100 km/hr through still air having a pressure of 7 N/cm^2 and temperature –5°C. Wind velocity may be taken as zero. Take R = 287.14 J/kgK. Calculate the pressure, temperature and density of air at stagnation point on the nose of the plane. Take K = 1.4. **(08 Marks)**

OR

10 a. Drive Bernoulli's equation for compressible flow undergoing isothermal and adiabatic process. **(10 Marks)**

b. With a neat sketch, explain the propagation of pressure waves in a compressible fluid. Define Mach cone, Mach number and Mach angle. **(10 Marks)**

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