CBCS SCHEME

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15ME44

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

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Define the following terms and mention their SI units:
(i) Density
(ii) Specific gravity
(iii) Viscosity **(06 Marks)**

b. The right limb of a U-tube containing mercury is opened to the atmosphere. The left limb contains water and is connected to a pipe full of water at a pressure. The free surface of mercury and the centre of pipe are at the same level. If the difference of level between two mercury surfaces is 80 mm, find the pressure intensity of water in the pipe. **(04 Marks)**

c. Obtain an expression for capillarity rise of a liquid. **(06 Marks)**

OR

2 a. Derive an expression for the depth of centre of pressure from free surface of liquid of an inclined plane surface submerged in the liquid. **(10 Marks)**

b. A rectangular block 0.5 m long, 0.25 m wide and 0.18 m deep is floating in a liquid. The shortest axis of the block is vertical and depth of immersion is 0.15 m. Calculate metacentric height. State whether equilibrium is stable or unstable. **(06 Marks)**

Module-2

3 a. Derive continuity equation for a three dimensional fluid flow in Cartesian coordinates. **(08 Marks)**

b. Distinguish between:
(i) Steady and un-steady flow
(ii) Laminar and Turbulent flow **(04 Marks)**

c. A stream function is given by $\psi = 5x - 6y$. Calculate the velocity components and also magnitude and direction of the resultant velocity at any point. **(04 Marks)**

OR

4 a. Derive an expression for Bernoulli's equation from the first principles and also mention the assumption made. **(10 Marks)**

b. A horizontal venturimeter with inlet diameter 20 cm and throat diameter 10 cm is used to measure the flow of water. The pressure at inlet is 147 kPa and vacuum pressure at the throat is 40 cm of mercury. Find the discharge of water through venturimeter. Take $C_d = 0.98$. **(06 Marks)**

Module-3

5 a. Derive an expression for the velocity distribution for Hagen-Poiseuille flow occurring in a circular pipe. Hence prove that the maximum velocity is twice the average velocity of the flow. **(10 Marks)**

b. A fluid of viscosity 0.7 NS/m^2 and specific gravity 1.3 is flowing through a circular pipe of diameter 100 mm. The maximum shear stress at the pipe wall is given as 196.2 N/m^2. Find:
(i) The pressure gradient
(ii) The average velocity
(iii) Reynolds number of the flow **(06 Marks)**

OR

6 a. Derive Darcy's equation for loss of head in a pipe due to friction. **(10 Marks)**
b. What do you understand by terms: major energy losses and minor energy losses in pipes? **(02 Marks)**
c. Define Reynold's number. What is its significance? **(04 Marks)**

Module-4

7 a. Define the following:
(i) Boundary layer thickness
(ii) Displacement thickness
(iii) Momentum thickness **(06 Marks)**
b. A square plate of side 2m is moved in a stationary air of density 1.2 kg/m^3 with a velocity of 50 kmph if the coefficient of drag and lift are 0.2 and 0.8 respectively. Determine:
(i) Lift force
(ii) Drag force
(iii) The resultant force
(iv) The power required to keep the plate in motion
(v) Direction of resultant force **(10 Marks)**

OR

8 a. State Buckingham's π theorem and explain dimensional homogeneity and geometric similarity. **(06 Marks)**
b. In a fuel inspection system, small droplets are formed by break up for liquid jet. Assume the droplet diameter 'd' is function of liquid density 'ρ', viscosity μ, surface tension σ, nozzle diameter, D and jet velocity V. Show using Buckingham's π - theorem, $\frac{d}{D} = \phi\left[\frac{\rho VD}{\mu}, \frac{\sigma}{\mu V}\right]$, considering D, V, μ are repeating variables. **(10 Marks)**

Module-5

9 a. Obtain an expression for velocity of the sound wave in a compressible fluid in terms of change of pressure and change of density. **(10 Marks)**
b. An Aeroplane is flying at an height of 15 km where the temperature is –50°C. The speed of the plane is corresponding to M = 2.0. Assuming K = 1.4 and R = 287 K/kgK. Find the speed of the plane. **(06 Marks)**

OR

10 a. What is computational fluid dynamics? Mention its application. **(06 Marks)**
b. Define the terms subsonic flow and supersonic flow. **(04 Marks)**
c. Find the velocity of bullet fired in standard air if the mach angle is 30°. Take R = 288 J/kgK and K = 1.4 for air. Assume temperature as 18°C. **(06 Marks)**

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