CBCS SCHEME

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17ME44

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. Explain the following fluid properties with relevant equations:
(i) Bulk modulus (ii) Capillarity
(iii) Kinematic viscosity (iv) Surface tension **(08 Marks)**

b. Define compressibility of a fluid. Derive an expression for compressibility of a fluid undergoing isentropic compression. **(04 Marks)**

c. A square plate of side 1m and weight 350 N slides down an inclined plane with a uniform velocity of 2 m/s. The inclined plane is laid on a slope of 6:8 and has an oil film of 1 mm thickness. Calculate the viscosity of oil. **(08 Marks)**

OR

2 a. Derive an expression for total pressure and centre of pressure on an inclined plane surface immersed in a static fluid. **(10 Marks)**

b. A wooden cylinder of specific gravity 0.6 and circular in cross section is required to float in oil of specific gravity 0.9. Find the L/D ratio for the cylinder to float with its longitudinal axis vertical in oil, where ℓ is the height of the cylinder and D is its diameter. **(10 Marks)**

Module-2

3 a. Derive the continuity equation in 3D Cartesian coordinates for steady incompressible flow. **(08 Marks)**

b. A fluid flow is given by $V = 10x^3 i - 8x^3 yj$. Find the shear strain rate and state whether the flow is rotational as irrotational. **(06 Marks)**

c. The velocity potential function is given by $\phi = -2\ell n(x^2 + y^2)$. Show that it represents a possible case of fluid flow. **(06 Marks)**

OR

4 a. A jet of water of diameter 75 mm moving with a velocity of 30 m/s, strikes a curved fixed plate tangentially at one end at an angle of 30° to the horizontal. The jet leaves the plate at an angle of 20° to horizontal. Find the force exerted by Jet on the plate in horizontal and vertical direction. **(04 Marks)**

b. Derive Euler's equation of motion for steady flow and deduce Bernoulli's equation. Also state the assumptions made. **(10 Marks)**

c. A horizontal venturimeter with inlet diameter 20 cm and throat diameter 10 cm is used to measure the flow of oil of specific gravity 0.8. The discharge of oil through venturimeter is 60 ℓt/s. Find the reading of oil mercury differential manometer. Take $C_d = 0.98$. **(06 Marks)**

Module-3

5 a. Derive an expression for velocity distribution (Hagen-Poiseullis flow equation) in circular pipe. Prove that maximum velocity is twice the average velocity of flow. **(10 Marks)**

b. A laminar flow is taking place in a pipe of diameter of 200 mm. The maximum velocity is 1.5 m/s. Find the mean velocity and the radius at which this occurs. Also calculate velocity at 4 cm from the wall of pipe. **(10 Marks)**

OR

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

b. The rate of flow of water through a horizontal pipe is 0.25 m^3/s. The diameter of pipe which is 200 mm is suddenly enlarged to 400 mm. The pressure intensity in the smaller pipe is 11.772 N/cm^2. Determine:
(i) Loss of head due to sudden enlargement
(ii) Pressure intensity in the larger pipe
(iii) Power lost due to enlargement **(10 Marks)**

Module-4

7 a. Explain the terms:
(i) Boundary layer thickness (ii) Displacement thickness
(iii) Momentum thickness (iv) Energy thickness **(08 Marks)**

b. Write a short note on boundary layer separation and methods to control it. **(06 Marks)**

c. A flat plate 1.5 m × 1.5 m moves at 50 km/hr in stationary air of density 1.15 kg/m^3. If the coefficient of drag and lift are 0.15 and 0.75 respectively. Determine:
(i) Lift force (ii) Drag force (iii) Resultant force (iv) Power required to keep Plate in motion. **(06 Marks)**

OR

8 a. The rate of discharge Q of a centrifugal pump is dependent upon density of fluid ρ, pump speed N in rpm, diameter of impeller D, pressure P, viscosity of fluid μ, using Buckingham's π-theorem show that $Q = ND^3\phi\left[\frac{P}{\rho N^2D^2}, \frac{\mu}{\rho ND^2}\right]$. **(10 Marks)**

b. What is dimensional analysis? Explain the need of dimensional analysis. **(04 Marks)**

c. Explain: (i) Geometric similarity (ii) Kinematic similarity (iii) Dynamic similarity **(06 Marks)**

Module-5

9 a. Define stagnation properties. Obtain an expression for stagnation pressure of a compressible fluid in terms of Mach number and pressure. **(10 Marks)**

b. What is CFD? Mention the advantages, disadvantages of CFD. Also mention application of it. **(10 Marks)**

OR

10 a. Define the following terms:
(i) Sonic flow (ii) Subsonic flow (iii) Supersonic flow (iv) Mach number **(04 Marks)**

b. Derive an expression for velocity of sound wave in a fluid and show that speed of sound wave in a medium $C = \sqrt{\frac{K}{\rho}}$. **(10 Marks)**

c. Calculate the velocity and mach number of a supersonic air craft flying at an altitude of 1000 m where the temperature is 280 K. Sound of air craft is heard 2.15 seconds after the passage of aircraft on the head of an observer. Take $\gamma = 1.41$ and $R = 287$ J/kgK. **(06 Marks)**

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