CBCS SCHEME

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18ME43

Fourth Semester B.E. Degree Examination, June/July 2024
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. Define the following terms : (i) Surface tension (ii) Kinematic viscosity (iii) Compressibility (iv) Capillarity **(08 Marks)**

b. The dynamic viscosity of an oil, used for lubrication between a shaft and sleeve is 6 poise. The shaft is of diameter 0.4 m and rotates at 190 rpm. Calculate the power lost in the bearing for a sleeve length of 90 mm. The thickness of the oil film is 1.5 mm. **(08 Marks)**

c. The right limb of a simple U-tube manometer containing mercury is open to the atmosphere while the left limb is connected to a pipe in which a fluid of sp. gr. 0.9 is flowing. The centre of the pipe is 12 cm below the level of mercury in the right limb. Find the pressure of fluid in the pipe if the difference of mercury level in the two limbs is 20 cm. **(04 Marks)**

OR

2 a. Define the following : (i) Total pressure (ii) Centre of pressure **(04 Marks)**

b. Derive an expression for the depth of centre of pressure from free surface of liquid of an inclined plane surface submerged in the liquid. **(08 Marks)**

c. A rectangular plane surface 2 m wide and 3 m deep lies in water in such a way that its plane makes an angle of 30° with the free surface of water. Determine the total pressure and position of centre of pressure when the upper edge is 1.5 m below the free water surface. **(08 Marks)**

Module-2

3 a. Define : (i) Buoyancy (ii) Centre of Buoyancy (iii) Meta-centre (iv) Meta-centric height **(08 Marks)**

b. Find the volume of water displaced and position of centre of buoyancy for a wooden block of width 2.5 m and of depth 1.5 m, when it floats horizontally in water. The density of wooden block is 650 kg/m^3 and its length 6.0 m. **(04 Marks)**

c. A block of wood of specific gravity 0.7 floats in water. Determine the meta-centric height of the block if its size is $2m \times 1m \times 0.8m$ **(08 Marks)**

OR

4 a. Derive the continuity equation for the 3-D flow in Cartesian co-ordinates. **(08 Marks)**

b. Differentiate between :
(i) Stream function and velocity potential function. (ii)Stream line and steak line.
(iii) Rotational and Irrotational flow. (iv) Laminar and Turbulent flow. **(08 Marks)**

c. Stream function is given by $\psi = 2xy$. Determine whether the flow is possible or not. **(04 Marks)**

Module-3

5 a. What is a Venturimeter? Derive an expression for the discharge through a Venturimeter. **(08 Marks)**

b. An oil of sp.gr. 0.8 is flowing through a venturimeter having inlet diameter 20 cm and throat diameter 10 cm. The oil-mercury differential manometer shows a reading of 25 cm. Calculate the discharge of oil through the horizontal venturimeter. Take $C_d = 0.98$. **(08 Marks)**

c. A pitot-static tube is used to measure the velocity of water in a pipe. The stagnation pressure head is 6 m and static pressure head is 5 m. Calculate the velocity of flow assuming the co-efficient of tube equal to 0.98 **(04 Marks)**

OR

6 a. Define Reynold's number. What is its significance? List the characteristics of laminar flow. **(08 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) Reynold's number of the flow. **(08 Marks)**

c. A rough pipe is of diameter 8.0 cm. The velocity at a point 3.0 cm from wall is 30% more than the velocity at a point 1 cm from pipe wall. Determine the average height of the roughness. **(04 Marks)**

Module-4

7 a. Define Lift force and drag force. Also derive their expressions. **(08 Marks)**

b. Define: (i) Laminar boundary layer. (ii) Turbulent boundary layer
(iii) Laminar sub-layer (iv) Boundary layer thickness **(08 Marks)**

c. A flat plate 1.5 m×1.5 m moves at 50 km/hour in stationary air of density 1.15 kg/m^3. If the co-efficient of drag and lift are 0.15 and 0.75 respectively, determine :
(i) The lift force.
(ii) The drag force.
(iii) The resultant force.
(iv) The power required to keep the plate in motion. **(04 Marks)**

OR

8 a. Explain dimensional homogeneity with examples. **(04 Marks)**

b. Define similitude and explain the following :
(i) Geometric similarity (ii) Kinematic similarity (iii) Dynamic similarity **(08 Marks)**

c. The resisting force (R) of a supersonic plane during flight can be considered as dependent upon the length of the aircraft (l), Velocity (V), Air Viscosity (μ), Air density (ρ) and Bulk modulus of air (K). Express the functional relationship between these variables and the resisting force. **(08 Marks)**

Module-5

9 a. Define : (i) Mach number (ii) Mach cone (iii) Zone of action (iv) Super-sonic flow **(04 Marks)**

b. Define stagnation properties. Obtain an expression for stagnation pressure of a compressible fluid in terms of Mach number and pressure. **(08 Marks)**

c. A projectile travels in air of pressure 10.1043 N/cm^2 at 10°C at a speed of 1500 km/hour. Find the Mach number and Mach angle. Take K = 1.4 and R = 287 J/kg°K. **(08 Marks)**

OR

10 a. What is CFD? Explain the necessity of CFD. **(04 Marks)**

b. List the advantages, disadvantages and applications of CFD. **(08 Marks)**

c. Write short note on "Engineering philosophy behind CFD. **(08 Marks)**

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