CBCS SCHEME

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15ME44

Fourth Semester B.E. Degree Examination, June/July 2023
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 properties of fluids mentioning their SI units:
(i) Density (ii) Specific weight (iii) Specific gravity (iv) Surface tension **(04 Marks)**

b. State and express mathematically with usual notations:
(i) Newton's law of viscosity (ii) Hydrostatic law **(04 Marks)**

c. 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)**

OR

2 a. A circular plate 3.0 m diameter having a concentric circular hole of diameter 1.5 m is immersed in water in such a way that its greatest and least depth 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)**

b. Explain the stability of floating body with a neat sketch having usual notations. **(08 Marks)**

Module-2

3 a. Explain the types of fluid flow in detail. **(08 Marks)**

b. Sketch the stream lines represented by $\psi = x^2 + y^2$. Also find out the velocity and its direction at point (1, 2). **(08 Marks)**

OR

4 a. Derive Euler's equation of motion and hence obtain Bernoulli's equation from it. **(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)**

Module-3

5 a. In a laminar flow through circular pipe, show that:
(i) Shear stress distribution across the section is linear.
(ii) Velocity distribution across the section is parabolic. **(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) Pressure gradient (ii) Average velocity (iii) Reynold number of the flow. **(08 Marks)**

OR

6 a. Derive an expression for finding the loss of head due to friction in pipes. **(08 Marks)**

b. For a town water supply, a main pipe line of diameter 0.4 m is required. As pipes more than 0.35 m diameter are not readily available, two parallel pipes of the same diameter were used for water supply. If the total discharge in the parallel pipes is same as in the single main pipe, find the diameter of the parallel pipe. Assume the coefficient of friction same for all pipes. **(08 Marks)**

Module-4

7 a. Experiments were conducted in a wind tunnel with a wind speed of 50 km/hr on a flat plate of size 2m long and 1m wide. The density of air is 1.15 kg/m^3. The coefficients of lift and drag are 0.75 and 0.15 respectively. Determine:
(i) Lift force (ii) Drag force (iii) Resultant force
(iv) Direction of the resultant force (v) Power exerted by air on the plate. **(08 Marks)**

b. 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, using Buckingham's π-theorem. **(08 Marks)**

OR

8 a. The efficiency of a fan depends on the density 'ρ', the dynamic viscosity 'μ' of the fluid, the angular velocity (w), diameter 'D' of the rotor and the discharge 'Q', express efficiency 'η' in terms of dimensionless parameters using Rayleigh's method. **(08 Marks)**

b. A man weighing 90 kg descends to the ground from an aeroplane with the help of a parachute against the resistance of air. The velocity with which the parachute, which is hemispherical in shape, comes down is 20 m/s. Find the diameter of the parachute. Assume $C_D = 0.5$ and density of air = 1.25 kg/m^3. **(08 Marks)**

Module-5

9 a. Mention the basic equations of compressible flow. **(04 Marks)**

b. What is Mach number? Classify flow of compressible fluid on the basis of Mach number. **(04 Marks)**

c. Find the sonic velocity for:
(i) Crude oil of sp.gr. 0.8 and bulk modulus 153036 N/cm^2.
(ii) Mercury having a bulk modulus of 2648700 N/cm^2. **(08 Marks)**

OR

10 a. What is CFD? Explain the necessity and limitations of CFD. **(08 Marks)**

b. Discuss the applications of CFD. **(08 Marks)**

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