ACHARYA INSTITUTE OF TECHNOLOGY LIBRARY BANGALORE

CBCS SCHEME

USN

21AE/AS33

Third 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 fluid properties with their SI units :
(i) Mass density
(ii) Specific weight
(iii) Viscosity
(iv) Kinematic viscosity
(v) Surface tension. **(10 Marks)**

b. An oil film of thickness 1.5 mm is used for lubrication between a square plate of size 0.9 m × 0.9 m and an inclined plane having an angle of inclination 20°. The weight of the square plate is 392.4 N and it slides down the plane with uniform velocity of 0.2 m/s. Find the dynamic viscosity of the oil in poise. **(10 Marks)**

OR

2 a. State and prove the Pascal's law. **(06 Marks)**

b. What do you understand by total pressure and center of pressure? **(04 Marks)**

c. Find the volume of the water displaced and position of center of buoyancy for 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 is 6.0 m. **(10 Marks)**

Module-2

3 a. Define the following :
(i) Steady and Unsteady flows.
(ii) Uniform and Non-uniform flows
(iii) Laminar and Turbulent flows
(iv) Compressible and In-compressible flows.
(v) Rotational and Irrotational flows.
(vi) One and Two dimensional flows. **(12 Marks)**

b. The velocity potential function is given by $\phi = 5(x^2 - y^2)$. Calculate the velocity components at the point (4, 5). **(08 Marks)**

OR

4 a. Derive an expression for continuity equation in 3D, in differential form for steady incompressible fluid flow (Cartesian co-ordinate). **(10 Marks)**

b. The velocity components in a 2-D flow field for an incompressible fluid are as follows :

$u = \frac{y^3}{3} + 2x - x^2 y$ and $v = xy^2 - 2y - \frac{x^3}{3}$.

Obtain an expression for the stream function ψ. **(10 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-3

5 a. State the assumptions made in Bernoulli's equation and obtain Euler's equation of motion. **(10 Marks)**

b. Explain the principle of Venturi meter. Derive an expression for the discharge of fluid through it. **(10 Marks)**

OR

6 a. Define the following terms :
(i) Geometric similarity
(ii) Kinematic similarity
(iii) Dynamic similarity. **(06 Marks)**

b. Using the 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 head causing flow.
D is the diameter of the orifice.
μ is the co-efficient of viscosity.
ρ is the mass density
g is the acceleration due to gravity. **(14 Marks)**

Module-4

7 a. Define the following terms with neat diagram :
(i) Laminar boundary layer.
(ii) Turbulent boundary layer
(iii) Laminar sub-layer. **(14 Marks)**

b. Find the ratios of displacement thickness to momentum thickness and momentum thickness to energy thickness for the velocity distribution in the boundary layer given as :

$$\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$$

where u = velocity in boundary layer at a distance 'y'
U = Free-stream velocity
δ = Boundary layer thickness. **(06 Marks)**

OR

8 a. Derive an expression for Von-Karman's momentum integral equation for boundary layer flows. **(10 Marks)**

b. A flat plate 2m × 2m moves at 40 km/hr in stationary air density 1.25 kg/m^3. If the co-efficient of drag and lift are 0.2 and 0.8 respectively. Find,
(i) The lift force
(ii) The drag force
(iii) The resultant force
(iv) The power required to keep the plate in motion. **(10 Marks)**

Module-5

9 a. Define the terms :
(i) Mach number
(ii) Sub-sonic flow
(iii) Supersonic flow
(iv) Mach angle
(v) Mach cone
(vi) Sonic flow. **(12 Marks)**

b. A gas is flowing through a horizontal pipe which is having area of cross section as 40 cm^2 where pressure is 40 N/cm^2 (gauge) and temperature is 15 °C. At another section the area of cross section is 20 cm^2 and pressure is 30 N/cm^2 (gauge). If the mass rate of flow of gas through the pipe is 0.5 kg/s.
Find the velocities of the gas at these sections assuming an isothermal change.
Take R = 292 N-m/kg.K and atmospheric pressure 10 N/cm^2. **(08 Marks)**

OR

10 a. With neat diagram, explain the structure of Hydraulic power system. **(06 Marks)**

b. Classify hydraulic pumps, explain with neat diagram, working of external gear pump and Lobe pump. **(08 Marks)**

c. Mention types of Actuators with neat diagram, explain working principle of double acting cylinder. **(06 Marks)**

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