CBCS SCHEME

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15ME44

Fourth Semester B.E. Degree Examination, July/August 2022
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 following and mention their units :
i) Mass density
ii) Dynamic viscosity
iii) Surface tension
iv) Bulk modulus. **(08 Marks)**

b. A U – tube manometer is used to measure the pressure of oil of specific gravity 0.85 flowing in a pipe line. Its left end is connected to the pipe and the right limb is open to the atmosphere. The centre of the pipe is 100mm below the level of mercury (specific gravity = 13.6) in the right limb of the difference of mercury level in the two limbs is 160mm, Determine the absolute pressure of the oil in the pipe. **(08 Marks)**

OR

2 a. Define the following terms :
i) Buoyancy
ii) Centre of Buoyancy
iii) Meta centre
iv) Meta centric height. **(06 Marks)**

b. A circular plate 1.5m diameter is submerged in water, with its greatest and least depths below the surface being 2m and 0.75m respectively.
Determine :
i) The total pressure on one face of the plate
ii) The position of the centre of pressure. **(10 Marks)**

Module-2

3 a. Derive the continuity equation for 3 dimensions in Cartesian co-ordinates. **(10 Marks)**

b. What is the irrotational velocity field associate with the potential
$\phi = 3x^2 - 3x + 3y^2 + 16t^2 + 12zt$.
Does the flow field satisfy the incompressible continuity equation? **(06 Marks)**

OR

4 a. Derive Euler's equation of motion and obtain an expression for Bernoulli's equation from Euler's equation of motion and also mention the assumptions made. **(10 Marks)**

b. A jet of water of 60mm diameter strikes a curved vane at its centre with a velocity of 18m/s. The curved vane is moving with a velocity of 6m/s in the direction of the jet. The jet is deflected through an angle of 165°. Assuming the plate to be smooth find :
i) Thrust on the plate in the direction of jet
ii) Power of the jet
iii) Efficiency of the jet. **(06 Marks)**

Module-3

5 a. Derive Hagen-Poisoulle's equation for viscous flow through a circular pipe. **(10 Marks)**

b. Oil of specific gravity 0.82 is pumped through a horizontal pipeline 150mm in diameter and 3km long at the rate of $0.015 m^3/s$. The pump has an efficiency of 68% and required 7.5KW to pump the oil.

i) What is the dynamic viscosity of the oil

ii) Is the flow Laminar? **(06 Marks)**

OR

6 a. Derive Darcy's equation for head losses due to friction in a circular pipe. **(08 Marks)**

b. Three pipes of diameters 300mm, 200mm and 400mm and length 450mm, 255m and 315m respectively are connected in series. The difference in water surface levels in two tanks is 18m. Determine the rate of flow of water if co-efficient of friction are 0.0075, 0.0078 and 0.0072 respectively considering : i) Minor losses ii) Neglecting minor losses. **(08 Marks)**

Module-4

7 a. Explain the terms :

i) Boundary layer thickness

ii) Displacement thickness

iii) Momentum thickness

iv) Energy thickness. **(06 Marks)**

b. The velocity distribution in the boundary layer is given by $\frac{u}{U} = \frac{Y}{\delta}$, where u is the velocity at a distance y form the plate and $u = U$ at $y = \delta$, δ being the boundary layer thickness. Find :

i) The displacement thickness

ii) The momentum thickness

iii) The energy thickness

iv) The value of δ^*/θ. **(10 Marks)**

OR

8 a. Explain the terms lift and drag on airfoil. **(04 Marks)**

b. Using Buckingham's 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 = head causing flow, D = Diameter of the orifice, μ = co-efficient of viscosity, ρ = Mass density and g = Acceleration due to gravity. **(12 Marks)**

Module-5

9 Write short notes on :

a. Internal energy and enthalpy

b. Speed of sound

c. Stagnation and sonic properties

d. Normal and oblique shocks. **(16 Marks)**

OR

10 Write short notes on :

a. Necessity of CFD

b. Limitations of CFD

c. Philosophy behind CFD

d. Applications of CFD. **(16 Marks)**

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