CBCS Scheme

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15AE35

Third Semester B.E. Degree Examination, June/July 2017
Mechanics of Fluid

Time: 3 hrs. Max. Marks: 80

Note: Answer FIVE full questions, choosing one full question from each module.

Module-1

1 a. Explain the phenomenon of capillarity. Obtain an expression for capillary rise and capillary fall. **(08 Marks)**

b. A pressure gauge consists of two cylindrical bulbs B and C each of 10 sq.cm cross-sectional area, which are connected by a U-tube with vertical limbs each of 0.25 sq.cm cross sectional area. A red liquid of specific gravity 0.9 is filled into C and clear water is filled into B, the surface of separation being in the limb attached to C. Find the displacement of surface of separation when the pressure on the surface in C is greater than that in B by an amount equal to 1 cm head of water. **(08 Marks)**

OR

2 a. A cubical tank has sides of 1.5 m. It contains water for the lower 0.6 m depth. The upper remaining part is filled with oil of specific gravity 0.9. Calculate for one vertical side of the tank:
i) Total pressure and
ii) Position of centre of pressure **(08 Marks)**

b. A square aperture in the vertical side of a tank has one diagonal vertical and is completely covered by a plane plate hinged along one of the upper sides of the aperture. The diagonals of the aperture are 2 m long and the tank contains liquid of specific gravity 1.15. The centre of aperture is 1.5 m below the free surface. Calculate the thrust exerted on the plate by the liquid and position of its centre of pressure. **(08 Marks)**

Module-2

3 a. Obtain an equation of stream function and potential function. Draw streamline and potential lines for source flow. **(06 Marks)**

b. A source and a sink of strength 4 m^2/s and 8 m^2/s are located at (-1, 0) and (1, 0) respectively. Determine the velocity and stream function at a point P(1, 1) which is lying on the flownet of the resultant stream line. **(10 Marks)**

OR

4 a. Derive the Navier-stokes equations by control volume approach. **(07 Marks)**

b. Obtain an integral form and differential form of energy equation using control volume approach. **(07 Marks)**

c. Mention the applications of continuity, momentum and energy equations. **(02 Marks)**

Module-3

5 a. Derive Euler's equation of motion for ideal fluids and hence deduce Bernoulli's equation of motion. State the assumptions made. **(06 Marks)**

b. Derive an expression for discharge through a venturi meter. **(06 Marks)**

c. A pitot-tube is inserted in a pipe of 300 mm diameter. The static pressure in pipe is 100 mm of mercury (vacuum). The stagnation pressure at the centre of the pipe, recorded by the pitot-tube is 0.981 N/cm^2. Calculate the rate of flow of water through pipe. If the mean velocity of flow is 0.85 times the central velocity. Take $C_V = 0.98$. **(04 Marks)**

OR

6 a. Using 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 coefficient of viscosity, ρ is the mass density and g is the acceleration due to gravity. **(06 Marks)**

b. The efficiency η of a fan depends on the density ρ, the dynamic viscosity μ of the fluid, the angular velocity ω, diameter D of the rotor and the discharge Q. Express η in terms of dimensionless parameters. **(06 Marks)**

c. Briefly explain the advantages of the dimensional and model analysis. **(04 Marks)**

Module-4

7 a. With a neat sketch, explain the laminar boundary layer. **(03 Marks)**

b. Define and obtain the expression for
- i) Displacement thickness (δ^*)
- ii) Momentum thickness (θ)
- iii) Energy thickness (δ^{**}) **(10 Marks)**

c. With a neat sketch, explain total drag on a flat plate due to laminar and turbulent boundary layer. **(03 Marks)**

OR

8 a. Derive the expression for drag and lift. **(05 Marks)**

b. With a neat sketch, explain the aerofoil characteristics. **(05 Marks)**

c. Consider two different points on the surface of an airplane wing flying at 80 m/s. The pressure coefficient and flow velocity at point 1 are –1.5 and 110 m/s, respectively. The pressure coefficient at point 2 is –0.8. Assuming incompressible flow, calculate the flow velocity at point 2. **(06 Marks)**

Module-5

9 a. Derive Bernoulli's equation for compressible flow undergoing isothermal and adiabatic process. **(08 Marks)**

b. Obtain the expression for velocity of sound wave in a fluid. **(08 Marks)**

OR

10 a. Derive velocity of sound in terms of bulk modulus, isothermal process and adiabatic process. **(06 Marks)**

b. With a neat sketch, explain the propagation of pressure waves in a compressible fluid. **(07 Marks)**

c. Find the velocity of bullet fired in standard air if the Mach angle is 30°. Take R = 287.14 J/kg°K and k = 1.4 for air. Assume temperature as 15°C. **(03 Marks)**

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