CBCS SCHEME

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15ME44

Fourth Semester B.E. Degree Examination, Dec.2019/Jan.2020
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 fluid with their units:
i) Specific volume ii) Viscosity iii) Vapour pressure
iv) Compressibility v) Newtonian fluid vi) Gauge pressure **(06 Marks)**

b. State and prove Pascal's law. **(06 Marks)**

c. A simple U-tube manometer containing mercury is connected to a pipe in which a fluid of specific gravity 0.80 and having vacuum pressure is flowing. The other end is open to atmosphere. Estimate the vacuum pressure in pipe if the difference of mercury level in the two limbs is 40 cm and the height of the fluid in the left limb from the center of pipe is 15 cm below. **(04 Marks)**

OR

2 a. Define the following:
i) Center of pressure ii) Buoyancy
iii) Meta center iv) Meta centric height **(04 Marks)**

b. Develop an expression for total force and depth of center of pressure for an inclined surface submerged in water. **(08 Marks)**

c. A solid cylinder of diameter 4.0 m has a height of 3m. Evaluate the meta centric height of the cylinder when floating in water with its axis vertical. The specific gravity of the cylinder is 0.60. **(04 Marks)**

Module-2

3 a. Compare:
i) Steady and unsteady flow
ii) One dimensional and two dimensional flow
iii) Stream line and path line **(06 Marks)**

b. Derive continuity equation in 3-D Cartesian coordinates. **(06 Marks)**

c. The velocity potential function is given by $\phi = 5(x^2 - y^2)$. Estimate the velocity components at the point (4, 5). **(04 Marks)**

OR

4 a. Explain impulse momentum equation. **(02 Marks)**

b. Derive an expression for Bernoulli's equation from first principles with assumptions made. **(10 Marks)**

c. Determine the velocity of the flow of an oil through a pipe when the difference of mercury level in a differential U-tube manometer connected to the two toppings of the pitot tube is 100 mm. Take coefficient of pitot tube 0.98 and specific gravity of oil = 0.80. **(04 Marks)**

Module-3

5 a. Define Reynold's number. Explain its importance. **(04 Marks)**

b. Analyze couette flow of fluid between two parallel plates. **(08 Marks)**

c. An oil of viscosity 10 poise flow between two parallel fixed plates which are kept at a distance of 50 mm apart. Estimate the rate of flow of oil between the plates. If the drop of pressure in a length of 1.2 m be 3.0 N/cm^2. The width of oil plate is 200 mm. **(04 Marks)**

OR

6 a. Differentiate between major loss and minor loss in pipes. **(06 Marks)**

b. What do you understand by (i) pipe in series (ii) pipes in parallel (iii) equivalent size of the pipe? **(06 Marks)**

c. Estimate the head when a pipe of diameter 200 mm is suddenly enlarged to a diameter of 400 mm. The rate of flow of water through the pipe is 250 lit/s. **(04 Marks)**

Module-4

7 a. Explain: (i) Boundary layer thickness (ii) Displacement thickness (iii) Momentum thickness. **(06 Marks)**

b. Illustrate the method of preventing the separation of boundary layer. **(04 Marks)**

c. An airfoil of Chord length 2m and of span 15m has an angle of attack as 6°. The air foil is moving with a velocity of 80 m/s in air where density is 1.25 kg/m^3. Estimate the weight of the airfoil and the power required to drive it. The values of coefficient of drag and lift corresponding to angle of attack are given as 0.03 and 0.5 respectively. **(06 Marks)**

OR

8 a. Explain dimensionless numbers: (i) Euler number (ii) Reynolds number (iii) Fraud number (iv) Weber number **(04 Marks)**

b. Analyze the Rayleigh's method of dimensional analysis. **(06 Marks)**

c. The frictional torque 't' of a disc of diameter 'D' rotating at a speed 'N' in a fluid at viscosity 'μ' and density 'ρ' in a turbulent flow is given by $T = D^5N^2\rho\phi\left[\frac{\mu}{D^2N\rho}\right]$. Prove this by the method of dimensions. **(06 Marks)**

Module-5

9 a. List and explain the basic thermodynamic relations of a perfect gas. **(08 Marks)**

b. What is Mach number? Explain its significance in compressible flow. **(04 Marks)**

c. A projectile travels in air of pressure 15 N/cm^2 at 10°C at speed of 1500 km/hr. Formulate the Mach number and Mach angle. Assume $\nu = 1.4$ and $R = 287$ J/kg-K. **(04 Marks)**

OR

10 a. List applications, advantages and limitations of CFD. **(08 Marks)**

b. Explain with neat sketch stagnation properties of compressible flows. **(04 Marks)**

c. Evaluate the stagnation pressure, temperature, and density at the stagnation point on the nose of a plane which is flying at 800 km/hour through still air having a pressure 8.0 N/cm^2 (abs) and temperature 10°C. Take R = 287 J/kg and K = 1.4. **(04 Marks)**

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