CBCS SCHEME

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18MT42

Fourth Semester B.E. Degree Examination, June/July 2023
Fluid Mechanics and Machines

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 and give their units:
(i) Specific weight (ii) Surface tension (iii) Kinematic viscosity **(06 Marks)**

b. Define capillarity and derive an expression for capillary rise. **(06 Marks)**

c. Determine the expression for surface tension on a water droplet and liquid jet. **(08 Marks)**

OR

2 a. Define: (i) Gauge pressure (ii) Vacuum pressure (iii) Absolute pressure **(03 Marks)**

b. Derive an expression for total pressure and centre of pressure for a vertical plane submerged in liquid. **(10 Marks)**

c. A rectangular plane surface is '2m' wide '3m' deep. It lies in vertical plane in water. Determine the total pressure and position of centre of pressure on the plane surface when its upper edge is horizontal:
(i) Coincides with water surface
(ii) 2.5 m below the free water surface **(07 Marks)**

Module-2

3 a. Derive continuity equation in Cartesian coordinates for three dimensional fluid flow. **(10 Marks)**

b. The stream function for a two-dimensional flow is given by $\psi = 2xy$, calculate the velocity at the point P(2, 3). Find the velocity potential function ϕ. **(10 Marks)**

OR

4 a. Derive Euler's equation of motion for ideal fluids and hence deduce Bernouli's equation. **(10 Marks)**

b. The water is flowing through a taper pipe of length 100 m having diameters 600 mm at the upper end and 300 mm at the lower end, at the rate of 50 litres/s. The pipe has a slope of 1 in 30. Find the pressure at the lower end if the pressure at the higher level is 19.62 N/cm^2. **(10 Marks)**

Module-3

5 a. The frictional torque 'T' of a disc of diameter 'D' rotating at a speed 'N' in a fluid of viscosity 'μ' and density 'ρ' in a turbulent flow is given by $T = D^5 N^2 \rho \phi\left[\frac{\mu}{D^2 N \rho}\right]$. Prove this by the method of dimensions using Buckingham (π) theorem. **(12 Marks)**

b. Explain the following:
(i) Mach number (ii) Weber number
(iii) Froude number (iv) Reynold number **(08 Marks)**

OR

6 a. Derive an expression for discharge through venturimeter. **(10 Marks)**

b. An orifice meter with orifice diameter 15 cm is inserted in a pipe of 30 cm diameter. The pressure difference measured by a mercury oil differential manometer on the two sides of the orifice meter gives a reading of 50 cm of mercury. Find the rate of flow of oil of specific gravity 0.9 when the coefficient of discharge of the meter = 0.64. **(10 Marks)**

Module-4

7 a. Compare a turbo machine and a positive displacement machine. **(08 Marks)**

b. Define a turbo machine. Explain with the schematic diagram showing principal parts of a turbomachine. **(08 Marks)**

c. List out the classification of turbomachines. **(04 Marks)**

OR

8 a. Derive Euler's turbine equation and state the assumptions made. **(10 Marks)**

b. Derive the expression for degree of reaction (R). **(05 Marks)**

c. Draw the velocity triangle when R = 0 and when R = 0.5 for axial flow turbine. **(05 Marks)**

Module-5

9 a. Derive an expression for maximum hydraulic efficiency of pelton wheel. **(10 Marks)**

b. A runner blade is to be designed for a Francis turbine 1.5 m outer diameter and 0.75 m inner diameter to operate under a head of 120 m with a specific speed of 150 and generate 14000 KW. Assume hydraulic efficiency = 0.92. What should be the inlet and outlet blade angles, if the water has to enter the wheel with an angle of 12° and leave with no whirl velocity? **(10 Marks)**

OR

10 a. With sketches explain velocity compounding and pressure compounding. **(10 Marks)**

b. A single stage impulse turbine has a diameter of 1.5 m and running at 3000 rpm. The nozzle angle is 20°. Speed ratio is 0.45. Ratio of relative velocity at the outlet to that at inlet is 0.9. The outlet angle of the blade is 3° less than inlet angle. Steam flow rate is 6 kg/s. Draw the velocity diagrams and find the following:

(i) Velocity of whirl
(ii) Axial thrust
(iii) Blade angles
(iv) Power developed **(10 Marks)**

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