CBCS SCHEME

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15MT42

Fourth Semester B.E. Degree Examination, Jan./Feb. 2021
Fluid Mechanics and Machines

Time: 3 hrs. Max. Marks: 80

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Assume missing data, if any with suitable reasoning.***

Module-1

1 a. Define the following with their units :
i) Weight Density ii) Specific volume iii) Specific gravity iv) Kinematic viscosity. **(06 Marks)**

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

c. Define surface tension. Prove that the relationship between surface tension and pressure inside a droplet of liquid in excess of outside pressure is given by $P = \frac{4\sigma}{d}$. **(04 Marks)**

OR

2 a. Derive an expression for the depth of centre of pressure from free surface of liquid of an inclined plane surface submerged in the liquid. **(08 Marks)**

b. A rectangular plane surface is 2m wide and 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 and i) Coincides with water surface ii) 2.5m below the free water surface. **(08 Marks)**

Module-2

3 a. Derive continuity equation for three Dimensional flows. **(08 Marks)**

b. A fluid flow field is given by $V = x^2yi + y^2zj - (2xyz + yz^2)K$. Prove that it is a case of possible steady incompressible fluid flow. Calculate the velocity and acceleration at the point (2, 1, 3). **(08 Marks)**

OR

4 a. Derive the Euler's equation of fluid motion and hence obtain the Bernoulli's equation for ideal fluids. State the assumptions. **(08 Marks)**

b. A pump has a tapering pipe running full of water. The pipe is placed vertically with the diameters at the base and top being 1.2m and 0.6m respectively. The pressure at the upper end is 240mm of Hg vacuum, while the pressure at the lower end is $15kN/m^2$. Assume the head loss to be 20% of difference of velocity head. Calculate the discharge, the flow is vertically upwards and difference of elevation is 3.9m. **(08 Marks)**

Module-3

5 a. The efficiency 'η' of a fan depends on density 'ρ' dynamic viscosity 'μ' of the fluid, angular velocity 'w', diameter 'D' of the rotor and the discharge 'Q'. Express 'η' in terms of dimensionless parameters. **(08 Marks)**

b. Define and explain :
(i) Froude's Number
(ii) Mach's Number
(iii) Hydraulic similarities
(iv) Distorted and undistorted models. **(08 Marks)**

OR

6 a. Derive the expression for rate of flow through Venturimeter. **(08 Marks)**

b. List out the advantages of V-notch. **(02 Marks)**

c. Water flows over a rectangular weir 1m wide at a depth of 150mm and after wards passes through a triangular right angled weir. Taking C_d for the rectangular and triangular weir as 0.62 and 0.59 respectively. Find the depth over the triangular weir. **(06 Marks)**

Module-4

7 a. Define a Turbomachine. Explain the schematic diagram showing principal parts of a turbomachine. **(06 Marks)**

b. List out the classification of Turbomachines. **(06 Marks)**

c. Compare a Turbomachine and positive displacement machine. **(04 Marks)**

OR

8 a. Derive Euler's turbine equation and state the assumptions made. **(08 Marks)**

b. For a radial flow Turbomachine show that degree of reaction, $R = \frac{2 + \text{Cot}\,\beta_2}{4}$, where β_2 = discharge blade angle. **(08 Marks)**

Module-5

9 a. Mention the general characteristics features of Pelton, Francis and Kaplan Turbines. **(08 Marks)**

b. The following data are given for a Francis turbine net head = 70m, speed = 600rpm, power at the shaft = 367.5kW, overall efficiency = 85%, Hydraulic efficiency = 95%, flow ratio = 0.25, width ratio = 0.1, outer diameter to inner diameter ratio = 2.0. The thicknesses of vanes occupy 10% of the circumferential area of runner. Velocity of flow is constant at inlet and outlet and discharge is radial at outlet.
Determine :
(i) Guide blade angle
(ii) Runner vane angles
(iii) Diameter of runner at inlet and outlet
(iv) Width of wheel at inlet. **(08 Marks)**

OR

10 a. For a 50% reaction steam turbine, show that $\alpha_1 = \beta_2$ and $\alpha_2 = \beta_1$ where α_1 and β_1 are the inlet angles of fixed and moving blades, α_2 and β_2 are the outlet angles of fixed and moving blades. **(08 Marks)**

b. Steam emerging from a nozzle to an impulse De-Laval turbine with a velocity of 1000m/s. The nozzle angle is 20°. The mean blade velocity is 400m/s. The blades are symmetrical ($\beta_1 = \beta_2$). The mass flow rate of steam is 1000 kg/hr. Friction factor is 0.8. Calculate the following :
(i) Blade angles
(ii) Axial thrust
(iii) Work done per kg of steam
(iv) Power developed. **(08 Marks)**

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