CBCS SCHEME

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21CV42

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

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 with units:
(i) Mass density (ii) Specific gravity
(iii) Dynamic viscosity (iv) Surface tension **(06 Marks)**

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

c. An U-tube differential manometer connects two pipes A and B. Pipe A contains $CC\ell_4$ (Sp. Gr. = 1.59) under 130 kN/m^2 gauge pressure. Pipe B contains oil (Sp. Gr. = 0.82) under 200 kN/m^2 gauge pressure. Pipe A is 2.5 m above pipe B. The manometer contains mercury. Calculate the difference in mercury levels. Draw neat sketch. The level of mercury connected to pipe A is in level with centre of pipe B. **(08 Marks)**

OR

2 a. Derive an expression for total pressure and centre of pressure on a plane surface immersed vertically in water. **(06 Marks)**

b. Calculate the specific weight, density, specific volume and specific gravity of two litres of a liquid which weighs 15 N. **(06 Marks)**

c. A 1.2 m × 1.8 m size rectangular plate is immersed in water with an inclination of 30° to the horizontal. The 1.2 m side of the plate is kept horizontal at a depth of 30 m below the water surface. Compute the total pressure on the surface and the position of centre of pressure. **(08 Marks)**

Module-2

3 a. Explain:
(i) Steady and unsteady flow
(ii) Rotational and irrotational flow
(iii) Laminar and turbulent flow **(06 Marks)**

b. Derive continuity equation in Cartesian coordinates for 3 dimensional flow. **(08 Marks)**

c. List the assumptions made in deriving Bernoulli's equation. **(06 Marks)**

OR

4 a. State and derive the Bernoulli's equation starting from the Euler's equation of motion with a neat sketch. **(06 Marks)**

b. What is venturimeter? Derive an expression for discharge through a venturimeter. **(06 Marks)**

c. A horizontal venturimeter with inlet diameter 200 mm and throat diameter 100 mm is employed to measure the flow of water. The reading of the differential manometer connected to the venturimeter is 180 mm of Hg. Determine the discharge (Q) is $C_d = 0.98$. **(08 Marks)**

Module-3

5 a. Explain different hydraulic coefficients and establish the relation between them. **(06 Marks)**

b. Derive an expression for discharge over a triangular notch. **(06 Marks)**

c. Water flows over a rectangular notch 1.2 m wide at a depth of 15 cm and afterwards passes through a triangular right angled notch. Taking coefficient of discharge for rectangular notch 0.62 and for triangular notch 0.59. Find the depth over the triangular notch. **(08 Marks)**

OR

6 a. Explain:
(i) Major and minor losses
(ii) Pipes in series and parallel
(iii) Water hammer **(06 Marks)**

b. Derive Darcy-Weisbach equation for head loss due to friction in a pipe. **(06 Marks)**

c. Water is required to be supplied to a colony of 4000 residents at a rate of 180 litres per person from a source 3 km away. If half the daily requirements need to be pumped in 8 hours against a friction head of 18 m, find the size of the main pipe supplying water. Assume friction factor as 0.028. **(08 Marks)**

Module-4

7 a. Define open channel flow. Give the classification of flow through channels with example. **(06 Marks)**

b. Define most economical channel section. Derive the conditions for best hydraulic triangular channel section. **(06 Marks)**

c. A rectangular channel 6m wide and 1m depth of water has a bed slope of 1 in 900 and is having n = 0.012. Determine the discharge. What will be the dimensions of the channel for maximum discharge with amount of lining being kept constant? Also compute percentage increase in discharge. **(08 Marks)**

OR

8 a. What is specific energy curve? Draw it and derive expressions for critical depth and critical velocity for rectangular channel. **(06 Marks)**

b. Derive the relationship between conjugate depths in case of hydraulic jump on a horizontal floor. **(06 Marks)**

c. A rectangular channel with bottom width 4m and bed slope 0.0008 has a discharge of 1.5 m^3/s. In a GVF channel the depth at a certain section is 0.3 m. If n = 0.016, determine the type of profile. **(08 Marks)**

Module-5

9 a. Show that for a free jet of water striking at the centre of semicircular vane, the maximum efficiency occurs when the vane velocity is $\frac{1}{3}$ of jet velocity and $\eta_{max} = 59.2\%$. **(06 Marks)**

b. With a neat sketch, explain the components of Pelton wheel. **(06 Marks)**

c. Obtain an expression for the work done per second by water on the runner of a Pelton wheel. Hence derive an expression for maximum efficiency of the Pelton wheel. **(08 Marks)**

OR

10 a. By means of a neat sketch, explain the Francis Turbine. **(06 Marks)**

b. Define: (i) Manometric head (ii) Static head (iii) Suction head (iv) Delivery head, for centrifugal pump. **(06 Marks)**

c. The following data is given for a Francis Turbine.
Net head H = 60 m, speed N = 700 rpm, shaft power = 294.3 KW, $\eta_0 = 84\%$, $\eta_h = 93\%$, flow ratio = 0.20; breadth ratio, n = 0.1; outer diameter of the runner = 2 × inner diameter of runner. The thickness of vanes occupy 5% of circumferential area of the 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 at inlet and outlet
(iii) Diameters of runner at inlet and outlet
(iv) Width of wheel at inlet **(08 Marks)**

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