CBCS SCHEME

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18CV43

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Applied Hydraulics

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. What is dimensional analysis? List the uses of dimensional analysis. **(04 Marks)**

b. The pressure drop 'ΔP' in a pipe of diameter D and length l depends on mass density ρ and viscosity μ of the flowing fluid, mean velocity of flow V and average height K of roughness projections on the pipe surface. Obtain a dimensionless expression for ΔP. Hence show that $h_f = \frac{f\ell v^2}{2gD}$. **(10 Marks)**

c. Explain detail the stability of submerged and floating bodies. **(06 Marks)**

OR

2 a. A solid cylinder of diameter 4.0m has a height of 3metres. Find the meta centric height of the cylinder when it is floating in water with its axis vertical. The specific gravity of the cylinder = 0.6. **(08 Marks)**

b. A 1:10 scale model of a submarine moving far below the surface of water is tested in a wind tunnel. If the speed of the prototype is 8m/sec, determine the corresponding velocity of water in the tunnel. Also determine the ratio of the drag for the model and prototype. Kinematic viscosity $\gamma_{seawater} = 1.121 \times 10^{-6}$ m^2/sec, $\gamma_{water} = 1 \times 10^{-6}$ m^2/sec, $\rho_{seawater} = 1027$kg/m^3, $\rho_{water} = 1000$kg/m^3. **(08 Marks)**

c. List and explain the selection of repeating variables in Buckingham's Pi theorem of dimensional analysis. **(04 Marks)**

Module-2

3 a. What is a most economical channel section? With usual notations derive the conditions for a most economical trapezoidal channel section. **(06 Marks)**

b. Explain briefly classification of flow in channel sections. **(05 Marks)**

c. Water flows in a trapezoidal channel having bottom width 6m, side slopes 2 horizontal to 1 vertical. If is has to carry a discharge of 65m^3/sec, compute the bottom slope required to be provided. Taking Mannings η = 0.025, depth of flow = 2m. **(09 Marks)**

OR

4 a. An irrigation channel of trapezoidal section, having side slopes 3 horizontal to 2 vertical is to carry a flow of 10m^3/sec on a longitudinal slope of 1 in 5000. The channel is to be lined for which the value of friction coefficient in Mannings formula is η = 0.012. Find the dimensions of the most economic section of the channel. **(09 Marks)**

b. Draw a neat specific energy curve in a flow in a channel section. Mark and explain the salient points in it. **(06 Marks)**

c. Show that for flow in a rectangular channel section, at critical conditions $y_c = \frac{2}{3}E$, where y_c is the critical depth and E is the energy of flow at critical depth. **(05 Marks)**

Module-3

5 a. With usual notations derive an expression for hydraulic jump in rectangular channels in term of Froude's number. **(09 Marks)**

b. The depth of flow of water, at a certain section of a rectangular channel of 2m width is 0.3m. The discharge through the channel is $1.5m^3/sec$. Determine whether a hydraulic jump will occur, and if so, find the height and loss of energy per kg of water. **(06 Marks)**

c. Describe briefly the water curves for a mild and sleep slopes. **(05 Marks)**

OR

6 a. A rectangular channel 7.5m wide has a uniform depth of flow of 2m and has a bed slope of 1 in 3000. If due to weir constructed at the downstream end of the channels water surface at a section is raised by 0.75m, determine the water surface slope with respect to horizontal at this section. Assume Mannings n = 0.02. **(08 Marks)**

b. With usual notations derive an expression for a length of back water curve, in a channel section. **(06 Marks)**

c. Explain in brief different types of hydraulic jump. What are the applications of hydraulic jump? **(06 Marks)**

Module-4

7 a. Give a brief description of impulse momentum equation and what are the practical applications of impulse momentum equation. **(04 Marks)**

b. With usual notations prove that the maximum efficiency of a jet striking a series of moving flat vanes fixed on the periphery of the wheel is 50%. **(06 Marks)**

c. With a neat sketch, explain the general layout of a hydraulic power plants. Explain different types of efficiencies of hydro electric turbines. **(10 Marks)**

OR

8 a. Give a brief account on classification of turbines based on different criteria. **(06 Marks)**

b. A Pelton wheel has to be designed for the following data. Power to be developed = 6000kW. Net head available = 300m, speed = 500rpm. Ratio of jet diameter to wheel diameter = $\frac{1}{10}$ and overall efficiency = 85%.

Find the number of jets, diameter of the jet, diameter of the wheel and quantity of water required. **(08 Marks)**

c. With a neat diagram, explain different components of Pelton wheel. With the help of velocity triangle find the expression for efficiency of Pelton wheel. **(06 Marks)**

Module-5

9 a. Design a Francis turbine runner with the following data. Net head H = 68m, speed N = 750 rpm, output power P = 330kW, $\eta_h = 94\%$, $\eta_0 = 85\%$, flow ratio $\psi = 0.15$, breadth ratio n = 0.1 inner diameter of runner is $\left(\frac{1}{2}\right)$ outer diameter. Also assume 6% of circumferential area of the runner to be occupied by the thickness of the vanes. Velocity of flow remains constant throughout and flow is radial at exit. **(08 Marks)**

b. Explain the functions of draft tube in reaction turbines. What are its different types explain with diagrams. **(04 Marks)**

c. A Kaplan turbine develops 24647.6kW power at an average head of 39 metres. Assuming a speed ratio of 2, flow ratio of 0.6, diameter of the boss equal to 0.35 times the diameter of the runner and an overall efficiency of 90%, calculate the diameter, speed the turbine. **(08 Marks)**

OR

10 a. With neat diagram, explain the component and working of centrifugal pumps. **(06 Marks)**

b. With a neat diagram, derive an expression for minimum starting speed of centrifugal pumps with usual notations. **(04 Marks)**

c. A centrifugal pump is running at 1000rpm. The outer vane angle of the impeller is 45° and velocity of flow at outlet is 2.5m/sec. The discharge through the pump is 200 litres/sec. When the pump is working against a total head of 20m. If the manometric efficiency of the pump is 80% determine:

i) The diameter of the impeller

ii) The width of the impeller at outlet. **(10 Marks)**

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