CBCS SCHEME

USN | | | | | | | | | | | **15CV43**

Fourth Semester B.E. Degree Examination, July/August 2022
Applied Hydraulics

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. A partially sub-merged body is towed in water. The resistance R to its motion depends on the density 'ρ' viscosity 'μ' of water, length L of the body, velocity 'V' of the body and the acceleration due to gravity 'g' show that the resistance to the motion can be expressed in the form $R = \rho L^2 V^2 \phi\left[\left(\frac{\mu}{\rho VL}\right), \left(\frac{Lg}{V^2}\right)\right]$. **(10 Marks)**

b. A model of a sub-marine of scale $1/40$ is tested in a wind tunnel. Find the speed of air in wind tunnel if the speed of the sub-marine in sea water is 15m/s. Also find the ratio of the resistance between the model and its prototype. Take the values of kinematic viscosities for sea-water and air as 0.012 stokes and 0.016 stokes respectively. The density of sea-water and of air are given as 1030kg/m^3 and 1.24 kg/m^3 respectively. **(06 Marks)**

OR

2 a. A wooden block of dimensions 1m × 0.5m × 0.4m floats in water with its shortest axis vertical. Determine the metacentric height and state the condition of its equilibrium. The specific gravity of wooden block is 0.8. **(08 Marks)**

b. A spillway model is to be built to a geometrically similar scale of $\frac{1}{40}$ across a flume of 50cm width. The prototype is 20m high and maximum head on it is expected to be 2m.
i) What height of model and what head on the model should be used?
ii) If the flow over the model at a particular heat is 10liters/sec, what flow per meter length of the prototype is expected?
iii) If the negative pressure in the model is 150mm, what is the negative pressure in the prototype? Is it practicable? **(08 Marks)**

Module-2

3 a. Define the term most economical section of a channel. Derive the conditions for most economical section for the trapezoidal section. **(10 Marks)**

b. The discharge of water through a rectangular channel of width 6m is 18m^3/s when depth of flow of water is 2m. Calculate :
i) Specific energy of the flowing water
ii) Critical depth and critical velocity
iii) Value of minimum specific energy. **(06 Marks)**

OR

4 a. A rectangular channel 4m wide has depth of water 1.5m. The slope of the bed of the channel is 1 in 1000 and value of Chezy's constant C = 55. It is desired to increase the discharge to a maximum by changing the dimensions of the section for constant area of cross-section, slope of the bed and roughness of the channel. Find the new dimensions of the channel and increase in discharge. **(08 Marks)**

b. What is specific energy curve? Draw and explain specific energy curve. And then derive expressions for critical depth, critical velocity and minimum specific energy in terms of critical depth. **(08 Marks)**

Module-3

5 a. A sluice gate discharges water into a horizontal rectangular channel with a velocity of 8m/s and depth of flow is 0.5m. The width of the channel is 6m. Determine whether a hydraulic jump will occur, and if so, find its height and loss of energy per unit weight of water. Also determine the power lost in the hydraulic jump. **(08 Marks)**

b. Derive an expression for the variation of depth along the length of the bed of the channel for gradually varied flow in an open channel. State all the assumptions made. **(08 Marks)**

OR

6 a. Explain the term hydraulic jump. Derive an expression for the height of hydraulic jump. **(08 Marks)**

b. Determine the length of the back water curve caused by an afflux of 1.5m in a rectangular channel of width 50m and depth 2.0m. The slope of the bed is given as 1 in 2000. Take Manning's N = 0.03. **(08 Marks)**

Module-4

7 a. A jet of water of diameter 100mm strikes a curved plate at its centre with a velocity of 15m/s. The curved plate is moving with a velocity of 7m/s in the direction of the jet. The jet is deflected through an angle of 150°. Assuming the plate smooth find :

i) Force exerted on the plate in the direction of the jet
ii) Power of the jet
iii) Efficiency of the jet. **(08 Marks)**

b. Obtain an expression for the work done per second by water on the runner of a Pelton wheel. Also derive an expression for maximum efficiency. Draw inlet and outlet velocity triangles for a Pelton wheel turbine and indicate the direction of various velocities. **(08 Marks)**

OR

8 a. A jet of water from a nozzle is deflected through 60° from its original direction by a curved plate it enters tangentially without shock with a velocity of 30m/s and leaves with a mean velocity of 25m/s. If the discharge from the nozzle is 0.8kg/s, calculate the magnitude and direction of the resultant force on the vane, if the vane is stationary. **(08 Marks)**

b. A Pelton wheel is to be designed for the following specifications : Shaft power = 735.75KW, S.P. Head = 200m, Speed = 800r.p.m, overall efficiency = 0.86 and jet diameter is not to exceed one – tenth the wheel diameter. Determine :

i) Wheel diameter
ii) The number of jets required
iii) Diameter of the jet

Take C_v = 0.98 and speed ratio = 0.45. **(08 Marks)**

Module-5

9 a. A Francis turbine with an overall efficiency of 70% is required to produce 147.15KW. It is working under a head of 8m. The peripheral velocity = $0.30\sqrt{2gH}$ and the radial velocity of flow at inlet is $0.96\sqrt{2gH}$. The wheel runs at 200r.p.m and the hydraulic losses in the turbine are 20% of the available energy. Assume radial discharge, determine :

i) The guide blade angle
ii) The wheel vane angle at inlet
iii) Diameter of the wheel at inlet
iv) Width of wheel at inlet. **(08 Marks)**

b. Derive an expression for the minimum speed for starting a centrifugal pump. **(08 Marks)**

OR

10 a. A Kaplan turbine working under a head of 20m develops 11722KW shaft power. The outer diameter of the runner is 3.5m and hub diameter is 1.75m. The guide blade angle at the extreme edge of the runner is 35°. The hydraulic and overall efficiencies of the turbine are 88% and 84% respectively. If the velocity of whirl is zero at outlet, determine :

i) Runner vane angles at inlet and outlet at the extreme edge of the runner
ii) Speed of the turbine. **(10 Marks)**

b. What do you mean by manometric efficiency, mechanical efficiency and over-all efficiency of a centrifugal pump? **(06 Marks)**

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