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17CV43

Fourth Semester B.E. Degree Examination, July/August 2021
Applied Hydraulics

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions.***

1 a. State Buckingham π-theorem. Explain the steps involved in adopting the theorem in dimensional analysis. **(07 Marks)**

b. Explain the stability cases of floating bodies with respect to center of gravity and metacentric height. **(07 Marks)**

c. A 1:64 model is constructed of an open channel in concrete which has Manning's n = 0.014. Find the value of n in model. The bed slope of model and prototype are same. **(06 Marks)**

2 a. Derive the various scale ratios of Froude model law. **(08 Marks)**

b. The pressure difference Δp in a pipe of diameter D, length L due to turbulent flow depends on velocity V, viscosity μ, density ρ and surface roughness K. Using Buckingham π-theorem, show that,

$$\Delta p = \rho V^2 \ \phi\left[\frac{L}{D}, \frac{\mu}{\rho VD}, \frac{K}{D}\right]$$ **(12 Marks)**

3 a. Derive Chezy's equation for the rate of uniform flow in open channel. **(08 Marks)**

b. Show that $\frac{Q^2}{g} = \frac{A^3}{T}$ for critical flow condition in open channel. **(06 Marks)**

c. The specific energy for a 5m wide rectangular channel is 4m. If Q = 20m^3/s, determine alternate depths. **(06 Marks)**

4 a. Draw specific energy curve. List the salient features. **(06 Marks)**

b. Derive the condition for most economical rectangular section and show that hydraulic mean depth is half the flow depth. **(07 Marks)**

c. A trapezoidal channel with side slopes of 3H:2V has to be designed to carry 10m^3/s of water at a velocity of 1.5m/s. Find the dimensions of channel for minimum lining. **(07 Marks)**

5 a. Define hydraulic jump. List its applications. **(05 Marks)**

b. Derive an equation to define the gradually varied flow profile. **(08 Marks)**

c. A hydraulic jump forms at the downstream end of a spillway carrying 17.93m^3/s discharge per meter width. If the depth before jump is 0.8m, what is the depth after jump and energy loss? **(07 Marks)**

6 a. Explain with neat sketches different types of GVF profiles. **(12 Marks)**

b. Derive an expression for energy loss due to hydraulic jump. **(08 Marks)**

7 a. State impulse-momentum equation. Give its applications. **(04 Marks)**

b. A jet of water of 50mm diameter and velocity 20m/s strikes a curved vane moving at 10m/s in the direction of jet. The jet leaves the vane at an angle of 60° to the direction of motion of vane at outlet. Determine:
   i) The force exerted by the jet on the vane in the direction of motion.
   ii) Workdone per second by the jet. **(08 Marks)**

c. Draw the general layout of hydroelectric power plant and explain the functions of each part. **(08 Marks)**

8 a. Give the classification of turbines. Give examples. **(04 Marks)**

b. A pelton wheel turbine has to be designed for a head of 60m when running at 200rpm to develop 96kW power. $C_V = 0.98$, $u = 0.45 \times$ velocity of jet, $\eta_0 = 85\%$. Determine discharge, diameter of runner, diameter of jet, number of jets, number of buckets. Assume $d = \frac{1}{12}D$. **(10 Marks)**

c. Draw neat sketch of Pelton wheel turbine and explain working principle. **(06 Marks)**

9 a. Define unit quantities and give expressions. **(03 Marks)**

b. Draw neat sketch of Kaplan turbine and explain its working. **(07 Marks)**

c. A Kaplan turbine working under a head of 20m develops 11772kW power. The outer diameter of runner is 3.5m and boss diameter is 2m. The guide blade angles at the extreme edge of runner at inlet is 35°. $\eta_h = 88\%$ and $\eta_0 = 84\%$. The velocity of whirl at outlet is zero. Determine:
   i) Runner vane angles at inlet and outlet
   ii) Speed of turbine. **(10 Marks)**

10 a. Define heads and efficiencies of centrifugal pump. **(07 Marks)**

b. The outer diameter of an impeller of a centrifugal pump is 400mm and outer width is 50mm. The pump speed is 800rpm and head on pump is 15m. The vane angle at outlet is 40° $\eta_{man} = 75\%$. Determine:
   i) Velocity of flow at outlet
   ii) Velocity of water leaving the vane
   iii) Discharge. **(08 Marks)**

c. Explain multistage centrifugal pumps. **(05 Marks)**

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