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06CV45

Fourth Semester B.E. Degree Examination, June-July 2009
Hydraulic and Hydraulic Machines

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions selecting at least TWO from each part.*
2. Missing data if any may be suitably assumed.

PART – A

1 a. Distinguish between open channel flow and pipe flow. **(04 Marks)**

b. Show that the length of one sloping side of a most economical trapezoidal channel is equal to half the top width. Also determine the hydraulic mean depth for this condition. **(08 Marks)**

c. A rectangular channel 6m wide and 1m deep has a slope of 1 in 900 and is lined with smooth concrete layer having Manning's roughness N = 0.012. It is required to increase the discharge to a maximum by changing the dimension of the channel but taking the amount of lining as same. Compute the new dimensions of rectangular channel and the percentage increase in discharge. **(08 Marks)**

2 a. Define specific energy. Derive the condition for minimum specific energy for a given discharge. **(06 Marks)**

b. Derive the expression for sequent depths of hydraulic jump occurring in a rectangular channel. **(06 Marks)**

c. It is observed in the formation of hydraulic jump in a 1.5m wide rectangular channel that the depth of flow before and after the jump are 0.15m and 1.2m respectively. Find the discharge, critical depth and loss of head in the jump. **(08 Marks)**

3 a. Explain the phenomenon of water hammer in pipes. **(04 Marks)**

b. Derive an expression for rise of pressure due to sudden closure of elastic pipe. **(08 Marks)**

c. A water main of concrete pipe 3.2km long and 300mm is diameter discharges into a reservoir at the rate of $0.1041 m^3/s$. If the line is gradually closed by a valve at reservoir end in 16 secs, show that there is a risk of pipe burst. Assume that pressure of concrete pipe is 25m. **(08 Marks)**

4 a. What is Rayleigh's method of dimensional analysis? Explain with an example. **(05 Marks)**

b. Explain briefly the following
i) Geometric similarity ii) Kinematic similarity iii) Dynamic similarity **(06 Marks)**

c. Using Buckingham's π theorem show that the velocity through a circular orifice is given by $V = \sqrt{2gH}\ \phi\left[\frac{D}{H}, \frac{\mu}{\rho v h}\right]$ where H is the head causing the flow, D is the diameter of orifice, μ is the coefficient of viscosity, ρ is the mass density and g is the acceleration due to gravity. **(09 Marks)**

PART – B

5 a. Show that the maximum efficiency for the jet striking a single curved vane symmetrical about the axis of jet moving in the direction of jet is 16/27. **(10 Marks)**

b. A pelton wheel has to be designed for the following data:
Power to be developed = 6000KW,
Net head available = 300m, speed = 550 rpm.
Ratio of jet diameter the wheel diameter = 1/10
Overall efficiency = 85%
Find the number of jets, diameter and jet, diameter of wheel and quantity of water required.
Assume C_v = .98 speed ratio = 0.46. **(10 Marks)**

6 a. A Francis turbine has to be designed to give an overall out put of 375 KW under a head of 80m. The rotational speed is 700 rpm. Determine the main dimensions of the runner, runner vane angles, assuming hydraulic losses as 10%, flow ratio 0.15, ratio of inner to outer diameter = 0.5, ratio of width to diameter at outlet = 0.1, overall efficiency as 0.82, Area blocked by thickness of runner vanes is 0.5%. **(10 Marks)**

b. A Kaplan turbine working under a head of 20m develops 12000 KW. The outer diameter of the runner is 3.5m and inner diameter of the hub is 1.75m. The guide blade angle at the extreme edge of the runner is 35°. The hydraulic and overall efficiencies are 88% and 84% respectively. If the velocity of whirl is zero at the outlet, determine the runner vane angle at outlet and inlet and also speed of the turbine. Draw the velocity triangles. **(10 Marks)**

7 a. Define specific speed of a hydraulic turbine. Derive an equation for specific speed in terms of operating speed, power and head. **(08 Marks)**

b. What is a draft tube? What are its functions? Write the different types of draft tube along with sketches. **(06 Marks)**

c. Define unit speed, unit discharge and unit power. Derive the expression for these terms. **(06 Marks)**

8 a. Define
   i) Manometric efficiency
   ii) Mechanical efficiency
   iii) Overall efficiency. **(06 Marks)**

b. What is priming of centrifugal pump and how it is done? **(08 Marks)**

c. The diameter of an impeller of a centrifugal pump at inlet and outlet are 300mm and 600mm respectively. The velocity of flow at outlet is 2m/s and the vanes are set back at an angle of 45° at the outlet. Determine the minimum starting speed of the pump if the manometric efficiency is 70%. **(06 Marks)**

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