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10CV45

Fourth Semester B.E. Degree Examination, June/July 2016
Hydraulics and Hydraulic Machines

Time: 3 hrs. Max. Marks:100

Note: *Answer FIVE full questions, selecting at least TWO questions from each part.*

PART – A

1 a. Define repeating variable. What are the guidelines for selection of repeating variables? **(05 Marks)**

b. The resistance due to wind on a tall vertical Chimney is dependent on the density ρ, viscosity μ of air, wind velocity V, diameter D and height H of the Chimney. By means of π-theorem develop an expression for the resistance of the building in terms of these quantities. **(09 Marks)**

c. A spillway model is constructed in the laboratory such that velocity and discharge in the model are respectively 2m/s and 2.5m^3/s. If the velocity in the prototype is 20m/s, what is the scale ratio of the model and the discharge in the prototype? **(06 Marks)**

2 a. Distinguish between open channel flow and pipe flow. **(06 Marks)**

b. Show that for most efficient triangular channel section, the crest angle will be 90°. **(06 Marks)**

c. A trapezoidal channel with side slopes 1:1 has to be designed to convey 10m^3/s of water so that the amount of lining is minimum. Find the dimensions of channel. Take n = 0.015 and channel bed slope is 0.00056. **(08 Marks)**

3 a. Derive the dynamic equation for non uniform flow in open channel:

$$\frac{dy}{dx} = \frac{s_o - s_f}{1 - \frac{Q^2 T}{gA^3}}.$$ **(08 Marks)**

b. In a horizontal jump on a horizontal floor, the Froude number before jump is $\sqrt{6}$, find Froude number after jump. **(04 Marks)**

c. A 3m wide rectangular channel carries 2.4m^3/s discharge at a depth of 0.7m. Determine: i) Specific energy at 0.7m depth; ii) Determine critical depth; iii) Determine alternate depth to 0.7m. **(08 Marks)**

4 a. A jet of water with velocity 'v' strikes a series of flat vanes moving with velocity 'u' in the direction of jet. The vanes are held normal to the jet. Show that the maximum efficiency of jet is 50%. **(10 Marks)**

b. A square plate weighing 100N and of uniform thickness has side 20cm and it can swing freely about the top edge. A horizontal jet 2cm diameter and velocity 12.5 m/s impinges on the plate. The center of the jet is 15cm below the hinge. The jet strikes normal to the plate. Calculate:

i) What horizontal force must be applied to the bottom of plate to hold the plate vertical?

ii) If the plate is allowed to swing freely, what is the angle of inclination made by the plate with vertical with the force removed? **(10 Marks)**

PART – B

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

b. A jet of water moving at 30m/s impinges on a series of vanes moving with a velocity of 15m/s. The jet makes an angle of 30° to the direction of motion of vanes when entering and leaves at an angle of 120° to the direction of motion of the vanes. Draw the velocity triangle at inlet and outlet and find: i) the angle of vane tips at inlet and outlet, ii) the work done per N of water and iii) hydraulic efficiency. **(10 Marks)**

6 a. Give the list of classification of turbines with example. **(10 Marks)**

b. Design a Pelton wheel turbine required to develop a power of 1500 kW working under a head of 160m at a speed of 400rpm. The overall efficiency may be taken as 85%. Take $C_v = 0.98$ and $C_u = 0.46$. Jet ratio = 12. **(10 Marks)**

7 a. Explain cavitation in turbines. How to prevent it? **(06 Marks)**

b. Define draft tube and explain its function. **(06 Marks)**

c. A Kaplan turbine runner is to be designed to develop 7350 kW power under a head of 5.5 m. Determine: i) Diameter of runner and boss; ii) Speed; iii) Specific speed. Take diameter of boss = $\frac{1}{3}$ of runner, speed ratio = 2.09 and flow ratio = 0.68, $\eta_o = 85\%$. **(08 Marks)**

8 a. Define: i) Manometric head; ii) Static head; iii) Suction head; iv) Delivery head. **(04 Marks)**

b. What is the minimum starting speed of a centrifugal pump? Derive an expression for the same. **(08 Marks)**

c. A centrifugal pump is to deliver 0.12 m^3/s at a speed of 1450 rpm against a head of 25 m. The impeller diameter is 250 mm, width at outlet is 50 mm. The manometric efficiency is 75%. Determine the vane angle at the outer periphery of the impeller. **(08 Marks)**

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