10CV45

Fourth Semester B.E. Degree Examination, Feb./Mar. 2022
Hydraulics and Hydraulic Machines

Time: 3 hrs.　　　　　　　　　　　　　　　　　　　　　　　Max. Marks:100

Note: *Answer any FIVE full questions, selecting atleast TWO questions from each part.*

PART – A

1 a. State and explain Buckingham's π - theorem. **(06 Marks)**
　 b. Explain different types of hydraulic similarities that must exist between a prototype and its model. **(06 Marks)**
　 c. A spillway model is constructed in the laboratory such that velocity and discharge in the model are respectively 2m/s and 2.5m³/s. If the velocity in the prototype is 20m/s, what is the scale ratio of the model and the discharge in the prototype? **(08 Marks)**

2 a. Derive an expression for discharge through a channel by Chezy's formula. **(06 Marks)**
　 b. What is meant by an economical section of a channel? What are the conditions for rectangular and trapezoidal channels of best sections? **(06 Marks)**
　 c. A trapezoidal channel has side slopes 3 horizontal to 4 vertical and slope of its bed is 1 in 2000. Determine the optimum dimensions of the channel, if it is to carry water at 0.5m³/s. Take Chezy's constant = 80. Find also Manning's N, and shear stress on boundary.

(08 Marks)

3 a. Explain the terms : specific energy, alternate depths and super critical flow as applied to non uniform flow. **(06 Marks)**
　 b. Drive the relation between sequent depths formed in a hydraulic in the form

$$\frac{d_2}{d_1} = \frac{1}{2}\left[-1 + \sqrt{1 + 8F_1^2}\right].$$
(06 Marks)

　 c. A discharge of 18m³/s flows through a rectangular channel 6m wide at a depth of 1.6m. Find:
　　 i) The specific energy
　　 ii) Critical depth
　　 iii) Minimum specific energy
　　 iv) State whether the flow is subcritical or super critical
　　 v) What is the depth alternate to the depth given above? **(08 Marks)**

4 a. Show that for a series of flat vanes mounted on periphery of a wheel the hydraulic efficiency of the jet as 50%. **(06 Marks)**
　 b. A jet of water 30mm diameter strikes a hinged square plate at its centre with a velocity of 20m/s. The plate is deflected through an angle of 20°. Find weight of the plate. If the plate is not allowed to swing what will be the force required at the lower edge of the plate to keep the plate in vertical position. **(06 Marks)**
　 c. A jet of water 75mm diameter having a velocity of 20m/s, strikes normally a flat smooth plate. Determine the thrust on the plate,
　　 i) if the plate is at rest
　　 ii) if the plate is moving in the same direction with a velocity of 5m/s. Also find the work-done per second on plate in each case and efficiency of the Jet when the plate is moving. **(08 Marks)**

PART – B

5 a. Prove that work done per second on a series of moving curved vanes by a jet of water striking one of the tips of the vane is given by

Workdone per sea = $\rho_{av_1}[V_{w1} \pm V_{w2}]u$. **(06 Marks)**

b. A jet of water 50mm diameter moving with a velocity of 25m/s impinges on a fixed curved plate tangentially at one end at an angle of 30° to the horizontal. Calculate the resultant force of the Jet on the plate if the Jet is deflected through an angle of 50°. **(06 Marks)**

c. A jet of water of diameter 50mm, having a velocity of 20m/s strikes a curved vane which is moving with a velocity of 10m/s in the direction of the Jet. The jet leaves 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) The work-done per second by the Jet. **(06 Marks)**

6 a. Describe briefly and give example :
   i)   impulse turbine
   ii)   reaction turbine
   iii) Tangential flow turbine
   iv)   Axial flow turbine **(06 Marks)**

b. With the help of a neat sketch explain Pelton wheel. **(06 Marks)**

c. A single jet Pelton wheel working under a head of 60m running at 200rpm develops a power of 95.6475KW. If the speed ratio is 0.45, overall efficiency is 85% and coefficient of velocity is 0.98. Find diameter of the wheel, diameter of jet, number of buckles. **(08 Marks)**

7 a. What is draft tube? Why it is used in reaction turbine? Explain with neat sketches different types of draft tubes. **(10 Marks)**

b. A Kaplan turbine develops 24647.6KW at an overage head of 39m. Assuming 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 diameter and speed of the turbine. **(10 Marks)**

8 a. What is priming? Why it is necessary? **(04 Marks)**

b. Derive an expression for minimum speed for starting a centrifugal pump. **(06 Marks)**

c. The outer diameter of an impeller of a centrifugal pump 400mm and outlet width is 50mm. The pump is running at 800rpm and working against a total head of 15m. The value of angle at outlet is 40° and manometric efficiency is 75%.
Determine :
i)   Velocity of flow at outlet
ii)   Velocity of water leaving the vane
iii) Angle made by the absolute velocity at outlet. With the direction of motion at outlet Discharge. **(10 Marks)**

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