



10CV45

**Fourth Semester B.E. Degree Examination, Aug./Sept.2020**  
**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. Write a note on 'Dimensional Homogeneity of an equation'. Give two examples. (04 Marks)
  - b. Using Buckingham's  $\pi$  theorem, obtain an expression for pressure difference ' $\Delta P$ ' in a pipe of diameter ' $D$ ' and height ' $l$ '. Due to the turbulent flow which depends on the velocity ' $V$ ', viscosity ' $\mu$ ', density ' $\rho$ ' and roughness ' $k$ '. (08 Marks)
  - c. A 7.2 m high and 15 m long spillway discharges 94 m<sup>3</sup>/s of water under a head of 2m. If a 1:9 scale model of this spillway is to be constructed, determine model dimensions, head over the spillway model and model discharge. If model experiences a force of 7500 N, determine force on prototype. (08 Marks)
2.
  - a. Bring out the difference between flow through pipes and flow through open channel. (04 Marks)
  - b. Derive the conditions for most economical channel section. (08 Marks)
  - c. A rectangular channel section carries water at the rate of 400 litres/sec when bed slope is 1 in 2000. Find the most economical dimensions of the channel if  $c = 50$ . (08 Marks)
3.
  - a. Define the term 'Hydraulic Jump'. Derive an expression for depth of hydraulic jump in terms of upstream Froude's number. (10 Marks)
  - b. A rectangular channel of bed width 4m is discharging water at the rate of 10 m<sup>3</sup>/s. Determine the following :
    - (i) Critical depth
    - (ii) Minimum specific energy
    - (iii) What will be the type of flow if the depth is 0.6m and 2m. (10 Marks)
4.
  - a. A 50mm diameter jet having a velocity of 25 m/s strikes a flat plate the normal of which is inclined at 30° to the axis of the jet. Calculate the normal force exerted on the plate.
    - (i) When the plate is stationary
    - (ii) When the plate is moving with a velocity of 10 m/s in the direction of the jet
    - (iii) when the plate is moving with a velocity of 8 m/s parallel to itself and in the direction of normal to its surface. Find the work done and efficiency when the plate is moving. (10 Marks)
  - b. A jet of water of diameter 25mm strikes a 200mm × 200mm square plate of uniform thickness with a velocity of 10 m/s at the centre of the plate which is suspended vertically by a hinge on its top. The weight of the plate is 98.1 N. The jet strikes normal to the plate. What force must be applied at the lower edge of the plate so that the plate is kept vertical? If the plate is allowed to deflect freely, what will be the inclination of the plate with vertical due to the force exerted by jet of water? (10 Marks)

**PART - B**

5.
  - a. Show that maximum efficiency of the jet striking a series of curved vanes moving in the direction at an angle  $\phi$ , with velocity  $U$  is  $\eta_{\max} = \frac{1 + \cos \phi}{2}$ . (10 Marks)

- b. A stationary vane having an inlet angle of zero degree and an outlet angle  $25^\circ$  received water at a velocity of 50 m/s. Determine the components of force per unit weight of water acting on it in the direction of jet and normal to it. Also find the resultant force. If the vane is moving with a velocity 20 m/s in the direction of jet, calculate the resultant force, work done and power developed. (10 Marks)
- 6 a. Draw a neat sketch of a hydroelectric power plant. Mention the function of each component. (06 Marks)
- b. Give the classification of turbines with examples. (04 Marks)
- c. Design the Pelton wheel with the following data:  
Shaft power = 735.75 kW,  $H = 200\text{m}$ ,  $N = 800\text{ rpm}$ ,  $\eta_0 = 0.86$ ,  $D/d = 10$ ,  $C_v = 0.98$ ,  $\phi = 0.45$ , determine  $D$ ,  $d$  and number of buckets. (10 Marks)
- 7 a. What are the uses of draft tube? Describe the neat sketches different types of draft tubes. (08 Marks)
- b. A Kaplan turbine runner is to be designed to develop 10000 kW. The net head is 6.0 m. The speed ratio = 2.09, flow ratio = 0.68, overall efficiency is 80% and diameter of the boss is  $1/3$  the diameter of the runner. Its speed and the specific speed of the turbine. (12 Marks)
- 8 a. Derive an expression for minimum starting speed of a centrifugal pump. (05 Marks)
- b. What is priming of a centrifugal pump? How is it done? (05 Marks)
- c. A centrifugal pump runs at 1000 rpm and delivers water against a head of 15m. The impeller diameter and width at the outlet are 0.3m and 0.05m respectively. The vanes are curved back at an angle of  $30^\circ$  with the periphery at the outlet.  $\eta_{\max} = 0.92$ . Find discharge. (10 Marks)

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