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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

September / October 2023 Supplementary Examinations

Programme: B.E **Semester: IV**
Branch: Civil Engineering **Duration: 3 hrs.**
Course Code: 19CV4PCHYM **Max Marks: 100**
Course: Hydraulics and Hydraulic Machines **Date: 21.09.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1 a) List the characteristics of critical flow in an open channel. Derive the condition for maximum discharge through a channel for a given specific energy. **10**

b) A trapezoidal channel with side slopes of 1:1 has to be designed to carry 10 m^3/sec, so that the amount of concrete lining for the bed and the sides is the minimum. **10**
i) Calculate the area of lining required for one metre length of the canal.
ii) If Manning's roughness coefficient n = 0.015, calculate the bed slope of the canal for the uniform flow for a velocity of flow 2 m/sec.

OR

2 a) In which condition flow through pipes can be considered as open channel flow. Justify your answer with suitable example. **05**

b) Derive the conditions for most economical rectangular channel section. **05**

c) The discharge of water through a rectangular channel of width 8 m is 15 m^3/sec. When the depth of flow of water is 1.2 m, calculate i) specific energy ii) critical depth iii) critical velocity iv) minimum specific energy. **10**

UNIT - II

3 a) A rectangular channel 7.5 m wide has a uniform depth of flow of 2.0 m and has a bed slope of 1 in 3000. If due to weir constructed at the downstream end of the channel, water surface at a section is raised by 0.75 m, determine the water surface slope with respect to horizontal at this section. Assume Manning's n = 0.02. **10**

b) A trapezoidal channel having bottom width 8 m and side slope 1:1, carries a discharge of 80 m^3/s. Find the depth conjugate to initial depth of 0.75 m before the jump. Also determine the loss of energy in the jump. **10**

UNIT - III

4 a) Show that the maximum efficiency for a jet striking a single semi-circular moving vane, symmetrical about the axis of the jet and moving in the direction of the jet is 16/27. **05**

b) A jet of water 75 mm diameter having a velocity of 20 m/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 as the jet with a velocity of **07**

5 m/s, (iii) work done per second on the plate in each case and (iv) efficiency of the jet when the plate is moving.

c) A jet of water having a velocity of 45 m/s impinges without shock a series of vanes moving at 15 m/s, the direction of motion of the vanes being inclined at 20° to that of the jet. The relative velocity at outlet is 0.9 of that at inlet, and the absolute velocity of the water at exit is to be normal to motion of the vanes. Determine (i) vane angles at entrance and exit (ii) work done on vanes per unit weight of water supplied by the jet and (iii) the hydraulic efficiency. **08**

UNIT - IV

5 a) A Pelton wheel has to be designed for the following data. Power to be developed = 6000 kW. Net head available = 300 m, speed = 550 r.p.m., ratio of jet diameter to wheel diameter =1/10, and overall efficiency = 85%. Determine the number of jets, diameter of the jet, diameter of the wheel, and the quantity of water required. Assume speed ratio =0.46 and coefficient of velocity =0.98. **10**

b) An inward flow reaction turbine with radial discharge and an overall efficiency of 80% is required to develop 150 kW. Head available at the inlet is 8 m, peripheral velocity of the wheel is $0.96\sqrt{2gH}$, and the radial velocity of the flow is $0.36\sqrt{2gH}$. The wheel is to make 150 r.p.m., and the hydraulic losses in the turbine are 22% of the available energy. Determine: (i) the angle of the guide blade at inlet, (ii) the wheel vane angle at inlet, (iii) the diameter of the wheel, (iv) the width of the wheel at inlet **10**

OR

6 a) Francis turbines contributes about 60% of the global hydropower capacity. Justify the statement. **05**

b) A Pelton wheel has a mean bucket speed of 12 m/s and is supplied with water at a rate of 750 litres per second under a head of 35 m. The bucket deflects the jet through an angle of 160°. Take the coefficient of velocity as 0.98. Neglect friction in the bucket. Determine (i) power developed by the turbine and its hydraulic efficiency (ii) overall efficiency of the turbine if its mechanical efficiency is 80%. **07**

c) Design a Francis turbine runner with the following data: Net head H = 68 m, speed N = 750 r.p.m, output power P = 330 kW, η_h = 94%, η_o = 85 %, flow ratio ψ = 0.15, breadth ratio n = 0.1, inner diameter of runner is half of outer diameter. Assume 6% of circumferential area of the runner to be occupied by the thickness of the vanes. Velocity of flow remains constant throughout and flow is radial at exit. **08**

UNIT - V

7 a) Comment on the need for priming in operating centrifugal pumps. **04**

b) A centrifugal pump has external and internal impeller diameters 600 mm and 300 mm, respectively. The vane angle at inlet and outlet are 30^o and 45^o respectively. If the water enters the impeller at 2.5 m/s, determine (i) speed of the impeller in r.p.m., and (ii) work done per kN of water. **06**

c) A centrifugal pump impeller has 200 mm diameter at inlet and 400 mm diameter at outlet. The impeller vanes are set back at an angle of 45^o to the outlet rim, and the entry of the pump is radial. The pump runs at 1000 r.p.m. and velocity of the through the impeller is constant at 3 m/s. Calculate (i) vane angle at the inlet, (ii) work done per kN of water and (iii) velocity as well as direction of the water at outlet. **10**

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