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

Autonomous Institute Affiliated to VTU

October 2023 Semester End Main Examinations

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

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

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

UNIT - I

1	a)	Define the term most economical section of a channel. Explain the conditions for a rectangular channel to be the most economical section.	**06**
	b)	Explain the following terms in an open channel flow i) Specific energy of a flow ii) Minimum specific energy iii) Critical depth	**06**
	c)	A trapezoidal channel has side slope 1 horizontal to 2 vertical and bed slope 1 in 1500. The area of the section is 40 m^2. Calculate the dimensions of the most economical section. Also, determine the discharge through the most economical section if Chezy's constant C = 50.	**08**

OR

2	a)	Prove that for a trapezoidal section to be most economical the hydraulic radius must be equal to half the depth of flow.	**08**
	b)	A rectangular channel 5.4 m wide and 1.2 m deep has a slope of 1 in 1000 and is lined with rubble for which Manning's n= 0.017. It is desired to increase the discharge to a maximum by changing the section dimensions without changing the amount of lining. Compute the new dimensions and percentage increase in the discharge.	**12**

UNIT - II

3	a)	A hydraulic jump is formed on a horizontal rectangular channel with Froude's number before jump as 10. If the head loss during the jump is 4 m, determine the depths before and after the jump, and Froude's number after the jump.	**10**
	b)	A rectangular channel has a bed width = 4 m, bottom slope = 0.0004 and Manning's roughness coefficient = 0.02. The normal depth of flow in this channel is 2.0 m. If the channel empties into a pool at the downstream end and the pool elevation is 0.60 m higher than the canal bed elevation at the downstream end, identify the surface profile in the region where the channel meets the pool.	**10**

UNIT - III

4 a) Show that the efficiency of a free jet normally striking on a series of flat plates mounted on the periphery of a wheel can never exceed 50%. **10**

b) A jet of water moving at 20 m/s impinges on a symmetrical curved vane shaped to deflect the jet through 120° (that is the vane angles θ and φ are each equal to 30°). If the vane is moving at 5 m/s, determine the angle of the jet so that there is no shock at inlet. Also determine the absolute velocity at exit in magnitude and direction, and the work done. **10**

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 (i) the number of jets (ii) diameter of the jet (iii) diameter of the wheel and (iv) quantity of water required. **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) For a Pelton wheel, show that the maximum hydraulic efficiency can be attained when the vanes are close to semicircular in shape. **10**

b) 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 the outer diameter. Also, 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. **10**

UNIT - V

7 a) A centrifugal pump has the following characteristics: outer diameter of impeller = 800 mm, width of impeller vanes at outlet = 100 mm, angle of impeller vanes at outlet = 40°. The impeller runs at 550 r.p.m and delivers 0.98 cubic metres of water per second under an effective head of 35 m. A 500 kW motor is used to drive the pump. Determine the manometric, mechanical and overall efficiencies of the pump. Assume water enters the impeller vanes radially at inlet. **08**

b) A centrifugal pump has an impeller 0.5 m outer diameter and when running at 600 r.p.m discharges water at the rate of 8000 lit/min against a head of 8.5 m. The water enters the impeller without whirl and shock. The inner diameter is 0.25 m and the vanes are set back at outlet at an angle of 45^o and the area of flow which is constant from inlet to outlet of the impeller is 0.06 m^2. Determine (i) Manometric efficiency of the pump (ii) Vane angle at inlet (iii) If a 30 kW motor is used to drive the pump, determine the mechanical and overall efficiencies. **12**

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