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06CV45

Fourth Semester B.E. Degree Examination, May/June 2010
Hydraulics and Hydraulic Machines

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Derive the Chezy's equation for uniform flow in an open channel. List the assumptions made in deriving the same. Hence establish a relation between Manning's n and Chezy's C. **(10 Marks)**

b. A trapezoidal channel with side slopes of 0.5 H : 1 V is to be designed as the most efficient channel to carry 30 m^3/sec discharge at a slope of 0.000556. Using Chezy's C as 60, determine the bottom width and depth of flow. **(10 Marks)**

2 a. Define the term specific energy. With a neat sketch, explain specific energy diagram. Derive the formulae for critical depth and minimum specific energy for critical flow in a rectangular channel. **(10 Marks)**

b. Water flows at a rate of 12 cumecs through a 6 m wide rectangular channel, depth of flow being 400 mm. Find out if a hydraulic jump will occur and if yes, what is the depth after the jump? Calculate the loss of energy due to the jump. **(10 Marks)**

3 a. A hydraulic pipeline 2 km long and 400 mm diameter is used to convey water with a velocity of 1.5 m/s. Determine the pressure rise if the valve provided at the outlet end is closed in (i) 12 seconds (ii) 2 seconds. Consider the pipe to be rigid and take bulk modulus of water $K_{water} = 20 \times 10^8$ N/m^2. **(10 Marks)**

b. Prove that the discharge over a spillway is given by the relation:

$$Q = VD^2 f\left[\frac{\sqrt{gD}}{V}, \frac{H}{D}\right]$$

where, V = velocity of flow ; D = depth at the throat ; H = head of water ; g = acceleration due to gravity. **(10 Marks)**

4 a. Derive the equation for the work done by a jet on a moving symmetrical curved vane and the jet striking at the centre. **(10 Marks)**

b. A square plate weighing 120 N has an edge of 350 mm. The thickness of the plate is uniform. It is hung so that it can swing freely about the upper horizontal edge. A horizontal jet of 25 mm diameter having 18 m/s velocity impinges on the plate. The centre line of jet is 200 mm below the upper edge of plate. Find what force must be applied at the lower edge of plate in order to keep it vertical. **(10 Marks)**

PART – B

5 a. What are turbines? Discuss in detail the classification of turbines. **(10 Marks)**

b. A pelton wheel has to develop 13200 KW under a net head of 820 m while running at a speed of 600 rpm. If the coefficient of jet $C_V = 0.98$, speed ratio $\phi = 0.46$ and the jet diameter is $\frac{1}{16}$ of wheel diameter, calculate:

i) Pitch circle diameter
ii) The diameter of the jet
iii) The quantity of water supplied to the wheel
iv) The number of jets required.

Assume overall efficiency as 85%. **(10 Marks)**

6 a. With a neat sketch of velocity triangles, derive the equation for efficiency of a Francis turbine. **(10 Marks)**

b. An inward flow water turbine has blades, the inner and outer radii of which are 30 cm and 50 cm respectively. Water enters the blades at the outer periphery with a velocity of 45 m/sec making an angle of 25° with the tangent to the wheel at the inlet tip. Water leaves the blade with a flow velocity of 8 m/sec. If the blade angles at inlet and outlet are 35° and 25° respectively, determine :

i) Speed of the turbine wheel

ii) Work done per Newton of water. **(10 Marks)**

7 a. With a neat sketch, explain the general layout of a hydroelectric power plant. **(10 Marks)**

b. Explain the terms specific speed and unit quantities, as applied to hydraulic turbines. How are they useful to practical engineers? **(06 Marks)**

c. Suggest a suitable type of turbine to develop 8000 kW power under a head of 20 m while operating at 220 rpm. What are the considerations for your suggestion? **(04 Marks)**

8 a. What is a centrifugal pump? Explain its working, with a neat sketch. **(10 Marks)**

b. Determine the overall efficiency of a centrifugal pump from the following test results:
Suction gauge reading = 120 mm of mercury
Delivery gauge reading = 220 kN/m^2
Height of delivery gauge over suction gauge = 200 mm
Discharge = 7500 *l*pm of water
Diameter of suction pipe = 300 mm
Diameter of delivery pipe = 200 mm
Power of motor = 40 KW. **(10 Marks)**

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