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10CV45

Fourth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Hydraulics and Hydraulic Machines

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Assuming that rate of discharge Q of a centrifugal pump is dependent upon the mass density ρ of fluid, pump speed N(rpm), the diameter of impeller D, the pressure P and viscosity of fluid μ, show using the Buckingham's π-theorem that it can be represented by :

$$Q = (ND^3)\phi\left[\left(\frac{gH}{N^2D^2}\right), \left(\frac{\upsilon}{ND^2}\right)\right]$$ where υ = kinematic viscosity, H = Head. **(08 Marks)**

b. Name different types of models. Where are their applications? **(04 Marks)**

c. The ratio of lengths of a submarine and its model is 30:1. The speed of submarine is 10m/sec. The model is tested in a wind tunnel. Find the speed air in wind tunnel. Also determine the ratio of the drag (resistance) between the model and its prototype. Take the value of kinematic viscosities for seawater and air as 0.012 Stokes and 0.016 stokes respectively. The density for seawater and air is given as 1030 kg/m^3 and 1.24 kg/m^3 respectively. **(08 Marks)**

2 a. Find the slope of the bed of a rectangular channel of width 5m when depth of water is 2m and rate of flow given as 20m^3/sec. Take Chezy's constant C = 50. **(04 Marks)**

b. Define most economical channel section. Derive the conditions for most economical channel section for maximum discharge through a circular channel section. **(08 Marks)**

c. A trapezoidal channel section to carry 142 m^3/ minute of water is designed to have a minimum cross-section. Find the bottom width and depth if the bed slope is 1in 2000, the side slope as 45° and Chezy's constant C = 55. **(08 Marks)**

3 a. Draw a neat diagram of specific energy diagram for a channel section and mark its salient points. **(06 Marks)**

b. A rectangular channel carries a discharge of 2m^3/sec per metre width. If the loss of energy in the hydraulic jump is found to be 2.75m determine the conjugate depths before and after the jump. **(08 Marks)**

c. State the relationship between water surface slopes and channel bottom slope for non uniform flow in channels. Give the classification of channel bottom slopes and state the conditions. **(06 Marks)**

4 a. State and explain Impulse-momentum equation. What are its applications? **(06 Marks)**

b. Derive an expression for force exerted by a jet on a series of moving flat plates fixed on a wheel. Find the maximum efficiency, with usual notations. **(08 Marks)**

c. A jet of water of diameter 25mm strikes a 20cm × 20cm square plate of uniform thickness with a velocity of 10m/sec at the centre of the plate which is suspended vertically by a hinge on its top horizontal edge. The weight of the plate is 98.1N. 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 the jet of water? **(06 Marks)**

PART – B

5 a. Derive expressions for force on the curved plate and also workdone by the jet on the plate/sec, when the plate is moving in the direction of jet, with usual notations. **(06 Marks)**

b. A jet of water having a velocity of 15m/sec, strikes a curved vane which is moving with a velocity of 5m/sec. The vane is symmetrical and it is so shaped that the jet is deflected through 120°. Find the angle of the jet at inlet of the vane so that there is no shock. What is the absolute velocity of jet at outlet in magnitude and direction and the work done per unit weight of water? Assume the vane to be smooth. **(14 Marks)**

6 a. List various classification of turbines. **(06 Marks)**

b. Draw a neat diagram of Pelton turbine and explain function of its various components. **(06 Marks)**

c. A Pelton wheel has a mean bucket speed of 10 metre/sec with a jet of water flowing at the rate of 700 litre/sec under a head of 30metres. The buckets deflect the jet through an angle of 160°. Calculate the power given by water to the runner and the hydraulic efficiency of the turbine. Assume co-efficient of velocity as 0.98. **(08 Marks)**

7 a. Define a draft tube. What are the functions of draft tube? Mention different types of draft tubes. **(06 Marks)**

b. What is cavitation in turbines? List the effects of cavitation and precautions for protection against cavitation. **(06 Marks)**

c. The hub diameter of a Kaplan turbine, working under a head of 12m, is 0.35 times the diameter of the runner. The turbine is running at 100rpm. If the vane angle of the extreme edge of the runner at outlet is 15° and flow ratio is 0.6, find:

i) Diameter of the runner
ii) Diameter of the boss
iii) Discharge through the runner.

The velocity of whirl of outlet is given as zero. **(08 Marks)**

8 a. Define suction head, delivery head, maometric efficiency and overall efficiency of a centrifugal pump. **(06 Marks)**

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

c. A centrifugal pump is running at 1000rpm. The outlet vane angle of the impeller is 45° and velocity of flow at outlet is 2.5m/sec. The discharge through the pump is 200 litres/sec, when the pump is working against a total head of 20m. If the manometric efficiency of the pump is 80%, determine:

i) Diameter of the impeller ii) Width of the impeller at outlet. **(08 Marks)**

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