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10CV45

Fourth Semester B.E. Degree Examination, Dec.2015/Jan.2016

Hydraulics and Hydraulic Machines

Time: 3 hrs. Max. Marks:100

Note: *1. Answer FIVE full questions, selecting at least TWO questions from each part.*
2. Missing data may suitably be assumed.

PART – A

1 a. Define the dimensional homogeneity. Give an example. **(06 Marks)**

b. Briefly explain geometric, kinematic and dynamic similarities. **(09 Marks)**

c. A 2.5m ship model was tested in fresh water $\rho = 1000 kg/m^3$ and measurements indicated that there was resistance of 45N when the model was moved at 2m/s. Workout the velocity of 40m prototype. Also calculate the force required to drive the prototype at this speed through sea water ($\rho = 1025 kg/m^3$). **(05 Marks)**

2 a. With neat sketches differentiate between flow through pipes and flow through open channels with examples. **(08 Marks)**

b. Derive an expression for the discharge through an open channel using Manning's formula. **(06 Marks)**

c. An earthen channel with a base width 2m and side slope 1H to 2V carries water with a depth of 1m. The bed slope is 1 in 625. Calculate the discharge if n = 0.03. Also calculate average shear stress at the channel boundary. **(06 Marks)**

3 a. Define specific energy. Draw specific energy curve, and then derive expressions for critical depth, critical velocity and minimum specific energy. **(10 Marks)**

b. Derive the expression for sequent depth of hydraulic jump interms of Froude number before a hydraulic jump in a rectangular channel flow. **(06 Marks)**

c. A horizontal rectangular channel 4m wide carries a discharge of $16 m^3/s$. Determine whether a jump may occur at an initial depth of 0.5m or not. If a jump occurs, determine the sequent detpth to this initial depth. Also determine the energy loss in the Jump. **(04 Marks)**

4 a. State impulse momentum equation. **(02 Marks)**

b. Show that in case of jet striking the flat plates mounted on wheels, the efficiency will be maximum when the tangential velocity of wheel is half that of jet and maximum efficiency is only 50%. **(10 Marks)**

c. A 75mm diameter jet having a velocity of 30m/s strikes a flat plate, the normal of which is inclined at 45° to the axis of the jet. Find the normal force exerted on the plate.
i) When the plate is stationary ii) when plate is moving with velocity of 15m/s in the direction of jet away from the jet.
Also determine the power and efficiency of the system when the plate is moving. **(08 Marks)**

PART – B

5 a. Show that when the jet of water striking symmetrical moving curved vane at the centre, the maximum efficiency for semicircular vane is $\frac{8}{27}(1+\cos\theta)$. **(10 Marks)**

b. A jet of water, 60mm in diameter, strikes a curved vane at its centre with a velocity of 18m/s. The curved vane is moving with a velocity of 6m/s in the direction of the jet. The jet is deflected through an angle of 165°. Assuming the plate to be smooth, Find :
   i) Thrust on the plate in the direction of jet
   ii) Power of the jet, and
   iii) Efficiency of the jet **(10 Marks)**

6 a. With the help of velocity triangles derive an expression for work done and maximum hydraulic efficiency of a pelton wheel. **(10 Marks)**

b. A Pelton wheel is receiving water from a penstock with a gross head of 510m. One third of gross head is lost in friction in the penstock. The rate of flow through the nozzle fitted at the end of the penstock is $2.2m^3/s$. the angle of deflection of the jet is 165°. Determine :
   i) Power given by water to the runner,
   ii) Hydraulic efficiency of the pelton wheel.
   Take $C_V = 1.0$ and speed ratio = 0.45. **(10 Marks)**

7 a. Draw the neat sketch of Kaplan turbine and mention the parts. **(08 Marks)**

b. Explain with the help of neat sketches the different types of draft tubes. **(06 Marks)**

c. A Kaplan turbine develops 22000kW at an average head of 35m. Assuming a speed ratio of 2, flow ratio of 0.6, diameter of the boss equal to 0.35 times the diameter of the runner and an overall efficiency of 88%, calculate the diameter, speed and specific speed of the turbine. **(06 Marks)**

8 a. Explain briefly the various types of efficiencies of a centrifugal pump. **(08 Marks)**

b. Distinguish between pumps in series and pumps in parallel. **(07 Marks)**

c. A centrifugal pump is to discharge $0.118m^3/s$ at a speed of 1450rpm against a head of 25m. The impeller diameter is 250mm, its width at outlet is 50mm and manometric efficiency is 75%. Determine the vane angle at the outer periphery of the impeller. **(05 Marks)**

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