Ex/BESUS/AM-402/07

B.E. (CE) Part-II 4th Semester Examination, 2007

Hydraulics-II

(AM-402)

Time : 3 hours **Full Marks : 70**

Use separate answerscript for each half.
The questions are of equal value.
Answer SIX questions, taking THREE from each half.
Assume data suitably wherever necessary.

FIRST HALF

1. A jet of water having a velocity of 40 m/s strikes, without shock, on a series of vanes moving at 15 m/s. The direction of motion of the curved vanes is inclined at 20^0 to that of the impinging jet. The relative velocity at outlet is 0.9 times that at the inlet, and the absolute velocity at outlet is normal to the direction of motion of vanes. Draw the neat sketches of velocity triangles at both the inlet and the outlet of vanes and calculate (a) inlet and outlet vane angles (b) work done on the vanes per weight of unit volume of water, and (c) the efficiency.

2. In case of a pelton wheel, the velocity of jet striking the vanes is V, the mean bucket velocity is u and the jet is deflected by an angle θ. Assume that the energy head lost due to bucket friction is $\frac{k_1}{2g}(V-u)^2$ and that due to bearing friction is $\frac{k_2}{2g}u^2$, where k_1 and k_2 are constants. Deduce an expression for the ratio $\left(\frac{u}{V}\right)$, in terms of k_1, k_2 and θ, when the hydraulic efficiency of the particular turbine is maximum. Then evaluate k_1 and k_2, if the maximum hydraulic efficiency is 80%, $\frac{u}{V} = 0.47$ and $\theta = 165°$.

3. In a vertical shaft inward flow reaction turbine, the top of the draft tube and the level of tailrace are 1m and 3m, respectively, below the horizontal axis of spiral casing, coincident with the level of turbine inlet. At the inlet to the turbine runner, the gauge pressure head is 15m and water has velocity 5m/s. At the runner outlet (top of draft tube), the velocity is 5 m/s without whirl, and water leaves the draft tube with velocity of 2.5 m/s. The head loss in the draft tube is 0.5m, when the discharge is 11.2 m^3/s and the runner speed is 250 rpm. Assuming 84% of

hydraulic efficiency and 80% of overall efficiency of the turbine, determine (a) the gauge pressure head at the runner outlet, (b) frictional head loss in the turbine runner, and (c) the specific speed of the turbine.

4. The axis of a centrifugal pump is 2.4m above the water level in the sump and the static lift from the pump centre is 33m. The friction losses in the suction and delivery pipes are 1m and 7.5m respectively. The suction and delivery pipes are each of 15cm diameter. The impeller of the pump is of 30cm diameter and 2cm width at the outlet, which runs at 1700 r.p.m. At the inlet to the impeller, water flows radially and the vane angle at the outlet is 32°. Assuming manometric efficiency of 77% and overall efficiency of 72%, calculate (a) the discharge delivered by the pump, and (b) the power to be supplied to run the pump.

5. (a) In case of a pelton wheel, the coefficient of velocity for the nozzle is C_V, the jet diameter is d, the runner diameter is D, the speed ratio is K_u and the overall efficiency is η. Obtain an expression for the specific speed of the turbine.

(b) Find the permissible height of setting a Francis turbine above the tailrace level, to avoid cavitation, using following data :

i) Power to be developed is 5 MW, under a head of 105 m.

ii) The generator coupled with the shaft has 8 nos. of poles with frequency 50 cycles/s.

iii) Local atmospheric pressure head is 9.5 m of water.

iv) The temperature of water is 40°C.

SECOND HALF

6. (a) Water from a reservoir flows through a pipe of length 'L' and diameter 'D' and discharge through a nozzle of tip diameter 'd'. The loss of head in the nozzle is $K\frac{V^2}{2g}$ where 'K' is a constant and 'V' is the velocity at the nozzle exit. If 'f' is the friction factor for the pipe, show that for maximum power of the jet

$$\frac{d}{D} = \left[\frac{(1 + K)\, D}{2\, f\, L}\right]^{1/4}$$

(b) A venturi flume of rectangular section, 1 m wide at inlet and 500 mm at the throat, has a horizontal bottom. Assuming that an ideal fluid flow occurs in the flume, find the rate of flow if the depths at inlet and throat are 500 mm and 455 mm, respectively. A hump is now installed at the throat of height 170 mm so that a hydraulic jump is formed beyond the throat. Calculate the change in the u/s depth assuming that the discharge remains the same.

10. (a) Show that in a rectangular channel of having constant width

$$\frac{Fr_1}{Fr_2} = \left[\frac{1}{2/-1 + \sqrt{1+8\,Fri^2}} \right]^{\frac{3}{2}},$$

where, Fr_1 = Froude No. at section 1

Fr_2 = Froude No. at section 2.

(b) Water is flowing from an under sluice into a very wide rectangular channel. The channel has a bed slope of 1 in 1000. The sluice is regulated to discharge 6 m^3/s per metre width of the channel, the depth at Venna Contracta being 0.5 m. Will a hydraulic jump form? If so, determine its location. Take 'η' = 0.015.

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