B.E. (C. E.) 4th Semester Final Examination, 2010

HYDRAULICS II (AM 402)

Time: 3 hrs. Full Marks: 70

Attempt SIX questions taking ANY THREE from each half

All questions cany equal marks

FIRST HALF

Q. **1.** a) A model with a scale of 1/10 is constructed for an impulse turbine to develop 7350 KW power under a net head of 9m while running at 100 rpm. If the efficiency of the actual turbine is 88% and the head available in the test house is 6m, find

i) Running speed of the model, ii) Flow rate required in the test house, iii) Power developed by the model and iv) Specific speed of the model and the actual turbine.

b) Find the permissible height of setting a Francis water turbine above the tailrace level using following data:

Power to be developed = 3.75 MW under a head of 100m.

The generator coupled with the shaft has 12 poles with frequency 50 cycles/sec.

Local atmospheric pressure = 9.75 m and vapor pressure head = 0.43 m.

Q. 2. a) Prove that the specific speed of a reaction turbine can be expressed as

$N_s = 576.33\ K_u\ (D_2/D_1)\ V\ (r|_c,\backslash|/_2 K_2)$, where,

K_u = Speed ratio, D_2 = Outlet diameter, Dj =Inlet diameter, = Blockage factor at outlet due to the vane thickness and y_2 = Flow ratio at the outlet.

b) A nozzle having a velocity coefficient of 0.98 discharges a 15 cm diameter water jet under a head of 275 m. Take ct| = 0°, 0 = 165°, speed ratio = 0.46, wheel diameter = 2.44m, mechanical efficiency = 97% and head loss in bucket surface friction as 0.5 $V_{r2}^2/2g$ where V_{r2} is the relative velocity at the outlet. Find i) absolute velocity of water at outlet ii) power carried away in the water discharged from the buckets ii) power lost in bucket friction iv) hydraulic efficiency and v) overall efficiency.

Q. **3.** The inner diameter of an inward flow reaction turbine is 0.65 times the outer diameter. The turbine has a wheel 0.6m diameter and 5 cm wide at the outer rim. The velocity of flow is uniform throughout the wheel and the wheel blade angles at the inlet and outlet are 95" and 14" respectively and 8% of the circumferential area is blocked by blade thickness. The head on the turbine is 53.6m, the hydraulic efficiency 88%, the overall efficiency 81% and the discharge at the outlet of the runner is radial. ric}<Tw'i«e ^V%* av><! cwij>t*t j-n^o <?\ii -Im V,„i

Q. **4.** A centrifugal pump having 4 stages in parallel delivers 180 litres/sec of liquid against a head of 2 5 m, the diameter of the impeller being 22.5 cm and speed 1700 rev/min. A pump is to be-made up with a number of identical stages in series each stage being similar to those as in the first pump, to run at 1250 rev/min and to deliver approximately 240 litres/sec against a head of 250 m. Find the number of stages, diameter of impeller and actual discharge.

Q. **5.** a) What is the use of DRAFT tube in reaction turbine?

b) The head available in a vertical shaft Francis turbine is 50m and the runner speed is 380 rev/min. The inlet of the turbine runner is placed 1.8m above the tailrace level and the area and diameter of the runner at the inlet are 0.24 m^2 and I m respectively. The guide and runner vane angle at the inlet are 20° and 120° respectively. The wnter enters a draft tube without whirl 1.6 m above the tail race level and the draft tube dia there is 56 cm. # outlet the draft tube is 72 cm diameter. If the frictional losses in the runner amount to 3 m and in the draft tube 1.5 m and the overall efficiency = 0.9 x hydraulic efficiency, find a) brake power of the turbine b) hydraulic efficiency c) pressure head at the inlet to the runner d) pressure head at the entry to the draft tube. Assume head loss in guide passage 0.! 5m.

SECOND HALF

[6], (a) Water from a reservoir flows through a pipe of length ***I*** and diameter ***D*** and discharges through a nozzle of tip diameter ***d.*** The loss of head in the nozzle is ***k*** $V^2/2g$ where ***k*** is constant and ***V*** is the velocity at the nozzle exit. If f is the friction factor for the pipe, show that for the maximum power of jet ***(d/D)*** = [{(l ***+k)*** D}/(2./L)]$^{0.25}$. (6)

(b) 200 KW is to be transmitted through a 10km long water pipe, the head at inlet of the pipe being 500m. If/- 0.03, '-^**B** the minimum diameter of the pipe,**tb W** y*T>^ . (5)

[7]. 30mVs of water is to be pumped for 14 hours a day to supply a township. The supply is carried through two identical pipes, each 12 km long, connected in parallel. The annual cost of each pipe line, in rupees, is 2.5 x 10^5 ***D~,*** where ***D*** is the pipe diameter in meters. The pumps are operated by electric motors and the overall efficiency of the pumps and motor units is 75%. The cost of electric energy supplied to the motors is 125paisa per KWH. The friction factor for the pipe is 0.02. Calculate the economic diameter of the pipes. (11)

[8]. (a) Derive Chezy equation for steady uniform flow in an open channel. (4)

(b) A trapezoidal channel is required to carry 6mVs of water at a velocity of 1.5m/s. Find the' most economical cross-section if the channel has side slopes of 1 vertical to 2 horizontal. Fur the same discharge what saving in power would result if this trapezoidal section is replaced by a rectangular section 1.5m deep and 3 m wide? Use C = 55 $m^{1/2}$/s in Chezy formula. (7)

[9]. (a) Water flows at a rate of 1 m^3/s along a channel of rectangular section 1.6m in width. Calculate the critical depth. If a standing wave occurs at a point where the upstream depth is 0.25m, what would be the rise in water level produced and power lost in the standing wave. (5)

(b) A rectangular channel 2.4m wide carries a uniform flow of 7m7s at a depth of 1.5m. If there is alocal rise of 0.15m in the bed level, calculate the change in water surface elevation. What can be the maximum rise in the bed elevation such that the upstream depth is not affected? (6)

[10]. (a) Define and explain the following terms- alternate depth, conjugate depth and specific energy (3)

(b) The spectflc^ener^^a^ a section of a 4m wide rectangular channel, conveying a discharge of 12mVs is 2m. ^ t £ e two possible flow depths. (3)

(c) A rectangular channel 5m wide conveys a discharge of 15m^3/s of water at a depth of 2m. If the width of the channel is reduced to 3.5m on the downstream side, will the water surface in the channel be disturbed in the upstream? What will be the depth of flow in the reduced section? (5)