BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR

B. E. (CE) 4th Semester Final Examination, 2013

Subject: Hydraulics II (AM 402)

Full Marks 70 Time: 3hrs

Attempt SIX questions taking ANY THREE from each half

All questions carry equal marks

FIRST HALF

Q. 1.a) Explain Manometric Head of a centrifugal pump. Show that the Manometric Head (H_m) of a centrifugal pump can be expressed in terms of discharge Q and the speed of the pump N as $H_m = AN^2 + BNQ + CQ^2$, where A, B and C are constants.

b) A pump has to pump water against a head of 40 m, the water temperature being 37.8°C (Sp. Gr. 0.993; Absolute Vapour Pressure 6.5 kN/m^2). In suction pipe near the pump, the pressure is vacuum of 42 cm of mercury. What are the values of NPSH (Net Positive Suction Head) and Cavitation Number (σ)? Take Barometric Pressure 100 kN/m^2. The velocity in suction pipe is 3.6 m/s.

Q. 2. a) A model with a scale of 1/10 is constructed for a reaction turbine to develop 7350 kW power under a net head of 9 m, 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 = 37.5 MW under a head of 100 m. The generator coupled with the shaft has 12 poles with frequency 50 cycles/s. Local atmospheric pressure = 9.75 m and vapour pressure head for water = 0.43 m.

Q. 3. a) Differentiate between an impulse turbine and a reaction turbine.

b) In the spiral casing of a reaction turbine the pressure head is 15 m above atmospheric and the speed of water is 5 m/s. The shaft is vertical and the flow is 11.2 m^3/s. The top of the draft tube and the level of the tail race are 1m and 3m below the horizontal central plane of the spiral casing. At the inlet to the draft tube the water has velocity of 5 m/s without whirl and it leaves the tube at 2.5 m/s. Assuming an overall efficiency of 0.8, a hydraulic efficiency of 0.84 and a loss of head in the draft tube of 0.5 m, determine i) the loss of head due to friction in the turbine runner ii) the pressure head at the top of the draft tube and iii) the specific speed if the machine operates at 250 rev/min.

Q. 4. a) A jet strikes tangentially at one end of a smooth curved vane moving in the same direction as the jet. The jet gets reversed at the end of the vane. Show that the maximum efficiency is 59.3%, neglecting the friction.

b) The head developed by the centrifugal pump is $H = 55 + 484Q - 1904Q^2$ where Q is in cumecs. Water enters the pump through a 100 mm diameter suction pipe and after passing through the pump flows through 63 mm diameter, 300 m long fire hose and discharges through a nozzle at a height of 10 m above the water level in the sump. The nozzle diameter is 20 mm. The head loss in the suction pipe is estimated as $8V_s^2/2g$. Find the velocity of the jet given that the friction factor for the hose pipe is 0.005 and C_v for the nozzle is 0.95.

Q. 5. a) Prove that for a single jet Pelton wheel, the specific speed is given by the relation

$$N_s = 219.78\, d/D\sqrt{\eta_o}$$

Where, d = diameter of the jet in meters, D = diameter of the runner in meters and η_o = overall efficiency of the wheel. The coefficient of velocity for the nozzle is 0.98 and bucket speed is 0.46 times the speed of the jet.

b) It is required to be designed a Pelton wheel to develop 750 kW at 400 rpm. A 1000m long pipe line supplies water from a reservoir whose level is 250 m above the wheel. The pipe line losses are to be 5% of the gross head. The friction factor is considered as 0.02. The bucket speed is 0.45 of the jet speed and efficiency of wheel is 85%. Calculate the pipe line diameter, jet diameter and the wheel diameter. Take C_v = 0.98.

SECOND HALF

6. (a) A hydraulic pipeline 3.8km long and 40cm in diameter is used to convey water with a velocity of 2.0 m/s. determine the pressure growth, if the valve provided at the outflow end is closed in (i) 20 sec. (ii) 3 sec. Consider the pipe to be rigid and take bulk modulus of water (K) = 20×10^8 N/m^2.

(b) Steel pipe 3 km long, 50 cm diameter and 1.2 cm wall thickness conveys water at the rate of 1.5 cumecs. Determine the increase in pressure when a valve provided at the downstream end of the pipe is closed instantaneously. Consider the pipe to be elastic and take bulk modulus of water (K) = 20×10^8 N/m^2, modulus of elasticity for steel (E) = 2×10^{11} N/m^2.

7. (a) Find the flow depth in terms of the diameter (d) of a circular channel for the condition of maximum discharge.
(b) A rectangular channel 8m wide and 1.5 m deep has a slope of 0.001 in 1 and is lined with smooth concrete plaster. It is desired to enhance the discharge to a maximum by changing the dimensions of the channel but keeping the same amount of lining. Workout the new dimensions and percentage increase in discharge. For smooth concrete plaster take Manning constant N = 0.015

8. (a) A discharge of 18 m^3 /s flows through a rectangular channel 6m wide at a depth of 1.6m. Find (i) specific energy head (ii) critical depth. State whether the flow is sub-critical or supercritical (iv) what is the depth alternate to the depth given above.
(b) A 6m wide channel conveys water at a depth of 2.15m. The bed slope of the channel is 0.001. Find the width to be provided in the transition so as to obtain critical depth. Also find, for the same width of 6m in the transition, find the rise in bed level required to produce critical flow in the channel. Take Manning constant N = 0.018.

9 (a). Explain what is specific force.
(b) Water flows at the rate of 1 m^3 /s along a channel of rectangular section 1.6 m 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 due to the jump and the power lost.

10. A very wide rectangular channel conveys a discharge of 3.25 m^3/s per meter width at a depth of 2.50m. The bed slope is 1 in 5000. Due to weir placed across the channel the water level is raised by 1.5m just on the upstream of it. Find at what distance upstream of the weir the depth of water will be 3m. Take C = 52. Use step method and take two steps. Also classify the type of water surface profile.