[Total No. of Pages : 4

Roll No.

6E3053

B. Tech. VI Semester (Main/Back) Examination, May/June - 2011

Mechanical Engineering

6ME5 Hydraulic Machines & Hydroelectric Power Plant

e : 3 Hours

Maximum Marks : 80

Min. Passing Marks : 24

tructions to Candidates:

*Attempt any **five** questions selecting **one** question from **each** unit. All questions carry **equal** marks. (Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.)*

Unit - I

a) Derive an Euler equation in the form shown below

$$E = \frac{1}{2}\left[\left(V_1^2 - V_2^2\right) + \left(u_1^2 - u_2^2\right) + \left(V_{r_2}^2 - V_{r_1}^2\right)\right]$$

Explain the nature and their relative value for the estimation of the performance of a machine.

Where

V_1 and V_2 = Absolute velocity at inlet and outlet

u_1 and u_2 = velocity of vane at inlet and outlet

V_{r_1} and V_{r_2} = Relative velocity of jet and vane at inlet and outlet. **(10)**

b) Define non dimensional specific speed (K_n) and prove that $K_n = 1042\ N_s$ where N_s = specific speed. **(6)**

2. a) Prove that for maximum efficiency conditions for curved vane, jet strikes at centre is given by $V = 3u$ and $\eta_{max} = \frac{8}{27}(1+\cos\theta)$. **(6)**

b) Define specific speed, unit speed, unit discharge and unit power as applied to hydraulic machines. Deduce expressions to indicate their values. What are the limitations of unit quantities? **(10)**

[Contd....

Unit - II

3. a) What are the limitations of Pelton wheel turbine? **(2)**

b) Why does a Pelton wheel turbine not posses any draft tube? **(2)**

c) Discuss the shape of bucket of a Pelton wheel turbine. **(2)**

d) How will you control the load with the help of spear rod and deflector plate, explain with the help of neat sketches? **(2)**

e) Under what circumstances more than one nozzle should be used for Pelton wheel turbine? What are the disadvantages of such an arrangement? **(2)**

f) The following data refer to a Pelton wheel

4 nozzles each 50 mm in diameter. Reservoir head 300 m.

Head lost in friction 30m on 360m of pipe with $\lambda = 4f = 0.024$.

Bucket pitch circle diameter 0.83m.

Bucket speed is equal to 0.46 jet speed.

Bucket friction reduces the relative velocity by 15 percent

Angle through which the buckets deflect the Jet 165^{O}.

Mechanical efficiency 94 percent.

Determine :

i) The diameter of Penstock supplying the machine

ii) The speed of rotation

iii) The output power, and non dimensional specific speed. **(6)**

4. a) Why the modern Pelton wheel turbine are provided with double regulation? **(4)**

b) A single jet Pelton wheel uses 840 liters/s of water when the level in the reservoir is 255m above the centre line of the needle controlled nozzle. The efficiency of power transmission through pipeline and nozzle is 88%

The head is increased to 270 m, by raising the water level in reservoir and the needle in the nozzle is adjusted so that the power of the jet remains the same as before. Assuming that the velocity coefficient of the nozzle is 0.97 in both cases and that the loss of head in the pipeline is proportional in the pipeline is proportional to Q^2. Where Q is the quantity of water used in liters/s, find

i) the increase in efficiency of power transmission.

ii) the reduction in the quantity of water used. **(12)**

Unit - III

5. a) Explain the function of scroll casing (spiral casing), speed rings and wicket gates (guide vanes). **(6)**

b) The vertical shaft inward flow reaction turbine runner develops 12.5 MW and uses 12.3 m^3/s of water when the net head is 115 m. The runner has a diameter of 1.5 m and rotates at 430 rpm. Water enters the runner without shock with a velocity of flow of 9.6 m/s and passes from the runner to the draft tube without whirl, with a velocity of 7.2 m/s. The difference between the sum of the pressure head and potential heads at entrance to the runner and at entrance to the draft tube is 60 m.

Determine :

i) The loss of head in the runner

ii) The entry angle of the runner blades and

iii) The velocity and direction of water entering the runner from the fixed guide blades. **(10)**

6. a) What are the causes of cavitation? **(1)**

b) What do you mean by cavitation erosions? **(1)**

c) Describe stages of cavitation. **(1)**

d) Describe the methods for preventing cavitation. **(1)**

e) What is Thoma's cavitation factor? Explain its practical utility? **(1)**

f) Prove that $\sigma_c = \frac{H_a - H_{min} - H_s}{H}$ **(1)**

g) Draw different types of bell mouth shaped draft tubes. **(2)**

h) Explain the runner blade control mechanism of Kaplan turbine. **(2)**

i) Explain why the air valve mounted on the cover plate of Kaplan turbine? **(2)**

j) Describe briefly the choice between Kaplan and propeller turbines. **(2)**

k) What are the differences between Francis turbine and Kaplan turbine? **(2)**

Unit - IV

7. a) Explain the reason for fitting large air vessels on the suction and delivery pipes of a reciprocating pump close to the cylinder. **(2)**

b) Calculate the work saved in overcoming friction by fitting large air vessels near the suction and delivery valves of a reciprocating pump layout of the following specifications :

Pump is single cylinder and single acting : speed 60 rpm ; diameter of cylinder 200 mm; stroke 350 mm ; delivery pipe is 100 mm diameter 50 m long; and suction pipe is 150 mm diameter and 8 m long. Take $\lambda = 4f = 0.04$. **(10)**

c) Prove that for single acting reciprocating pump, the ratio of work done against friction without air vessel to with air vessel is given by $\left(\frac{2\pi^2}{3}\right)$. **(4)**

8. a) Define the following with reference to torque convertor, speed ratio, torque ratio, stall speed, design point, coupling point run away point and fluid drive efficiency. **(4)**

b) Define the followii g efficiencies of hydraulic ram D' Aubuissions and Rankine. **(2)**

c) Draw a neat sketch of jet pump uses a nozzle venturi design to pump water. **(4)**

d) In a hydraulic ram installation the supply pipe is 60 mm diameter and 4 m long ; the waste valve is 130 mm diameter, it has an effective lift of 6.4 mm, it weight 1.4 kg, and it makes 123 beats per minute. Estimate the discharge through the delivery pipe against a delivery head (above water level in supply reservoir) of 8 meters, neglecting all losses. **(6)**

Unit - V

9. a) What are trashracks? State their uses. How is the debris removed from the trashracks? What method is used in cold countries? **(4)**

b) What is a forebay? What is the difference between a forebay and a surge tank? **(3)**

c) Why is a surge tank necessary in case of high and medium head plants? **(3)**

d) How are hydroelectric power plants classified according to the utilization of water? **(3)**

e) What is the difference between run of river plants and storage plants? **(3)**

10. a) Discuss the advantages of hydroelectric power generation over thermal power generation. **(2)**

b) Differentiate between micro, mini and small hydel plants. **(4)**

c) Differentiate three types of bulb turbines

Bulb turbine, Pit turbine and Straflo turbine. **(4)**

d) Draw a neat sketch of Banki turbine. Why Banki turbine is ideally suited for micro hydel plants? **(4)**

e) What is the difference between dam and spillways? Draw line diagrams. **(2)**