TE-sem-VI - old-Mech - HM

10/5/16

QP Code : 29397

(3 Hours) **[Total Marks : 100**

Instructions to candidates:

1. Q.No.1 is compulsory.
2. Answer any 4 of the remaining questions
3. Assume suitable data , if necessary

Q.No.1 Answer the following 20

(a) Compare the operating characteristics of the Kaplan turbine, Francis turbine and Pelton turbine. How do operating characteristics influence the selection of turbines in a power station ?

(b) What is negative slip in a reciprocating pump. When does it occur?

(c) What are the functions of stay vanes and guide vanes in a reaction turbine

(d) Discuss series and parallel operation of pumps.

Q.No.2

08

(a) Prove that the work done per unit weight for a turbine can be expressed as :

$$\text{Work done/unit wt} = \frac{V_1^2-V_2^2}{2g} + \frac{U_1^2-U_2^2}{2g} + \frac{Vr_2^2-Vr_1^2}{2g}$$

Draw the velocity triangles

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(b) In a water turbine installation for low head duties, the placement of the turbine above the tail water level is fixed on the basis of Thoma's cavitation parameter 'σ' which is dependent on the specific speed of the turbine as follows:

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Ns (Specific speed)	300	385	514	685	856
σ	0.4	0.5	0.75	1.2	1.4

The turbine is a vertical shaft unit developing 18400 KW under a net head of 14m. The runner has a peripheral velocity of 28 m/s. What would be the minimum diameter of the runner if the turbine were placed (i) 2m above the tail water level and (ii) 2m below the tail water level. The vapour pressure of water is 0.03 Kg per sq.cm (abs) and the atmospheric pressure head is 10.3 m of water column.

Q.No.3 14

(a) A centrifugal pump running at 1440 rpm gave the following results on a test bed

Discharge (litres per sec)	0	75	150	225	300
Head (m)	22.9	22.6	21.9	19.8	14.3

The pump is connected to a 200 mm suction and delivery pipe of total length 150m. The pump delivers to a tank which is 16 m above the sump level. The friction factor for the pipe is 0.025. Determine the operating point of the pump. The flow is to be reduced to 50% of that at the operating point by using a throttle valve in the delivery pipe. What will be the head developed by the pump in this case? What is the head and power lost in the throttle valve? Plot all the relevant points on the Head vs. Discharge graph.

06

(b) Explain the function of a draft tube in a reaction turbine. Discuss the different types of draft tubes normally used in practice and their relative performance.

Q.No.4 10

(a) Each unit of a hydroelectric scheme has two Pelton wheels fitted on the same shaft each operating with a single nozzle. The unit generates 50000 KW under a head of 870 m. Assuming coefficient of velocity for nozzles as 0.98, speed ratio as 0.46 and overall efficiency as 90% find:

(i) The diameter of the jet

(ii) Total flow in litres /sec

If the jet ratio is not to be less than 12, find the synchronous speed at 50 cycles per frequency and the corresponding diameter of the runner

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(a) The following particulars refer to a reciprocating pump

Diameter of cylinder	14 cms
Stroke	30 cms
Speed	70 rpm
Suction pipe diameter	100 mm
Atmospheric pressure	750 mm of mercury
Vapor pressure of water	0.8 m of water column absolute

If the length of the suction pipe exceeds the static suction lift by 1.5 m, find the limiting value of the static suction lift to avoid cavitation. Draw the indicator diagram

Q.No.5

08

(a) Derive an expression for the pressure rise within the impeller and discuss the influence of the blade angle at exit 'β_2' on the pressure rise. What are the limitations on lowering the value of β_2 to very small values.

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(b) The following details relate to an inward flow reaction turbine

Net head	20m
Inlet diameter of runner	600 mm
Exit diameter of runner	300 mm
Runner width at inlet	150 mm
Runner rpm	425

Flow velocity through runner is constant at 2.5 m/s

Runner inlet is 2.5 m above tail water level and exit is 2.1 m above tail water level.

Guide blade angle	12^0
Velocity at draft tube exit	1.3 m/s
Head lost in draft tube	0.2 m

Head lost in casing and guide vanes = head lost in runner

Mechanical efficiency	95 %

Volumetric efficiency is 100%

The exit is without whirl. Draw the velocity triangles at inlet and exit and determine the following:

(i) Pressure at runner inlet and exit

(ii) Power developed by the runner

(iii) Hydraulic efficiency of the turbine

Q.No.6

08

(a) A centrifugal pump has a specific speed of 42. It works at its design point of 85m and 50 lps of water.. Its overall efficiency is 75%. Calculate its speed in rpm and the input power required. If the blade exit angle is 30 degrees and the flow velocity at exit is 0.15 times the peripheral velocity at the exit of the impeller, find the impeller diameter assuming a manometric efficiency of 85%

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(b) A Kaplan turbine operates under a head of 5.5 m. The runner has four aerofoil shaped blades and rotates at 75 rpm. The mean radius of the blade circle is 1.6 m and the blade length in the radial direction is 600 mm. The length of chord is 2.6 m and the chord line is inclined at 30^0 to the direction of rotation of the blades.

The velocity of flow is 5 m/s. Calculate the power developed by the turbine and its theoretical efficiency if the C_L and C_D for the blades are 0.8 and 0.05 respectively. The blades occupy 5 % of the circumferential area. Plot the velocity triangles.

Q.No.7 Answer the following

08

(a) A quarter scale turbine model is tested under a head of 10.8 m. The full scale turbine is required to work under a head of 30m and to run at 7.14 rev/sec. At what speed must the model be run? If it develops 100 KW and uses 1.085 m^3/s of water, what power will be obtained from the full scale turbine. The efficiency of the full scale turbine is 3% higher than the model efficiency. What is the specific speed of the full scale turbine?

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(b) Discuss the various factors to be considered in selection of a turbine for a given installation

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(c) Why are blades of a centrifugal pump curved backwards? How does the blade angle influence the head vs. discharge and the Power vs. discharge characteristics

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