

Duration 3 hrs

Total marks assigned to the paper 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

- (a) What is priming? Why do centrifugal pumps have to be primed before starting? What will happen if the pump is not primed?
- (b) What are the factors to be considered in selection of a hydro turbine for a given site?
- (c) Define unit quantities in a turbine and derive expressions for unit speed, unit discharge and unit power
- (d) What is axial thrust in centrifugal pumps? What are the different methods employed to counter the effects of axial thrust

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Q.No.2

- (a) In a vertical shaft inward-flow reaction turbine the sum of the pressure and kinetic heads at the entrance to the spiral casing is 118 m. The spiral casing inlet is 4 m above the tail race level. The runner has a peripheral velocity of 35 m/s and the discharge from the runner is without any whirl. The velocity of flow through the impeller is constant at 8.5 m/s. The hydraulic losses are as follows:

- Casing and guide vane losses : 4.6 m
- Runner losses : 8.5 m
- Draft tube losses : 0.9 m
- Kinetic energy rejected to the tail race : 0.48 m

Draw the velocity triangles at inlet and exit

Determine the guide vane angle and the runner blade angle at the inlet and the pressure heads at entry to and exit from the runner

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- (b) What is NPSH ? Explain the difference between available and required NPSH. How is the cavitating and non-cavitating region of operation of a centrifugal pump determined?

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Q.No.3

- (a) A centrifugal pump has the following characteristics:

Q (m ³ /hr)	0	23	46	69	92	115
H (m)	17	16	13.5	10.5	6.6	2
Eff (%)	0	49.5	61	63.5	53	10

The pump is used to pump water over a static head of 8 m through a pipe 800 m long and 150 mm in diameter. The friction factor for the pipe is 0.025

($h_f = f l v^2 / 2 g d$). Determine the operating point of the pump and the input power requirement.

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- (b) Derive an expression for the specific speed of a hydro turbine. How does the specific speed of a turbine influence its cavitation characteristics?

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Q.No.4

- (a) A single acting reciprocating pump having a bore and stroke of 200 mm and 400 mm respectively runs at 20 rpm. The static suction lift is 3.6 m, the suction pipe length and diameter are 9.1 m and 100 mm respectively. There is no air vessel on the suction side. The discharge pipe is 100 mm in diameter and 470m long. The static delivery head is 15.2 m and an air vessel is fitted 15 m from the pump. Assuming SHM for the piston and taking friction factor 0.028 for all the pipes calculate the cylinder pressures at the start, middle and end of the suction and discharge strokes. Take atmospheric pressure as 10.33 metres of water column. Draw the indicator diagram.

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- (b) What is governing of turbines ? With the help of a sketch explain how governing of Kaplan turbine is done

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Q.No.5

(a) A single jet Pelton turbine operates under a head of 495 m. The jet diameter is 15 cms. The shaft rotates at 380 rpm and the mean runner diameter is 2.25 metres. The flow over the buckets is deflected through 165° . The Cv for nozzle is 0.98 and the mechanical losses are 2.5% of the power supplied. The relative velocity of water is reduced by 15% while passing over the buckets. Calculate the following:

- i) The input power
- ii) the force on the buckets
- iii) The power output and the hydraulic efficiency
- iv) The overall efficiency

Draw the velocity triangles

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(b) It is stated that the draft tube enables a reaction turbine to be placed above the tail water level without loss of effective head. Explain this with the help of appropriate equations.

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Q.No.6

(a) The critical Thoma cavitation parameter ' σ_{cr} ' for a reaction turbine varies in the following manner with the specific speed:

Ns (power is in KW)	0	50	100	150	200	250
σ_{cr}	0	0.04	0.1	0.18	0.28	0.41

The turbine operates under a net head of 50 m and generates 2 MW of power while running at 290 rpm. If the vapour pressure of water is 0.052 kg/cm^2 (abs) and the atmospheric pressure is equivalent to 755 mm of Hg what is the maximum safe height to which the runner can be placed with reference to the tail water level(TWL).If the runner is placed 5 m above the TWL will it cavitate?

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- (b) Plot the performance characteristics of a reciprocating pump and explain the nature of the characteristic curves

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Q.No.7

- (a) A centrifugal pump delivers 120 litres/sec of fuel oil of specific gravity 0.85 at a pressure of 200 KPa while running at 1000 rpm

The impeller inlet diameter 200 mm

Impeller exit diameter 400 mm

Blade width at inlet 50 mm

Blade width at exit 25 mm

10% of the flow area is blocked by blade thickness

The manometric efficiency of the pump is 85% and the overall efficiency is 70 %. Determine the following:

- (i) Impeller inlet and outlet angles
(ii) Power required to drive the pump

Draw the velocity triangles

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- (b) Why are pressure recuperating devices used in centrifugal pumps? Describe the commonly used pressure recuperating device. Draw neat sketches of the same

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