sem VI / mech / 30-11-11 / Hydraulic machinery-

,n. 5986-11.

MP–3493

(3 Hours) [ Total Marks : 100

N.B. : (1) Question No. 1 is **compulsory**.
(2) Attempt any **four** questions out of remaining **six** questions.
(3) **Figures** to the **right** indicate **full** marks.
(4) Assume **suitable** data if **necessary**.



Q.1 (A) Enumerate advantages of hydropower plant over other types of power plants. 05

(B) Define terms 'unit power', 'unit discharge', 'unit speed' and 'specific speed' with respect to hydraulic turbine 05

(C) Why is it that the speed of a reciprocating pump without air vessel is not high? Explain with indicator diagram. 05

(D) Explain methods to balance axial and radial thrust in centrifugal pump 05

Q. 2(A) The three jet Pelton turbine is required to generate 10000 KW under a net head of 400 m. The blade angle at outlet is $15^0$ and the reduction in the relative velocity while passing over the blade is 5%. If the overall efficiency of the wheel is 80%, $C_v$=0.98 and speed ratio=0.46, then find: (i) the diameter of the jet (ii) total flow in $m^3/s$ and (iii) the force exerted by a jet on the buckets. If the jet ratio is not to be less than 10, find the speed of the wheel for a frequency of 50 hertz/sec and the corresponding wheel diameter. 14

(B) Discuss the influence of the exit blade angle on the performance of a centrifugal pump. Assume radial flow at entrance. Support your conclusion on head Vs discharge plot. 06

Q.3 (A) In an inward flow reaction turbine (vertical shaft) the sum of the pressure and kinetic heads at entrance to the spiral casing is 132 m and vertical distance between this section and the tail race level is 3.3 m. The peripheral velocity of the runner at entry is 33 m/s, the radial component of velocity of water (velocity of flow) is constant at 11 m/s and the discharge from the runner is without whirl, i.e. radial discharge. The hydraulic losses are: (a)losses between turbine entrance and discharge from guide vanes = 4.95 m, (b) losses in the runner = 8.8 m, (c) losses in the draft tube = 0.88 m, (d) kinetic energy rejected to the tail race = 0.55 m, Determine: 14

(i) The guide vane angle and the runner blade angle at inlet;

(ii) The pressure heads at entry to and discharge from the runner.

(B) Explain working of gear pump with neat sketch 06

Q. 4(A) The following data pertain to a Kaplan turbine: 12

Power available at shaft = 22500 KW; Head = 20 m; Speed = 150 rpm. Hydraulic efficiency = 95 %; Overall efficiency = 88%; Outer diameter = 4.5 m; Diameter of the hub = 2 m. Assuming that the turbine discharges without whirl at exit, determine the runner vane angles at the hub and at the outer periphery.

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(B) A single acting reciprocating pump has a stroke length of 15 cm. The suction pipe is 7 meters long and the ratio of the suction diameter to the plunger diameter is ¾. The water level in the sump is 2.5 meters below the axis of the pump cylinder, and the pipe connecting the sump and pump cylinder is 7.5 cm diameter. If the crank is running at 75 rpm, determine the pressure head on the piston: 08

(i) in the beginning of the suction stroke (ii) in the middle of the suction stroke. Take coefficient of friction as 0.01.

Q.5(A) The critical Thoma cavitation parameter 'σ' for a certain type of turbine varies in the following manner: 10

| Ns (power in KW) | 0 | 50 | 100 | 150 | 200 | 250 |
|---|---|---|---|---|---|---|
| $\sigma_{cr}$ | 0 | 0.04 | 0.1 | 0.18 | 0.28 | 0.41 |

The turbine runs at 300 rpm under a net head of 50 m and produces 2MW of power. If the runner is placed 4.7 m above the tail water level, will the turbine cavitate? Take saturation vapour pressure to be 0.04 bar absolute and atmosphere pressure to be equivalent to 10.3 m of water. What is the maximum safe height at which the turbine can be placed with reference to the tail race level?

(B) A centrifugal pump discharges 0.15 $m^3/s$ of water against a head of 12.5 m, the speed of the impeller being 600 rpm. The outer and inner diameters of impeller are 500 mm and 250 mm respectively and the vanes are bent back at $35^0$ to the tangent at exit. If the area of flow remains 0.07 $m^2$ from inlet to outlet, calculate: (i) Manometric efficiency of the pump, (ii) Vane angle at inlet, and (iii) Loss of head at inlet to impeller when the discharge is reduced by 40% without changing the speed. 10

Q.6 (A) Test on single stage centrifugal pump at 1450 rpm gave the following results:- 14

| Q ($m^3/s$) | 0 | 0.006 | 0.012 | 0.018 | 0.024 | 0.030 | 0.036 |
|---|---|---|---|---|---|---|---|
| H (m) | 22.6 | 21.9 | 20.3 | 17.7 | 14.2 | 9.7 | 3.9 |

When two such identical pumps are connected in parallel, the flow rate through the system is the same as when they are connected in series. Determine the flow rate that the individual pump would deliver if connected to the same system. Assume that the system characteristic is purely resistive with no static lift.

(B) Distinguish clearly between NPSH available and NPSH required and discuss the various factors that affect them. Show both the NPSH characteristics graphically and indicate the cavitating and non-cavitating zones. 06

Q.7 (A) Write short note on (i) Self priming pump (ii) Determination of number of buckets on Pelton wheel. 10

(B) A 1/5 scale turbine model is tested under a head of 15 m. The actual turbine will work under head of 30 m and speed of 450 rpm. If model develops 100 KW of power using 1.1 $m^3/s$ of water, then calculate: (i) speed of the model turbine (ii) Power developed by prototype 05

(C) Explain working principle of air vessel with a neat sketch. 05