TE-sem-VI-OH-Mech.

HM

19/11/15

QP Code : 1855

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

Note : 1. Question number 1 is **compulsory**
2. Solve any **four** questions from remaining **six** questions
3. **Assume** suitable data if required.
4. Assumptions made should be clearly stated.
5. Use of **Calculator** and **Graph** paper is **allowed**.

Q.1. **(a)** Write a short note on performance characteristic of Reciprocating pump. **05**

(b) What are multistage pumps? Discuss the variation of pressure and velocity in successive stages in multistage pumps. **05**

(c) Define terms unit power, unit discharge, unit speed specific speed with respect to turbine. **05**

(d) If reaction turbine generates 10 MW power and degree of reaction is 65%. What is mean by this statement? **05**

Q.2. **(a)** A Pelton wheel is to be designed for the following conditions: **10**

Power to be developed = 8 MW; Net head available = 300 m;

Speed of the wheel = 600 rpm ; Speed ratio =0.46;

Jet ratio = 8 ; Mechanical efficiency = 90% ; C_v of nozzle =0.98 ;

Calculate:

i) The number of jets required.

ii) The diameter of jet and wheel.

iii) Quantity of water required.

(b) Prove that manometric head of centrifugal pump may be written in the form, **10**

$$H_m = AN^2 + BNQ - CQ^2$$

where, N= Speed, Q = Discharge, A, B and C are constant.

State the assumptions made.

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Q.3. (a) A vertical shaft inward flow reaction turbine runs at 215 rpm and uses 10.2 m^3/s of water, when the net head is 20.4 m. The hydraulic efficiency is 90%. The inlet angle of the runner vanes is 112^0, measured from the direction of runner speed. Water enters the runner without shock with a velocity of flow of 7.3 m/s and enters the draft tube without whirl with velocity of 6.1 m/s. The discharge velocity from the draft tube is 2.4 m/s. The mean height of runner entry surface and entrance to the draft tube are 1.5 m and 1.2 m respectively above the tail race level. Find: 14

i) Diameter of runner entry surface.
ii) Specific speed of the runner
iii) The pressure head at the entrance to the runner and entrance to draft tube, assuming that the loss of head due to friction is 0.9 m in the runner and 0.6 m in the draft tube.

(b) Explain methods to balance axial and radial thrust in centrifugal pump. 06

Q.4. (a) A Kaplan turbine is fitted with four aerofoil blades and has a speed of 120 rpm. The mean radius of blade circle is 1.5 m and the blade length in radial direction is 0.5 m. The chord of the aerofoil blade is inclined at 25^0 to the direction of motion. The chord length is 2.5 m. The values of C_L and C_D for the angle of incidence used are 0.7 and 0.04 respectively. The turbine is supplied with water under a head of 8 m neglecting the areas occupied by the blade thickness and assuming a velocity of flow at 5 m/s. Calculate the power developed and theoretical efficiency of turbine. 12

(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 aqnd non-cavitating zones. 08

Q.5. (a) Calculate the least diameter of centrifugal pump to just start delivering water to an actual height of 30 m, if the inside diameter of impeller is half of outside and pump runs at 1000 rpm. 05

(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 m. If model develops 100 Kw of power using 1.1m^3/s of water then calculate: 05

i) Speed of the model, ii) Power developed by prototype

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(c) Write short notes on: (ANY TWO) 10

i) Air vessel used in reciprocating pump.

ii) Constant head characteristic curves of Pelton wheel.

iii) Application of CFD in turbines.

Q.6. (a) A plant is located at an elevation of 100 m mean sea level. The average water temperature is 25^0 C. The turbine develops 36760 KW at 115 rpm under a head of 40 m. Calculate the maximum allowable suction head for the draft tube. 10

Given:

σ	0.5	0.4	0.2	0.1	0.05	0.03
N_s	515	400	267	182	129	98
Barometric head (m)	6.5	7.25	8.5	9.0	9.75	10
Vapour pressure (KPa)	38.8	31.4	15.8	9.6	4.8	1.7

(b) A single acting reciprocating pump has a stroke length of 15 cm. The suction pipe is 7 m long and the ratio of the suction diameter to the plunger diameter is 3/4 . The water level in the sump is 2.5 m below the axis of the pump cylinder and the pipe connecting the sump. The pump cylinder is 7.5 cm diameter. If the crank is running at 75 rpm, determine the pressure head on the piston taking coefficient of friction as 0.01; 10

i) in the beginning of the suction stroke

ii) ii) in the middle of the suction stroke

Q.7. (a) In a water power site the available discharge is 340 m^3/s under a net head of 30 m. Assuming a turbine efficiency of 88% and rotational speed of 166.7 rpm, determine the number of machines all of the same size that may be installed if the selection rests with 08

i) Francis turbine with N_s not greater than 230.

ii) Kaplan turbine with N_s not greater than 685.

What will the output of each unit? Which of the two installations will be more economical?

(b) A centrifugal pump is used to pump water from a low to high reservoir having water level of 32 m. Total length of pipe is 1000 m with a friction factor F=0.020 and its diameter is 200 mm. Neglecting all losses except friction, determine the rate of flow between the reservoirs and power required to drive the pump. The characteristics of the pump are as follows: 12

$Q\ (m^3/hr)$	0	46	92	138	184	230
H_m (m)	68	64	54	42	26.4	8
η_0 (%)	0	49.5	61	63.5	53	10