KR-8639

(3 Hours) [Total Marks : 100

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

1. Answer any **four** of the following questions :— 20
   (a) Explain the function of draft tube.
   (b) What are the different efficiencies of a centrifugal pump ?
   (c) Why is a reciprocating pump called positive displacement pump ?
   (d) What are the limitations of pelton wheel turbine ?
   (e) Define specific speed, unit speed and unit power as applied to hydraulic machines.

2. (a) What are the essential components and their functions of a Pelton Wheel turbine. 8
   (b) The water available for a Pelton wheel is 4 m³/s and the total head from the reservoir 12
   to the nozzle is 250 m. The turbine has two runners with two jets per runner.
   All the four jets have the same diameters. The pipe is 3 km long. The efficiency
   of transmission through the pipeline and the nozzle is 91% and efficiency of each
   runner is 90%. The velocity co-efficient of each nozzle is 0·975 and co-efficient
   of friction '4f' for the pipe is 0·0045.
   Determine :—
        (i) The power developed by the turbine
        (ii) The diameter of the jet
        (iii) The diameter of the pipeline.

3. (a) What is the difference between Francis turbine and Kaplan turbine ? 8
   (b) Water flows through a vertical Francis turbine at the rate of 15·5 m³/s and makes 12
   its runner to rotate at 428·4 rpm. The velocity and the pressure head at the inlet
   of the spiral casing are 8·5 m/s and 240 m respectively and the centre line of its
   inlet is 3 m above the tail race level. The diameter and the width of the runner
   at inlet are 2 m and 300 mm respectively. If the hydraulic and overall efficiencies
   of the turbine are 93% and 90% respectively.
   Determine :—
        (i) Output power
        (ii) Guide vane angle
        (iii) Runner blade angle at inlet.

4. (a) What are the causes of cavitation ? How will you prevent cavitation in 12
   hydraulic turbines ?
   (b) A Kaplan turbine is to develop 20 MW when running at 240 rpm under a net head 8
   of 45 m. In order to predict its performance, a model to a scale of 1/7 is tested
   under a net head of 20 m. At what speed should the model run, and what power
   would it develop ? If the overall efficiency of the model were found to be 84%,
   at the best operating point, what quantity of water would the model and the full
   scale turbine require. **[TURN OVER**

5. (a) Show that the rise of pressure in the impeller of a centrifugal pump when frictional   **8**
    and other losses in the impeller are neglected is given by :

$$\frac{1}{2g}\left[vf_1^2 + u_2^2 - vf_2^2 \cosec^2 \phi \right]$$

    where vf_1, vf_2 = Velocities of flow at inlet and outlet respectively.
    u_2 = Tangential velocity of impeller at outlet.
    ϕ = Vane angle at outlet.

  (b) The impeller of a centrifugal pump having external and internal diameters   **12**
    500 mm and 250 mm respectively, width at outlet 50 mm and running at 1200
    rpm works against a head of 48 m. The velocity of flow through the impeller is
    constant and equal to 3 m/s. The vanes are set back at an angle of 40° at outlet.
    Determine :—
      (i)   Inlet vane angle
      (ii) Work done by the impeller on water per second
      (iii) Manometric efficiency.

6. (a) Explain the performance characteristic curves of centrifugal pump.   **8**
  (b) A centrifugal pump is used to pump water from a low to high reservoir having   **12**
    water level of 32 m. The total length of pipe is 1000 m with a friction factor
    '4f' = 0·020 and its diameter is 200 mm. Neglecting all losses except friction,
    determine the rate of flow between the reservoirs and the power required to drive
    the pump. The characteristics of the pump are as follows :

Q (m³/n)	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

7. (a) What is an indicator diagram ? What is its importance in reciprocating pumps ?   **8**
  (b) A single acting reciprocating pump has a diameter (piston) of 150 mm and stroke   **12**
    length 350 mm. The centre of the pump is 3·5 m above the water surface in the
    sump and 22 m below the delivery water level. Both the suction and delivery
    pipes have the same diameter of 100 mm and are 5 m and 30 m long respectively.
    If the pump is working at 30 rpm.
    Determine :—
      (i)   The pressure heads on the piston at the beginning, middle and end of
            both suction and deliery strokes.
      (ii) The power required to drive the pump.
            Take atmospheric pressure as 10·3 m of water.