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BT-5 / D-17

FLUID MACHINES

Paper–ME-303E

Time allowed : 3 hours] *[Maximum marks : 100*

Note :- *Attempt five questions, selecting at least one question from each unit. Assume any missing data suitably.*

Unit–I

1. (i) Derive an expression for the efficiency of a curved radial vane. 10

   (ii) A jet of 50 mm diameter impinges on a curved vane and is deflected through an angle of 175°. The vane moves in the same direction as that of the jet with a velocity of 35 m/s. If the rate of flow is 170 litres per second, determine the component of force on the vane in the direction of motion. How much would be the power development by the vane and what would be the water efficiency? Neglect friction. 10

2. The discharge Q of a centrifugal pump depends upon the mass density of the fluid (ρ), the speed of the pump (N), the diameter of the impeller (D), the manometric head (H_m) and the viscosity of the fluid (μ). Show that 10

$$Q = ND^3 \phi\left(\frac{gH}{N^2D^2}, \frac{\mu}{\rho ND^2}\right)$$

Unit–II

3. A Pelton wheel of 1.1 m mean bucket diameter works under a head of 500 m. The deflection of jet is 165° and its relative velocity is reduced over the bucket by 15 percent due to friction. If the diameter of jet is 100 mm and the water is to leave the bucket without any whirl, determine: 20

   (i) Rotational speed of the wheel.

   (ii) Ratio of bucket speed to jet velocity.

   (iii) Impulsive force and power developed by the wheel.

   (iv) Available power (water power)

   (v) Power input to buckets, and

   (vi) Efficiency of the wheel with power input to bucket as reference input.

   Take $C_v = 0.97$

4. (i) What is the difference between a propeller and a Kaplan turbine? 5

   (ii) The following data pertain to a Kaplan turbine:

   Power available at shaft = 22500kW

   Head = 20 m

   Speed = 150 r.p.m.

   Hydraulic efficiency = 95%

   Overall efficiency = 88%

   Outer diameter of runner = 4.5m

Diameter of the hub = 2 m.

Assuming that the turbine discharges without whirl at exit, determine vane angles at the hub and at the outer periphery.

Unit–III

5. The following data refer to a radial, single stage, double suction, centrifugal pump: 20

Discharge at the pump outlet = 90 litres/sec

Diameter at inlet = 100 mm

Diameter at outlet = 290 mm

Head = 36 m

Speed of impeller = 1750 r.p.m.

Width at inlet = 25 mm per side

Width at outlet = 23 mm in total

Overall efficiency = 60 percent

Leakage losses = 2.7 litres / sec

Mechanical losses = 1.5 kW

Contraction factor due to vane thickness = 0.87

Outlet vane angle = 27°

Assuming that water enters the impeller at inlet radially, determine:

(i) The inlet vane angle.

(ii) The angle at which water leaves the wheel.

(iii) The speed ratio

(iv) The absolute velocity of water leaving the impeller.

(v) The manometric efficiency.

(vi) The volumetric efficiency.

(vii) The mechanical efficiency.

6. The bore and stroke of a reciprocating pump are 250 mm and 500 mm respectively. The pump delivers water through a 100 mm delivery pipe to a tank located at 14 m above it and 27 m horizontally from it. If separation occurs at a pressure of 22 kN/m^2 absolute, find the safe speed at which the pump should run for the following arrangements of delivery pipe:

(i) The delivery pipe is horizontal from the pump and then vertical upto tank and

(ii) The delivery pipe is vertical from the pump and then horizontal upto the tank.

The atmospheric pressure at the pump side = 10.3 m of water and connecting rod-crank ratio = 5.

Unit–IV

7. (i) What is cavitation? How can it be avoided in reaction turbines? 10

(ii) Explain with the help of a neat sketch the construction and working of airlift pump. 10

8. Describe with the aid of a neat sketch the construction and working of a hydraulic ram. Also discuss the working cycle of a hydraulic ram.