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(v)Kaplan turbine is a

- (a) impulse turbine
- (b) reaction turbine
- (c) may either impulse or reaction turbine
- (d) none of the above.

(vi) For an axial flow pump

- (a) head is high and discharge is low
- (b) discharge is high and head is low
- (c) both head and discharge are very high
- (d) both head and discharge are very low.

(vii)

gH $\frac{S}{N^2 D^2}$ is known as (a) Head coefficient (c) Flow coefficient

(b) Power coefficient (d) None of these.

- (viii) Cavitation in a centrifugal pump is likely to occur at the (a) outlet to the pump (b) inlet to the pump (c) both inlet and outlet to the pump (d) none of the above
- The indicator diagram of a reciprocating pump is a plot of (ix) (a) work done vs stroke length
 - (b) acceleration head vs stroke length
 - (c) angular displacement *vs* stroke length
 - (d) pressure head vs stroke length.
- (x) In a reciprocating pump without air vessel, the acceleration head in the suction pipe is maximum at the crank angle θ = (a) 0⁰ (b) 90° (c) 135° (d) 180⁰.

Group - B

- Stating the assumptions, derive an expression for the ideal head 2. (a) developed by the impeller of a centrifugal pump.
 - Show that the pressure head rise in the impeller of a centrifugal (b)pump with no swirl at inlet, and no frictional and other losses in the impeller, is given by

 $\frac{1}{2\sigma} \left[V_{f1}^2 + U_2^2 - V_{f2}^2 \cos ec^2 \beta_2 \right] \text{ where } V_{f1} \text{ and } V_{f2} \text{ are velocity of }$

flow at inlet and outlet respectively, β_2 is the blade angle at outlet.

6 + 6 = 12

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- A centrifugal pump is running at 1000 r.p.m. The outlet blade angle 3. (a) of the impeller is 30^o and velocity of flow at outlet is 3m/s. The pump is working against a total head of 30m and the discharge through the pump is $0.3m^3/s$. If the manometric efficiency of the pump is 75%, determine at outlet (i) the diameter of the impeller and (ii) the width of the impeller.
 - (b) What is priming of a centrifugal pump? What is its importance? 8 + 4 = 12

Group - C

- Which type of turbine is best suited for changing load condition and 4. (a) whv?
 - An inward flow Francis turbine has a diameter of 1.4 m and rotates (b) at 430 rpm. Water enters the runner without shock with a flow velocity of 9.5 m/s and leaves the runner without whirl with an absolute velocity of 7 m/s. The total head difference between the runner entry and exit is 62 m. The turbine develops 12.25 MW. The flow rate through the turbine is $12 \text{ m}^3/\text{s}$ for a net head of 115 m. Find, (i) absolute velocity of water at the runner entry and guide vane exit angle. (ii) runner blade angle at the runner entry. (iii) loss of head in the runner.

3 + 9 = 12

- 5. (a) What are the differences between an impulse and reaction turbine?
 - (b) A Pelton wheel has a mean bucket speed of 10m/s and is supplied with water at a rate of $0.7m^3/s$ under a head of 30m. If the jet is deflected by the buckets at an angle of 150°, find (a) the hydraulic efficiency of the turbine. (b) the wheel efficiency. The coefficient of velocity C_v = 0.92. Neglect blade friction loss.

4 + 8 = 12

Group - D

- Draw and discuss main characteristics, operating characteristics and 6. (a) constant efficiency curves of a centrifugal pump.
 - A centrifugal pump is to deliver water from a tank against a static lift (b) of 40m. The suction pipe is 50m long and 25 cm diameter and friction factor f = 0.02. The delivery pipe is of 20cm diameter, 1600m long and friction factor f = 0.022.

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The pump characteristics is given as $H_P = 100 - 6000Q^2$ where H_p = Pump head in metres and Q= discharge in m³/s. Neglecting the minor losses, calculate the operating head and discharge of the pump.

6 + 6 = 12

- 7. (a) Define unit speed, unit discharge and unit power in case of a turbomachine and deduce the expression for those terms.
 - A turbine develops 8000 kW when running at 100 r.p.m. The head on (b) the turbine is 30m. If the head is reduced to 18m, determine the speed and power developed by the turbine.

6 + 6 = 12

Group - E

For a single acting reciprocating pump derive the expression 8. (a) $(h_a)_{\max} = \frac{l}{g} \times \frac{A}{a} \omega^2 r$

where the symbols have their usual meanings.

A double acting reciprocating pump running at 40 rpm, is (b) discharging 1.0 m³ of water per minute. The pump has a stroke of 400 mm. The diameter of the piston is 200 mm. The delivery and suction head are 20 m and 5 m respectively. Find the slip of the pump and power required to drive the pump.

7 + 5 = 12

- Write a short note with schematic diagram on 'Air Vessels' used in 9. (a) reciprocating pump.
 - (b)A single acting reciprocating pump has a stroke length of 15cm. The suction pipe is 7m long and the ratio of the suction pipe diameter to the plunger diameter is 3: 4. The water level in the sump is 2.5m below the axis of the pump cylinder and the pipe connecting the sump and pump cylinder is 7.5cm diameter. If the crank is running at 75 r.p.m, determine the pressure head on the piston in the beginning of the suction stroke. Take coefficient of friction as 0.01.

5 + 7 = 12

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FLUID MACHINERY (MECH 2201)

Time Allotted : 3 hrs

Full Marks: 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group - A (Multiple Choice Type Questions)

1. Choose the correct alternatives for the following:

 $10 \times 1 = 10$

- (i) Rotodynamic Pump is a device in which
 - (a) mechanical energy is transferred to the working fluid from the rotor
 - (b) mechanical energy is transferred from the working fluid to the rotor
 - (c) mechanical energy remains constant at all points in the fluid (d) none of the above.
- In a centrifugal pump the inlet blade angle will be designed to have (ii) (a) relative velocity vector in the radial direction
 - (b) absolute velocity vector in the radial direction
 - (c) velocity of flow to be zero

(d) peripheral velocity to be zero.

(iii) The mechanical efficiency of a centrifugal pump takes into account the losses in

(a) pump impeller	(b) bearings and windage
(c) pipes	(d) all of the above.

- Two hydraulic turbines are similar and homologous when they are (iv) geometrically similar and have the same (a) unit speed (b) Froude number
 - (c) specific speed
 - (d) rotational speed.

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