

FLUID MACHINERY
(MEC2202)

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group - A

1. Answer any twelve:

$12 \times 1 = 12$

Choose the correct alternative for the following

- (i) Which of the following pump is preferred for flood control and irrigation application?
 - (a) centrifugal pump
 - (b) axial flow pump
 - (c) mixed flow pump
 - (d) reciprocating pump
- (ii) The efficiency of a centrifugal pump is maximum when its blade are
 - (a) straight
 - (b) bent backward
 - (c) bent forward
 - (d) bent forward first and then backward
- (iii) Muschel curves belong to the category of
 - (a) main characteristic curves of a turbine
 - (b) operating characteristic curves of a turbine
 - (c) constant efficiency curves of a turbine
 - (d) operating characteristics of a pump
- (iv) When the diameter of a centrifugal pump impeller is doubled but the discharge is to remain same, then the head needs to be reduced by
 - (a) 4 times
 - (b) 16 times
 - (c) 8 times
 - (d) 20 times
- (v) Two hydraulic pumps are similar and homologous when they are geometrically similar and have the same
 - (a) unit speed
 - (b) Froude number
 - (c) specific speed
 - (d) rotational speed
- (vi) To avoid shock at entrance and exit, the relative velocities at entrance and exit namely V_{r_1} and V_{r_2} must be
 - (a) radial
 - (b) tangential
 - (c) axial
 - (d) none of these

Fill in the blanks with the correct word

- (xi) Axial flow pump has low head and _____ discharge.
- (xii) For operating characteristics of centrifugal pump, the parameter that is kept constant, is _____.
- (xiii) The draft tube in reaction turbine is used to convert K.E. to _____ head.
- (xiv) Unit speed is the speed of a turbine when it is working under unit _____.
- (xv) In a reciprocating pump without air vessel, the friction head in the delivery pipe is maximum at the crank angle $\theta =$ _____.

Group - B

2. (a) Define and explain the terms suction head, delivery head, static head and manometric head. *[(CO2)(Understand/LOCQ)]*

(b) The internal and external diameters of a centrifugal pump are 20 cm and 40 cm respectively. The pump is running at 1200 r.p.m. The vane angles of the impeller at inlet and outlet are 20° and 30° respectively. The water enters the impeller radially and velocity of flow is constant. Determine the work done by the impeller per kg of water. *[(CO3)(Apply/IOCQ)]*

6 + 6 = 12

3. (a) Compare with practical applications between centrifugal, mixed flow and axial flow pump. *[(CO1)(Understand/LOCQ)]*

(b) A centrifugal pump has an impeller of 0.5 m outer diameter and when running at 600 rpm discharges 9000 lpm against a head of 11.0 m. The water enters the impeller radially without whirl. The inner diameter is 0.15 m. The vanes are set back at an angle of 28° to the tangent at the periphery of the outlet. The area of flow is constant from inlet to outlet of the impeller and is 0.05 m^2 . Determine the

- (i) vane angle at inlet,
- (ii) manometric efficiency of the pump,
- (iii) Euler head when the pump is running in reverse direction at 600 rpm.

[(C03)(Apply/IOCQ)]
6 + 6 = 12

Group - C

4. (a) In case of a general pumping system from a low to high level reservoir, using Bernoulli's equation show that the net head developed by a centrifugal pump is given by $H = H_{static} + \sum h_{loss}$, where the symbols have their usual meanings. [(C03)(Apply/IOCQ)]

(b) Two homologous pumps A and B are to run at the same speed of 600 rpm. Pump A has an impeller of 50 cm diameter and discharges 0.4 m³/s of water under a net head of 50 m. Determine the diameter of impeller of pump B and its net head, if it is to discharge 0.3 m³/s of water. [(C05)(Analyse/IOCQ)]

6 + 6 = 12

5. (a) The relations between the total head developed H in m and the discharge Q in m³/s for two centrifugal pumps 1 and 2 are given by $H_1 = 20 - 80Q_1^2$ and $H_2 = 30 - 270Q_2^2$ respectively. For parallel operation of the pumps, find

- (i) The discharge up to which only second pump would contribute flow to the system.
- (ii) The total discharge corresponding to zero head.

[(C06)(Evaluate/HOCQ)]

(b) Write short notes on (i) multistage Pump, (ii) system resistance curve. [(C02)(Apply/IOCQ)]

6 + 6 = 12

Group - D

6. (a) Show that the maximum efficiency of the Pelton wheel $\eta_{h_{max}} = \frac{(1+\cos\phi)}{2}$, where ϕ = vane angle at outlet. [(C03)(Apply/IOCQ)]

(b) A Pelton wheel is driven by two similar jets transmits 3750 kW to the shaft running at 375 rev/min. The total head available is 200 m and losses are 0.1 times of the total head. The diameter of the wheel is 1.45 m, the relative velocity coefficient of the bucket is 0.9, and the deflection of the jet is 165°. Find the hydraulic efficiency, overall efficiency and the diameter of each jet, if the mechanical efficiency is 90%. [(C03)(Apply/IOCQ)]

6 + 6 = 12

7. (a) Draw the constant head characteristics curves for Pelton wheel, Francis turbine and Kaplan turbine. [(C02)(Apply/IOCQ)]

(b) A Francis turbine has a diameter of 1.4 m and rotates at 430 rpm. Water enters the runner without shock with a velocity 9.5 m/s and leaves the runner without whirl with an absolute velocity of 7 m/s. The difference between the sum of the static and potential heads at entrance to the runner and at the exit from the runner is 62 m. The turbine develops 12.25 MW. The flow rate through the turbine is 12 m³/s for a net head of 115 m. Find

- (i) The absolute velocity of water at entry to the runner and the angle of the inlet guide vanes.
- (ii) The entry angle of the runner blades.
- (iii) The loss of head in the runner.

[(CO3)(Apply/IOCQ)]

6 + 6 = 12

Group - E

8. (a) Draw and explain the diagram of rate of delivery vs crank angle for (i) single acting and (ii) double acting reciprocating pump. [(CO4)(Apply/IOCQ)]

(b) Derive the expression of maximum value of head loss due to friction in suction or delivery pipe of a reciprocating pump, where the symbols have their usual meanings.

$$(h_f)_{max} = \frac{flv^2}{2gd} \times \left[\frac{A}{a} \omega r \right]^2$$

[(CO4)(Analyse/IOCQ)]

(2 + 2) + 8 = 12

9. (a) Draw the schematic diagram of a double-acting reciprocating pump and show all important components. [(CO1)(Remember/LOCQ)]

(b) A reciprocating pump has a suction head of 6 m and delivery head of 15 m. it has a bore of 150 mm and stroke of 250 mm and piston makes 60 double stroke in a minute. Calculate the force required to move the piston during the (i) suction stroke, (ii) delivery stroke. Find also the power to drive the pump.

[(CO4)(Analyse/HOCQ)]

4 + 8 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	16.67	68.75	14.58