FLUID MACHINERY
(MECH 2202)

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 alternative for the following: **10 × 1 = 10**

(i) Which of the following pump is preferred for very high head purposes and overall cost will be less?
(a) Centrifugal pump (b) Axial flow pump
(c) Mixed flow pump (d) Reciprocating pump.

(ii) Normally submersible pump is used for _____ head development purposes.
(a) high (b) low
(c) moderate (d) both (a) and (b)

(iii) To produce a high head by multistage rotodynamic pump, the impellers are connected
(a) in parallel (b) in series
(c) both (a) & (b) (d) none of these.

(iv) Pressure development of a centrifugal pump depends on
(a) impeller diameter (b) pump shaft speed
(c) type of casing (d) both (a) and (b).

(v) The specific speed of a turbine is given by –
(a) $\frac{N\sqrt{Q}}{H^{3/4}}$ (b) $\frac{N\sqrt{P}}{H^{5/4}}$ (c) $\frac{N\sqrt{Q}}{H^{2/3}}$ (d) $\frac{N\sqrt{P}}{H^{3/2}}$

(vi) In negative slip of a reciprocating pump, the actual discharge as compared to theoretical discharge is
(a) equal (b) less
(c) more (d) none of the above.

(vii) During suction stroke of a reciprocating pump, the flow separation may take place
(a) at the end of suction stroke (b) in the middle of suction stroke
(c) in the beginning of suction stroke (d) separation never occurs.

(viii) Efficiency of an ideal Pelton wheel will be maximum if the ratio of jet velocity to tangential velocity of the wheel is
(a) ½ (b) 1 (c) 2 (d) 4

(ix) Muschel curves mean
(a) curves at constant head (b) curves at constant speed
(c) curves at constant discharge (d) curves at constant efficiency.

(x) A Kaplan turbine is
(a) a high-head mixed flow turbine (b) a low head axial flow turbine
(c) an outward flow reaction turbine (d) an inward flow impulse turbine.

Group- B

2. (a) Explain the terms suction head, manometric head and impeller eye of a centrifugal pump. *[(CO1)(Remember/LOCQ)]*

(b) A centrifugal pump 1.3 m in diameter delivers 3.5 m^3/s of water at a tip speed of 10 m/s and a flow velocity of 1.6 m/s. The outlet blade angle is 30° to the tangent at the impeller periphery. Assuming zero whirls at inlet and zero slip, calculate the torque delivered by the impeller. *[(CO2)(Evaluate/HOCQ)]*

6 + 6 = 12

3. (a) Discuss the effect of outlet blade angle (BCV, FCV and radial) on head development of a rotodynamic pump. *[(CO2)(Understand /IOCQ)]*

(b) The impeller of a centrifugal pump is 0.5 m in diameter and runs at 1450 rpm. The pressure gauges on suction and delivery sides show the difference 25 m. The blades are curved to an angle of 30°. The velocity of flow through impeller being constant and equal to 2.5 m/s. Find manometric efficiency of the pump. *[(CO3)(Evaluate/HOCQ)]*

6 + 6 = 12

Group – C

4. (a) Write short notes on similarity and model testing of rotodynamic machine. *[(CO6)(Understand /IOCQ)]*

(b) To predict the performance of a large centrifugal pump, its model having the following parameters was constructed:
H = 8 m, N = 925 rpm, P = 17.64 kW. Diameter of impeller of the model pump is 9 times smaller than that of the prototype. The prototype has to work against a head of 30 m. Find its working speed and power required to drive it. Determine the rate of flow for the both the pumps. *[(CO4)(Evaluate/HOCQ)]*

6 + 6 = 12

5. (a) With neat sketches, explain the characteristics curves of two similar centrifugal pumps operated (i) in series and (ii) in parallel. *[(CO6)(Analyze/IOCQ)]*

(b) Discuss the main and operating characteristics of a centrifugal pump. What is the importance of constant efficiency curves? *[(CO4)(Understand/LOCQ)]*

6 + 6 = 12

Group - D

6. (a) Explain What are the differences between inward and outward flow reaction turbines? *[(CO4)(Remember/LOCQ)]*

   (b) A Kaplan turbine develops 15 MW of power at a head of 30 m. The diameter of the hub is 0.35 times the diameter of the runner. Assuming a speed ratio of 2.0, flow ratio of 0.65 and overall efficiency of 90%, calculate the (i) the diameter of the runner, (ii) rotational speed, and (iii) specific speed of the turbine. *[(CO2)(Evaluate /HOCQ)]*

6 + 6 = 12

7. (a) A conical type draft tube attached to a Francis turbine has an inlet diameter of 3 m and its area at outlet is 20 m^2. The velocity of water at inlet, which is 5 m above the tailrace level, is 5 m/s. Assuming the loss of draft tube equal to 50% of velocity head at outlet, find
   (i) the pressure head at top of the draft tube
   (ii) the total head at the top of the draft tube taking tailrace level as datum
   (iii) power lost in the draft tube. *[(CO3)(Understand/IOCQ)]*

   (b) A Kaplan turbine runner is to be designed to develop 7357.5 kW shaft power. The net available head is 5.5 m. Assume that the speed ratio is 2.09 and flow ratio 0.68 and the overall efficiency is 60%. The diameter of the boss is 1/3 of the diameter of runner. Find the diameter of runner, its speed and its specific speed. *[(CO2)(Analyze/HOCQ)]*

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. *[(CO5)(Understand/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 strokes in a minute. Calculate the force required to move the piston during the (i) suction stroke and (ii) delivery stroke. Find also the power to drive the pump. *[(CO5)(Evaluate/HOCQ)]*

4 + 8 = 12

9. (a) Explain the unit quantities and the effects of cavitation in hydraulic machines. *[(CO6)(Remember/LOCQ)]*

   (b) A single acting reciprocating pump having a bore of 150 mm and stroke of 300 mm is used to raise water through a total height of 20 m. Its crank rotates at 50 rpm. Find the theoretical power required to run the pump and the theoretical discharge. If actual discharge is 5 litre/s, find the percentage slip. If delivery pipe is 100 mm in diameter and is 15 m long, find the acceleration head at the beginning of the delivery stroke. *[(CO5)(Evaluate/IOCQ)]*

6 + 6 = 12

Cognition Level	*LOCQ*	*IOCQ*	*HOCQ*
Percentage distribution	*29*	*31*	*40*

Course Outcome (CO):

After the completion of the course students will be able to

1. Select different types of fluid machines and list their components.
2. Implement the working principle of rotodynamic machines for evaluating different flow parameters.
3. Identify losses in fluid machines and relate different efficiencies.
4. Compare performance characteristics of various fluid machines.
5. Examine different components and working principles of a positive displacement machine.
6. Describe different processes and phenomena involving operation of fluid machines.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*