TURBO MACHINERY
(MECH 3143)

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) For an axial flow pump
(a) head is more and discharge is less
(b) discharge is more and head is more
(c) discharge is more and head is less
(d) both head and discharge are very less.

(ii) $\frac{P}{\rho N^3 D^5}$ is known as
(a) pressure coefficient (b) head coefficient
(c) flow coefficient (d) power coefficient.

(iii) The expression of unit discharge is
(a) $\frac{Q}{\sqrt{H}}$ (b) $\frac{Q}{H\sqrt{H}}$ (c) $\frac{Q}{H^{5/4}}$ (d) $\frac{Q}{H}$

(iv) The expression of specific speed of a pump is
(a) $\frac{N\sqrt{Q}}{H^{\frac{5}{2}}}$ (b) $\frac{N\sqrt{P}}{H^{\frac{5}{2}}}$ (c) $\frac{N\sqrt{P}}{H^{\frac{5}{4}}}$ (d) $\frac{N\sqrt{Q}}{H^{\frac{3}{4}}}$

(v) Adjustable runner blades are found in
(a) Francis turbine (b) Propeller turbine
(c) Pelton turbine (d) Kaplan turbine.

(vi) Shut off head of axial flow pump is
(a) more than duty point head (b) less than duty point head
(c) equal to duty point head (d) equal to zero

(vii) In an axial flow turbomachine, the direction of flow of fluid is along
(a) parallel to the shaft (b) perpendicular to the shaft
(c) 45° inclined to the shaft (d) both (b) and (c).

(viii) A turbomachine is classified as radial or axial or mixed, depending on the flow direction across the
(a) rotor passage (b) stator passage
(c) exit pipe (d) volute casing.

(ix) Compression ratio for compressors is
(a) less than 1 (b) more than 1.2 (c) 0 (d) 1.

(x) Mushel curves means
(a) curves at constant head (b) curves at constant speed
(c) curves at constant efficiency (d) curves at variable efficiency.

Group – B

2. (a) What is the significance of similarity and model study for turbomachines.

(b) Derive the basic equation of energy transfer for a pump.

6 + 6 = 12

3. (a) Explain different types of draft tubes with diagrams.

(b) Compare positive displacement machines with dynamic (non-positive) machines. What is meant by 'homologous series'? Explain unit quantities for turbomachines.

5 + (2 + 5) = 12

Group – C

4. (a) What is NPSH? Write the relation between NPSH and Thoma's caviataion factor.

(b) A centrifugal pump is rotating at 1000 rpm delivers 0.160 m^3/s of water against a head of 30 m. The pump is installed at a place where atmospheric pressure 1×10^5 Pa (abs) and vapour pressure of water is 3 kPa (abs). The head loss in suction pipe is equivalent to 0.2 m of water. Calculate minimum NPSH.

4 + 8 = 12

5. (a) The diameter of an impeller of a centrifugal pump at inlet and outlet are 300 mm and 600 mm respectively. The velocity of flow at outlet is 2.5 m/s and vanes are set back at an angle of 45° at outlet. Determine the minimum starting speed of the pump if the manometric efficiency is 75%.

(b) Explain with neat sketch the effect of blade outlet angle of a centrifugal pump.

6 + 6 = 12

Group – D

6. (a) Discuss the functions of different components of a Francis turbine with neat sketch.

   (b) A Francis turbine develops 5 MW brake power while running at 240 rpm under a head of 220 m. Assuming overall efficiency 80%, calculate the unit speed, unit discharge, and unit power.

6 + 6 = 12

7. (a) Explain 'surging' in water conveyance system.

   (b) Why efficiency of Kaplan turbine is higher than of propeller turbine? Describe the design aspects of a Pelton turbine.

4 + (2 + 6) = 12

Group – E

8. (a) Briefly discuss the choking of a centrifugal compressor.

   (b) Air at 30°C enters into a centrifugal compressor running at 20000 rpm. Assume slip factor 0.8, power input factor 1, isentropic efficiency 80%, and outer blade tip diameter 0.5 m. Assuming same inlet and exit absolute velocities, calculate the static temperature rise and static pressure ratio for the compressor. Given c_p of air = 1005 J/kg-K.

4 + 8 = 12

9. (a) Describe the axial flow compressor characteristics.

   (b) Show the flow through stages in axial flow compressor with neat sketch.

6 + 6 = 12