

**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) Froude number is defined as
 (a) $\sqrt{\text{(Inertia Force / Surface Tension Force)}}$
 (b) $\sqrt{\text{(Inertia Force / Gravity Force)}}$
 (c) $\text{(Inertia Force / Surface Tension Force)}$
 (d) $\text{(Inertia Force / Gravity Force)}$.
- (ii) For a radial 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.
- (iii) $\frac{Q}{ND^3}$ is known as
 (a) head coefficient
 (b) power coefficient
 (c) flow coefficient
 (d) none of these.
- (iv) The expression of unit power is
 (a) $\frac{P}{\sqrt{H}}$ (b) $\frac{P}{H^{3/2}}$ (c) $\frac{P}{H^{5/2}}$ (d) $\frac{P}{H^{3/4}}$
- (v) For a pipe flow, the value of Reynolds number is 4980; the corresponding flow is called
 (a) laminar flow (b) turbulent flow
 (c) flow in transition zone (d) none of these.

- (vi) The expression of specific speed of a turbine 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) $\frac{N\sqrt{Q}}{H^{\frac{3}{2}}}$
- (vii) Which one is not hydro turbine installation loss of turbo machine?
 (a) frictional head loss in the delivery pipe line
 (b) excessive leakage through wearing surfaces
 (c) obstruction of penstock and draft tube
 (d) incorrect layout of inlet and outlet piping system.
- (viii) If the value of specific speed of a turbine is 900 rpm (metric), then the type of turbine is called
 (a) Pelton (b) Francis
 (c) Kaplan (d) all of these.
- (ix) A nozzle is a duct by flowing through which the kinetic energy of a fluid increases at the expense of _____ drop.
 (a) velocity (b) pressure energy
 (c) acceleration (d) all of these.
- (x) Pressure rise of gases achieved up to 0.07 bar by a device, which is called a
 (a) fan (b) blower
 (c) compressor (d) b and c both.

Group - B

2. (a) What is the importance of model study in turbo machines?
 (b) Explain the effect of Reynold's number and specific speed in turbo machine study.
 (c) Write different installation losses in hydraulic machines.
3 + (2 + 2) + 5 = 12
3. (a) A single stage centrifugal pump with impeller diameter of 300 mm rotates at 2000 rpm and lifts 3m³/s to height of 30 m with an efficiency of 75%. Find the number of stages and diameter of each impeller of a similar multi stage pump to lift 5 m³/s of water to a height of 200 m when rotating at 1500 rpm.
 (b) A turbine model of 1:10 develops 1.84 kW under a head of 5m of water at 480 rpm. Find the power developed by the prototype under a head of 40 m. Also find the speed of the prototype. Assume efficiency of both the turbine to be same. Find and verify the specific speed.
7 + (3 + 2) = 12

Group – C

4. (a) (i) Draw the velocity diagram of a centrifugal pump and explain the parameters.
(ii) Explain series and parallel operation of pump with H-Q diagram.
- (b) Write a short note on deep well or submersible pump.
- (4 + 4) + 4 = 12**
5. (a) Write the demerits of cavitation and how will you minimize the cavitation effects in centrifugal pump.
- (b) A centrifugal pump having outer diameter equal to two times of the inner diameter and running at 1200 rpm works against a total head of 75m. The velocity of flow through the impeller is constant and equal to 3m/s. The vanes are set back at an angle of 30° at outlet. If the outer diameter of the impeller is 600mm and width at outlet is 50 mm, determine:
(i) the vane angle at inlet
(ii) work done by impeller on water per second
(iii) manometric efficiency.

4 + 8 = 12**Group – D**

6. (a) (i) How hydraulic turbines are classified?
(ii) Define Degree of Reaction of a hydraulic turbine with mathematical expression.
- (b) Suggest the method of selection of hydraulic turbines based on specific speed.
- (4 + 4) + 4 = 12**
7. (a) Explain with neat sketch the working principle of Governing of a Pelton turbine.
- (b) Write the importance of water conveyance system and surge tank.

7 + 5 = 12**Group – E**

8. (a) Briefly discuss about the components and principle of operation of a centrifugal compressor.

- (b) The pressure ratio developed in a centrifugal air compressor is 1.46 (isentropic compression). The impeller rotor speed is 7000 rpm. Air flows-in at the inlet without any whirl component. The stagnation temperature at the inlet is 290 K. The slip factor and power input factor are assumed to be 0.8 and 0.9 respectively. Determine the impeller outlet diameter. Assume, $c_p = 1.005 \text{ kJ/kg K}$ and $\gamma = 1.4$ for air.

5 + 7 = 12

9. (a) (i) What is an axial flow compressor?
(ii) Describe the advantages of axial flow compressors.
- (b) Draw the velocity triangle diagram for a stage (both rotor and stator) of an axial flow compressor following standard notations at the inlet and outlet locations.

(2 + 4) + 6 = 12