

**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) The stagnation pressure rise in a centrifugal compressor takes place
    - (a) in the diffuser only
    - (b) in the impeller only
    - (c) in the diffuser and impeller
    - (d) in the inlet guide vanes only.
  - (ii) The capacity of a compressor is expressed in
    - (a) kg/m<sup>2</sup>
    - (b) kg/m<sup>3</sup>
    - (c) m<sup>3</sup>/min
    - (d) m<sup>3</sup>/kg.
  - (iii) In a Kaplan turbine runner, the number of blades are generally between
    - (a) 2 to 4
    - (b) 4 to 8
    - (c) 8 to 16
    - (d) 16 to 24.
  - (iv) If  $H_g$  is the gross or total head and  $h_f$  is the head lost due to friction, then net or effective head ( $H$ ) is given by
    - (a)  $H = H_g/h_f$
    - (b)  $H = H_g \times h_f$
    - (c)  $H = H_g + h_f$
    - (d)  $H = H_g - h_f$ .
  - (v) The static head of a centrifugal pump is equal to the \_\_\_\_\_ of suction head and delivery head.
    - (a) product
    - (b) difference
    - (c) sum
    - (d) cross product
  - (vi) The ratio of actual work available at the turbine to the energy imparted to the wheel is known as \_\_\_\_\_ efficiency.
    - (a) hydraulic
    - (b) mechanical
    - (c) overall
    - (d) volumetric
  - (vii) Which of the following pump is preferred for flood control and irrigation applications?
    - (a) Centrifugal pump
    - (b) Axial flow pump
    - (c) Mixed flow pump
    - (d) Reciprocating pump.

- (viii) Discharge ( $Q$ ) of a centrifugal pump is given by (where  $D$  = Diameter of impeller at inlet,  $b$  = Width of impeller at inlet, and  $V_f$  = Velocity of flow at inlet)
- (a)  $Q = \pi.D.V_f$  (b)  $Q = \pi.b.V_f$   
(c)  $Q = \pi.D.b.V_f$  (d)  $Q = D.b.V_f$ .
- (ix) A centrifugal pump will start delivering liquid only when the pressure rise in the impeller is equal to the
- (a) potential head (b) velocity head  
(c) manometric head (d) static head.
- (x) The maximum number of jets, generally, employed in an impulse turbine without jet interference are
- (a) 2 (b) 4 (c) 6 (d) 8.

**Group – B**

2. (a) Explain Reynolds model law and Froude model law. Give at least two applications of each model.  
(b) State different installation losses of turbo machines.
- (5 + 3) + 4 = 12**
3. (a) Give two examples of positive displacement machines. Why are they called “Positive displacement” machines?  
(b) A turbine is to operate under a head of 25 m at 200 r.p.m. . The discharge is 9 m<sup>3</sup>/s. If the overall efficiency is 90 per cent, determine :  
(i) Power generated, (ii) Specific speed of the turbine, (iii) Type of the turbine.
- 4 + 8 = 12**

**Group – C**

4. (a) What is NPSH? Write the relation between NPSH and Thoma’s cavitation factor.  
(b) The impeller of a centrifugal pump has an external diameter of 450 mm and internal diameter of 200 mm and it runs at 1440 r.p.m. Assuming a constant radial flow through the impeller at 2.5 m/s and that the vanes at exit are set back at an angle 25°, determine:  
(i) Inlet vane angle, (ii) The angle, absolute velocity of water at exit makes with the tangent, and (iii) The work done per Newton of water.
- 4 + 8 = 12**
5. (a) With a neat sketch of a volute type centrifugal pump show different components.  
(b) It is required to pump water out of deep well under a total head of 90 m. A number of identical pumps of design speed 1000 r.p.m. and specific speed 30 with a rated capacity of 0.15 m<sup>3</sup>/s are available. How many pumps are required and how should they be connected whether in series or in parallel?
- 5 + 7 = 12**

**Group – D**

6. (a) Explain the function of governing system used in hydraulic turbines. Explain the working principle of deflector governor used in a hydraulic Pelton turbine system with a neat sketch.
- (b) A Kaplan turbine develops 22000 kW at an average head of 35 m. Assuming a speed ratio of 2, flow ratio of 0.6, diameter of the boss equal to 0.35 times the diameter of the runner and an overall efficiency of 88 per cent, calculate:  
(i) the diameter, (ii) speed and (iii) specific speed of the turbine.
7. (a) Describe the function of surge tank. With a neat sketch explain simple surge tank.
- (b) A turbine is to operate under a head of 25 m at 200 r.p.m. The discharge is 9 m<sup>3</sup>/s. If the efficiency is 90 per cent determine the performance of the turbine under a head of 20 m.

**(2 + 4) + 6 = 12****(2 + 4) + 6 = 12****Group – E**

8. (a) Show that the stagnation temperature ratio at the diffuser vane outlet and the impeller inlet of a centrifugal compressor may be expressed as  

$$\frac{T_{3t}}{T_{1t}} = 1 + \frac{\psi \sigma U_2^2}{c_p T_{1t}}$$
(symbols have usual standard meaning).
- (b) Briefly discuss various losses in centrifugal compressor.
9. (a) (i) What is an axial flow compressor?  
(ii) Describe the advantages of axial flow compressors.
- (b) The primary design of an axial flow compressor is to be based upon simplified consideration of the mean diameter conditions. Suppose that the characteristics of a repeating stage of such a design are as follows:  
Stagnation temperature rise ( $\Delta T_{sat}$ ) = 30 K; Degree of Reaction ( $\lambda$ ) = 0.6; Flow coefficient ( $V_f/U$ ) = 0.5; Blade speed ( $U$ ) = 300 m/s. Assuming constant axial velocity across the stage and equal absolute velocities at inlet and outlet, determine the blade angles of the rotor for a shock free flow. ( $C_p$  for air = 1005 J/kg K).

**8 + 4 = 12****(2 + 4) + 6 = 12**

| Department & Section | Submission link:                                                                                                                                                                                                                                  |
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