slip factor and power input factor to be unity, the process of compression is isentropic and for air $\gamma = 1.4, C_p = 1000\, J/kgK$.

6 + 6 = 12

9. (a) (i) For axial compressor, explain compressor staging and flow through stages.
(ii) What are fan laws?

(b) Draw the schematic diagram of dependence of various losses with mass flow in a centrifugal compressor and explain the phenomena.

(4 + 2) + 6 = 12

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) Specific speed is minimum for
(a) Francis turbine (b) Pelton turbine
(c) Axial flow turbine (d) Radial flow turbine.

(ii) $\frac{gH}{N^2D^2}$ is known as
(a) Pressure coefficient (b) Head coefficient
(c) Flow coefficient (d) Power coefficient.

(iii) Compression ratio for a compressor is
(a) More than 3 (b) In between 1.5 and 2
(c) In between 1.1 and 1.2 (d) Less than 1.1.

(iv) The main function of the governor is to maintain the turbine____ constant irrespective of load on the turbine
(a) Head (b) Power (c) Speed (d) Discharge.

(v) Which one of the following is an axial flow type turbine?
(a) Francis turbine (b) Propeller turbine
(c) Pelton turbine (d) All of these.

(vi) The discharge is _____ from a centrifugal air compressor when 'choking' occurs.
(a) Minimum (b) Variable
(c) Maximum (d) Constant

(vii) Normally backward curved vane pump is used because
(a) casing size is required smaller
(b) casing size is required larger
(c) casing size is required equal to impeller size
(d) no casing required.

(viii) Generally axial flow compressor consists of
(a) Single stage (b) Multiple stages
(c) Rotor blades only (d) Stator blades only.

(ix) Inducer is placed in the centrifugal compressor before
(a) Volute casing (b) Impeller eye
(c) Diffuser vane (d) Both (a) and (c).

(x) Cordier Diagram shows the empirical relationship between
(a) Specific speed and specific diameter
(b) Specific speed and specific gravity
(c) Specific speed and specific volume
(d) Specific speed and specific weight.

Group – B

2. (a) The discharge Q of a centrifugal pump depends upon the mass density of fluid (ρ), the speed of the pump (N), the diameter of the impeller (D), the manometric head (H) and the viscosity of fluid (μ). Show that $Q / ND^3 = \varphi\left(\frac{gH}{N^2D^2}, \frac{\mu}{\rho ND^2}\right)$.

(b) Why similarity and model study for turbomachines are required?

8 + 4 =12

3. (a) A hydro-turbine is required to give 25 MW at 50 m head and 90 r.p.m. runner speed. The laboratory facilities available permit testing of 20 kW model at 5 m head. What should be the model runner speed and model to prototype scale ratio?

(b) Explain Restricted orifice surge tank with a schematic diagram.

8 + 4=12

Group – C

4. (a) Explain briefly the following efficiencies of a centrifugal pump: (i) Manometric efficiency, (ii) Volumetric efficiency, (iii) Mechanical efficiency, and (iv) Overall efficiency.

(b) Find the number of pumps required to take water from a deep well under a total head of 88.5m. All the pumps are identical and are running at 800

rpm. The specific speed of each pump is given as 25 while the rated capacity of each pump is 0.16 m^3/s.

6 + 6 =12

5. (a) How we can minimize cavitation in a centrifugal pump?

(b) A centrifugal pump impeller having external and intenal diameters 480 mm and 240 mm respectively is running at 100 r.p.m. The rate of flow through the pump is 0.0576 m^3/s and velocity of flow is constant and equal to 2.4 m/s. The diameters of the suction and delivery pipes are 180 mm and 120 mm respectively and suction and delivery heads are 6.2 m (abs.) and 30.2 m of water respectively. If the power required to drive the pump is 23.3 kW and the outlet vane angle is 45°, determine:
(i) Inlet vane angle
(ii) The overall efficiency of the pump, and
(iii) The manometric efficiency of the pump.

4 + 8 = 12

Group – D

6. (a) A reaction turbine works at 450 r.p.m. under a head of 120 m. Its diameter at inlet is 1.2 m and the flow area is 0.4 m^2 . The angles made by absolute and relative velocities at inlet are 20° and 60° respectively with the tangential velocity. Determine : (i) The volume flow rate, (ii) The power developed, and (iii) The hydraulic efficiency.

(b) With a neat sketch explain the construction of a hydraulic turbine having very high specific speed.

8 + 4=12

7. (a) A Pelton wheel has to develop 13230 kW under a net head of 800 m while running at a speed of 600 r.p.m. If the co-efficient of the jet C_v = 0.97, speed ratio K_u = 0·46 and the ratio of jet diameter is 1/16 of wheel diameter, determine the following : (i) The diameter of the pitch circle, (ii) The diameter of each jet, (iii) The quantity of water supplied to the wheel, and (iv) The number of jets required. Assume overall efficiency as 85 percent.

(b) Explain the purpose of 'Inlet guide vanes' to reaction turbine.

9 + 3 = 12

Group – E

8. (a) With neat sketch, describe the working principle of an axial compressor.

(b) Determine the pressure ratio developed and the specific work input to drive a centrifugal air compressor with an impeller diameter of 0.5 m and running at 7000 rpm. Assume zero whirl at the entry and $T_{1t} = 290K$. The