B.TECH/ME/5TH SEM/MECH 3143/2018
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 maximum for
(a) Francis turbine (b) Pelton turbine
(c) Axial flow turbine (d) Radial flow turbine.

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

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

(iv) Torque is generated in turbomachines from
(a) Flow velocity component
(b) Whirl velocity component
(c) Both flow and whirl velocity components
(d) Relative velocity component.

(v) The purpose of diffuser vanes is to convert _____.
(a) Potential head to pressure head
(b) Velocity head to potential head
(c) Velocity head to pressure head
(d) Pressure head to velocity head.

(vi) Degree of reaction for a pure reaction turbine is
(a) 0.5 (b) 0 (c) 2 (d) 1.

(vii) $\frac{Q}{ND^3}$ is known as
(a) Pressure coefficient (b) Head coefficient
(c) Flow coefficient (d) Power coefficient.

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

(ix) Intercooler is placed in compressor
(a) Before compression (b) During compression
(c) After compression (d) both (a) and (b)

(x) Stagnation condition is defined for
(a) Isentropic process
(b) Isobaric process
(c) Reversible process with heat transfer
(d) Irreversible process without heat transfer

Group – B

2. (a) Describe the classification of turbo machines based on 'direction of flow' and 'specific speed'.

(b) Explain different types of similarities exist between model and prototype.

(2+ 2 + 2) + 6=12

3. (a) Define specific speed of a pump. Why we need volute casing in a CF pump? What is overall efficiency of a pump?

(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.

6 + 6 = 12

Group – C

4. (a) (i) What is priming in centrifugal pump?
(ii) Write a short note on selection of a pump.

(b) Derive the expression of minimum speed of pump to deliver liquid.

(2 + 3)+ 7= 12

5. (a) A centrifugal pump running at 900 rpm delivers 0.1 m^3/s of water. The diameter of the impeller is 250mm and the width is 40 mm. The blades are curved backward at 45° to the tangent at exit. If the manometric efficiency is 90%, compute the specific speed of the pump.

(b) (i) Why net positive suction head is important in pumping system?
(ii) What is slip factor in a pump?
(iii) What are the specialities of a submersible pump?

6 + (2+ 2 + 2) = 12

Group – D

6. (a) Discuss the function of different components of a Pelton turbine with neat sketch.

(b) A Pelton wheel has a mean bucket speed of 10 m/s with a jet of water flowing at the rate of 700 litre/s under a head of 30 m. The bucket deflects the jet through an angle of 160°. Calculate the power delivered and hydraulic efficiency of the turbine. (Assume C_v = 0.98).

6 + 6 = 12

7. (a) A Francis turbine has a diameter of 1.4 m and rotates at 430 rpm. Water enters the runner without shock with a velocity 9.5 m/s and leaves the runner without whirl with a absolute velocity of 7 m/s. The difference between the sum of the static and potential heads at entrance to the runner and at the exit from the runner is 62 m. The turbine develops 12.25 MW. The flow rate through the turbine is 12 m^3/s for a net head of 115 m. Find

(i) The absolute velocity of water at entry to the runner and the angle of the inlet guide vanes.

(ii) The entry angle of the runner blades

(iii) The loss of head in the runner.

(b) What are the functions of draft tube? Name any two types of draft tube

9 + 3 = 12

Group – E

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

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

$$\frac{T_{03}}{T_{01}} = 1 + \frac{\Psi \sigma U_2^{\,2}}{C_P T_{01}}$$

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(symbols have usual standard meaning). **7 + 5 =12**

9. (a) Describe the working principle of axial flow compressor.

(b) At the mean diameter of an axial flow air compressor, blade velocity U=200m/s, flow velocity V_f=180m/s, blade angle β_1=44°, β_2=14°, work done factor λ = 0.9, stage isentropic efficiency η_s=0.85, and inlet stagnation temperature T_{01} = 290K. Calculate the pressure ratio. Given C_p=1005 J/kgK, and γ=1.4 for air.

6 + 6 = 12