Total No. of Questions : 10]

SEAT No. :

P3344

[Total No. of Pages : 4

[5353]-514

T.E. (Mechanical Engineering) (Semester - I)

TURBO MACHINE

(2015 Pattern)

Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) ***Answer Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q.7 or Q.8, Q.9 or Q.10.***
2) ***Figures to the right indicate full marks.***
3) ***Use of scientific calculator is allowed.***
4) ***Use of steam table is permitted.***
5) ***Assume data whenever necessary.***
6) ***Due credit will be given to neat figures wherever necessary.***

Q1) a) Derive an expression for the force exerted by the jet of water on the fixed curved plate, jet strikes at centre of the curved plate at normally. **[4]**

b) A Pelton turbine develops 3000 kW under the head of 300 m the overall efficiency of the turbine is 83%. If the speed ratio is 0.46 Coefficient of nozzle Cv = 0.98 and specific speed is 16.5 find : i) diameter of the turbine ii) diameter of the jet **[6]**

OR

Q2) a) Define : **[4]**

i) Unit speed

ii) Unit discharge

iii) Unit power

State its significance

b) A Kaplan turbine develops 24647.6 kW power at an average head of 39 m. Assuming the speed ratio of 2, flow ratio 0.6, the diameter of boss equal to 0.35 times the diameter of the runner and an overall efficiency 90% calculate the diameter, speed and specific speed of the runner. **[6]**

P.T.O.

Q3) a) An outward flow reaction turbine has internal and external diameters of runner as 0.6 m and 1.2 m respectively . The guide blade angle is 15° and velocity of flow through runner is constant and equal to 4 m/sec. If the speed of the turbine 200 rpm, head on the turbine is 10 m and discharge at outlet is radial determine **[7]**

i) Runner vane angle at inlet and outlet

ii) Work done by water on runner

iii) Hydraulic efficiency

b) What are the applications of impulse momentum principle? **[3]**

OR

Q4) a) Write a short note on factors influencing performance of turbine. **[4]**

b) Two inward flow turbine runners having same diameter of 0.50 m have the same efficiency, and work under same head. Both the turbines have same velocity of flow of 5.6 m/sec. If one of the runner 'A' runs at 525 RPM and has an inlet blade angle of 65° and the other runner 'B' has inlet blade angle of 110° what should be the speed of the runner 'B'. Both the turbines discharge radially at outlet. **[6]**

Q5) a) Explain the term Reheat Factor in steam turbines. **[6]**

b) In a stage of a Turbine with Parson's blading delivers dry saturated steam at 2.7 bar from the fixed blades at 90 m/sec. The mean Blade height is 40 mm, and the moving blade exit angle is 20°. The axial velocity of steam is 3/4 of the blade velocity at the mean radius. Steam is supplied to the stage at the rate of 9000 kg/hr the effect of the blade tip thickness on the annulus area can be neglected. Calculate **[10]**

i) Wheel speed in RPM

ii) The diagram power

iii) The diagram efficiency

iv) The enthalpy drop of steam in the stage

OR

Q6) a) Explain why subsonic nozzle is convergent while supersonic nozzle is divergent. **[4]**

b) Derive an expression for diagram efficiency of single stage impulse Turbine. Obtain the Condition for Maximum efficiency & its value. **[6]**

c) In a single stage impulse turbine the mean diameter of the blade ring is 1m and the rotational speed is 3000 rpm. The steam is issued from the nozzle at 300 m/see. and nozzle angle is 20°. The blades are equiangular. If the friction loss in the blade channel is 19% of the Kinetic energy corresponds to relative velocity at the inlet to the blades. What is the power developed in the blading when the axial thrust on the blades is 98 N. Solve the problem graphically. **[6]**

Q7) a) What do you mean by cavitation. What are its effects? How we can overcome the cavitation effect in centrifugal pump. Derive relation for maximum suction lift of a centrifugal pump. **[8]**

b) The outer diameter of an impeller of a Centrifugal pump is 400 mm & outlet width is 50 mm. The pump is running at 800 rpm & is working against a total head of 15m. The vanes angle at outlet is 40°& manometric efficiency is 75%. Determine : **[10]**

i) Velocity of flow at outlet,

ii) Velocity of water leaving the vane,

iii) Angle made by the absolute velocity at outlet with the direction of motion at outlet

iv) Discharge

OR

Q8) a) Show that rise in pressure in impeller of a centrifugal pump is expressed as **[6]**

$$\frac{1}{2g}\left(Vf_1^2 + u_2^2 - 2Vf_2^2 \operatorname{Cosec}^2 \phi\right),$$

where all symbols have their usual meanings.

b) A centrifugal pump impeller has an external diameter of 450 mm and discharge area of 0.11 m^2. The vanes are bent backwards at an angle of 35° at outlet. The diameter of the suction and delivery pipes is 300 mm and 230 mm respectively. Pressure gauge at points on suction and delivery pipes close to the pump and each gauge 1.50 m above the level of supply sump showed gauge pressure head of 3.70 m below and 19 m above atmospheric head respectively. When the pump was delivering 200 lit/sec of water at 800 rpm. It requires 70 kW to drive the pump. Find the loss of head in the suction pipe, manometric efficiency and overall efficiency of the pump. **[12]**

Q9) a) What are the various losses in Axial Flow Compressor? **[4]**

b) Write short note on Slip & Slip Factor in compressors. **[4]**

c) A Centrifugal Compressor used as a supercharger for aero engine handles 180 kg/min of air. The suction pressure and temperature are 1 bar and 280 K. The suction velocity is 90 m/sec. After isentropic compression in the impeller conditions are 1.5 bar, 335 K and 230 m/sec. Calculate **[8]**

i) Isentropic efficiency

ii) Power required to drive compressor

iii) Overall efficiency of the unit

Assume that kinetic energy of the air gained in impeller is entirely converted into pressure in diffuser. Take $\gamma = 1.4$ for air.

OR

Q10)a) Derive an expression for the overall pressure ratio developed in the Centrifugal Compressor. **[6]**

b) A centrifugal compressor running at a speed of 15000 rpm admits 25 m^3/sec air at static states 1 bar and 300 K and compresses it adiabatically by the pressure ratio of 2. The air velocity at inlet and the radial velocity at exit is the same as 75 m/sec. The inlet and outlet impeller diameters are 60cm and 80 cm respectively. Considering the inlet to be axial find **[10]**

i) Blade angles at inlet and outlet of impeller

ii) Angle at which air leaves the impeller

iii) Impeller breadth at inlet and exit.