Total No. of Questions : 10]

SEAT No. :

P2491

[Total No. of Pages : 4

[5253]-509

T.E. (Mechanical Engineering)

TURBO MACHINES

(2015 Pattern) (Semester - I)

Time : 2.5 Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) ***Figures to the right indicate full marks.***
2) ***Use of non programmable scientific calculator is allowed.***
3) ***Assume data wherever necessary and mention it.***
4) ***Draw neat and suitable figures wherever necessary.***
5) ***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.***
6) ***Use of steam table is permitted.***

Q1) a) Show that the ratio of flow rate, Ql/Q2 = (1+cosθ) / (1–cosθ) for the impact of jet on stationary flat plate inclined at θ^0 to the direction of the horizontal jet. Where Q1 = upward directed flow rate and Q2 = downward directed flow rate. **[6]**

b) What is the difference between the impulse and reaction turbine? **[4]**

OR

Q2) a) Classify water turbines in brief. **[4]**

b) The mean bucket speed of a Pelton wheel is 40 m/s and the discharge is 1.2 m^3/sec. The head over the turbine is 385 m. The head loss due to friction in penstock is 9 m. The bucket deflects the jet through 165°. If the coefficient of velocity of nozzle is 0.9.Detemine i) Power developed by the turbine and ii) Hydraulic efficiency of turbine. Neglect bucket friction. **[6]**

Q3) a) Discuss main characteristics of the Pelton wheel. **[4]**

b) A Kaplan turbine runner has outer diameter of 4.5 m and the diameter of the hub is 2m. It is required to develop 20.6 MW when running at 150 rpm, under a head of 21m .Assuming hydraulic efficiency of 94% and overall efficiency of 88%. determine the runner vane angle at inlet and exit at the mean diameter of the vane. **[6]**

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OR

Q4) a) Write a short note on selection of turbines. **[4]**

b) Particulars of the reaction turbine are given below Head of the turbine is 180 m, Inlet diameter is 4.25 m, Outlet diameter is 2.75 m, Inlet vane angle is 120 deg., Velocity of flow at outlet is 16 m/s, hydraulic efficiency is 92 %, width of wheel is same at inlet and outlet, Discharge is radial at outlet calculate the speed of the turbine. **[6]**

Q5) a) Write a difference between throttle and nozzle governing used in steam turbines and explain with neat sketch of nozzle governing. **[8]**

b) Steam issues from the nozzles of an angle of 20 deg at a velocity of 440 m/s, the friction factor is 0.9, for a single stage turbine designed for a maximum efficiency determine (i) Blade velocity (ii) moving blade angles for equiangular blades (iii) Blade efficiency (iv) stage efficiency if the nozzle efficiency is 93% & power developed for mass flow rate of 3kg/s. **[8]**

OR

Q6) a) Discuss reheat factor with the help of T.S. diagram. **[6]**

b) Following data refer to the signle row of impulse steam turbine mean diameter of the blade ring = 1.lm, Speed = 3000rpm, Nozzle angle = 17 deg., ratio of blade velocity to the steam velocity = 0.45, blade friction factor = 0.82, Blade angle at exit is less by 3 deg to that at inlet, steam mass flow rate = 10.2 Kg/s. Draw a velocity diagram and find the following (i) Blade angles at inlet and outlet (ii) Tangential force (iii) Axial force (iv) Resultant force (v) Power developed. **[10]**

Q7) a) Explain with neat sketch any two types of impellers used in centrifugal pump. **[6]**

b) The impeller of the centrifugal pump has an outer diameter of 250mm and an effective area of the $0.017m^2$.The blades are bent backward so that the direction of outlet relative velocity makes an angle of 148 deg with the tangent drawn in the direction of impeller rotation. The diameters of suction and delivery pipes are 150mm and 100mm respectively. The pump delivers $0.031m^3/s$ at 1450 rpm when suction and delivery lifts are 4.6m and 18m respectively. The head losses in the suction and delivery pipes are 2m and 2.9m respectively. The motor driving the pump delivers 10KW.Assuming that water enters the pump without shock and whirl Determine (i) Manometric efficiency and (ii) The overall Efficiency of the pump. **[10]**

OR

Q8) a) Discuss the significance of the effect of outlet blade angle on performance of centrifugal pump. **[7]**

b) Three stage centrifugal pump has impellers 40cm diameter and 2cm wide at outlet. The vanes are curved back at the outlet at 45deg and reduce the circumferential area by 10%.Its Manometric efficiency is 90% and overall efficiency is 80%.Determine the head generated by the pump when running at 1000rpm.Delivering 50 LPS. What should be the shaft power and specific speed? **[6]**

c) Tests on a pump model indicate a Thomas cavitation factor is 0.1 .A homologous unit is installed at a location where atmospheric pressure is 0.91 bar and vapour pressure as 0.035 bar (abs) and is to pump water against a head of 25m.What is the maximum permissible suction lift/ head? Neglect frictional losses in the suction pipe. **[3]**

Q9) a) Explain flow processes through Axial flow compressor with h-S diagram for single stage. **[8]**

b) A centrifugal compressor running at 10000rpm delivers 660m^3/min of air. The air is compressed from 1bar and 20°C to a pressure ratio of 4 with an isentropic efficiency of 82%.Blades are radial at outlet of the impeller and flow velocity of 62m/s may be assumed throughout constant. The outer radius of the impeller is twice the inner and the slip factor may be assumed as 0.9.The blade area coefficient may be assumed 0.9 at outlet, Determine, (i) Final temperature of the air (ii) Theoretical power (iii) Impeller diameter at inlet and outlet. (iv) Bredth of the impeller at inlet (v) Impeller blade angle at inlet (vi) Diffuser blade angle at inlet. R=287 J/kgK, Cp = 1.005 KJ/kgK. **[10]**

OR

Q10)a) Explain surging and choking in axial flow compressor. **[6]**

b) Define (i) Flow coefficient and (ii) Blade loading Coefficient. **[2]**

c) A centrifugal compressor runs at 15000rpm with overall stagnation pressure ratio of 4. An ambient air conditions are 25°C and 1bar, vanes are radial slip factor is 0.96 and power input factor (work factor) is 1.04. Flow in the inlet section up to the impeller entry is isentropic and that in the impeller and diffuser is adiabatic there is no Prewhirl at axial entry to the impeller. Mechanical efficiency is 96% and the electric motor driving the compressor is 98% efficient. The stagnation pressure loss from impeller exit to diffuser exit is 0.1 bar isentropic efficiency of the impeller alone is 90% taking $\gamma = 1.4$, Cp= 1.005 KJ/kgK for air, Determine (i) Electrical energy consumed by electric motor per kg of air. (ii) Overall efficiency of the compressor (iii) Impeller tip diameter Draw a neat T-S diagram. **[10]**