Total No. of Questions : 10]

SEAT No. :

P1700

[Total No. of Pages : 4

[5460]-518
T.E. (Mech.)
TURBO MACHINES
(2015 Pattern) (Semester - I)

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) A jet has a direct impact on a series of flat plate vanes mounted over the periphery of a large wheel. Determine the force of impact and the work done per second. **[4]**

b) A pelton wheel has to develop 13250 kW under a net head of 800 m at a speed of 600 rpm. The coefficient of velocity for the jet is 0.97. The peripheral velocity is $0.46\sqrt{2gH}$. The diameter of the jet is not to exceed one sixteenth the wheel diameter. Find the discharge, the wheel diameter, the jet diameter and the number of jets required. Assume the overall efficiency to be 85%. **[6]**

OR

Q2) a) What are surge tanks? What is the role of surge tank in hydro electric power plant? **[4]**

b) A jet of water discharges 140N per second at 40 m/s in the direction making 30° to the direction of a series of curved vanes moving at 17.50 m/s. If the outlet angle of the vane is 20°, determine : **[6]**

i) The inlet vane angle of the vanes so that there is no shock at entry.

ii) The direction of flow at outlet

iii) The work done per second

P.T.O.

Q3) a) A turbine was originally installed at the tail water level. If it is now proposed to place it above the tail water level without any decrease in head on the turbine, how this can be achieved? **[4]**

b) Find the main dimensions and blade angles for an inward flow reaction turbine to the following data:

Velocity of flow through runner is constant; Speed = 950 rpm; Head on the turbine = 105 m; Output = 800kW; Guide blade angle at inlet = 18°; Inner diameter = 0.6 Outer diameter; Hydraulic efficiency = 88%; Overall efficiency = 80%; Breadth at inlet = 0.10 times the inlet diameter; 6 % of the circumferential area of the runner is blocked by vane thickness; the turbine discharges radially at outlet. **[6]**

OR

Q4) a) What do you mean by characteristic curves of a turbine? Why these are important? **[4]**

b) A propeller turbine runner has an external diameter of 5 m and the diameter at hub is 2 m. The turbine has to develop a shaft power of 29430 kW under a head of 25 m at a speed of 160 rpm. If the hydraulic efficiency is 95% and the overall efficiency is 85%, determine the runner vane angles at inlet and outlet at mean diameter and at extreme edge of the runner. Assume that the turbine discharges without whirl at outlet. **[6]**

Q5) a) Explain the pressure compounded impulse turbine showing pressure and velocity variations along the axis of the turbine. **[6]**

b) In a single stage steam turbine saturated steam at 10 bar (absolute) is supplied through a convergent divergent steam nozzle. The nozzle angle is 20° and the mean blade speed is 400 m/s. The steam pressure leaving the nozzle is 1 bar (absolute). Find:

i) The best blade angles if the blades are equiangular

ii) The maximum power developed by the turbine if a number of nozzles used are 5 and the area at the throat of each nozzle is 0.6 cm^2.

Assume nozzle efficiency 88%, blade friction coefficient of 0.87 and index of expansion n = 1.4. Solve using graphical method. **[10]**

OR

Q6) a) Enumerate the energy losses in steam turbine. **[6]**

b) A 50% reaction turbine (with symmetrical velocity triangles) is running at 400 rpm has the exit angle of blades as 20° and the velocity of the steam relative to the blades at the exit is 1.35 times the mean blade speed. The steam flow rate is 8.33 kg/s and at a particular stage the specific volume is 1.381 m^3/kg. Calculate for the stage : **[10]**

i) A suitable blade height, assuming the rotor mean diameter 12 times the blade height.

ii) The diagram work.

Q7) a) Define maximum suction lift. State the expression to calculate it. What factors affect its values? **[6]**

b) The effective inlet and outlet radial area of flow of a centrifugal pump are respectively 645 cm^2 and 580 cm^2, the water entering with the radial velocity of 5.50 m/s. The impeller vanes are set back at an angle of 45° to the tangent at outlet. The outer peripheral velocity is 27.50 m/s and manometric efficiency is 80%. Assuming the losses of head due to friction are i) between suction flange and impeller inlet = 3.05 m ii) Through impeller = 4.80 m iii) between guide vanes and delivery flange = 1.52 m and that at the outlet velocity from the guides is two-fifths of the inlet velocity to them. Find 1) The loss of head due to friction in guides vanes. 2) The guide vane efficiency. **[12]**

OR

Q8) a) What is cavitation? Explain the phenomenon of cavitation. State some methods of eliminating or reducing cavitation. **[6]**

b) Show that the rise in the pressure in the impeller of a centrifugal pump is given by $\frac{1}{2g}\left[Vf_1^2 + u_2^2 - Vf_2^2 \cos ec^2\phi\right]$

A centrifugal pump has an impeller if internal diameter 125 mm and exit diameter 250 mm and rotates at 1800 rpm. The absolute velocity of water at inlet is radial and the vanes are bent back at an angle of 30° to the tangent at discharge. The breadth of the impeller at inlet and outlet are 12.5 mm and 6.25 mm respectively. Determine the rise in pressure head as water passes through the impeller neglecting losses. The discharge of the pump is 8.5 lit/sec. **[12]**

Q9) a) Describe axia1 flow compressor with velocity diagrams. **[6]**

b) A centrifugal compressor running at 10000 rpm delivers 660 m^3/min of free air. The air is compressed from 1 bar and 20°C to a pressure ratio of 4 with an isentropic efficiency of 82%. Blades are radial at outlet of the impeller and the flow velocity of 62 m/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 is 0.9 at inlet.

Calculate : **[10]**

i) Final Temperature of the air

ii) Theoretical power

iii) Impeller diameter at inlet and outlet

iv) Impeller blade angle at inlet

v) Diffuser blade angle at inlet

OR

Q10) a) Explain the phenomena of stalling of the blades. **[6]**

b) Following data pertains to a centrifugal compressor:

Total pressure ratio	= 3.6:1
Diameter of inlet eye of compressor impeller	=35cm
Axial velocity at inlet	= 140 m/s
Mass flow	= 12kg/s
The velocity in the delivery duct	= 120 m/s
The tip speed of impeller	= 460 m/s
Speed of the impeller	= 16000 rpm
Total head isentropic efficiency	= 80%
Pressure coefficient	= 0.73
Ambient conditions	=1.0132 bar and 15°C

Calculate: **[10]**

i) The static pressure and temperature at inlet and outlet of the compressor.

ii) The static pressure ratio.

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