Total No. of Questions :10]

SEAT No. :

P2843

[Total No. of Pages :4

[4958]-1017
T.E. (Mechanical)
TURBO MACHINES
(2012 Course) (End Sem) (Semester - II)

Time : 2:30 Hours] *[Max. Marks :70*

Instructions to 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) ***Assume data whenever necessary and mention it.***
5) ***Draw neat and suitable figures wherever necessary.***

Q1) a) State the advantages of using draft tube and justify not using it in Pelton wheel. **[4]**

b) A Pelton wheel operates with a jet of 15 cm in diameter under a head of 500 m. Its mean runner diameter is 2.25 m and it rotates with the speed of 375 rpm. The outlet angle of bucket tip is 15°, the coefficient of velocity as 0.98, Mechanical efficiency as 97% and buckets are smooth. Determine the shaft power, hydraulic efficiency and power lost in bucket. **[6]**

OR

Q2) a) How does the number of vanes, vane shape and hydraulic efficiency of any hydraulic machine vary with increasing specific speed? **[4]**

b) Following data is available related to Francis turbine: Shaft power = 14990 kW, runner speed = 275 rpm, net head = 110 m, diameter at inlet = 1.8 times diameter at outlet, axial length of the blade at inlet = 0.15 times diameter at inlet, flow ratio = 0.2, hydraulic efficiency = 90%, Overall efficiency = 85%, velocity of flow at inlet = velocity of flow at oultet determine: **[6]**

i) Inlet and Outlet diameters.

ii) Guide blade angles.

iii) Runner vane angles.

Assume radial flow at exit.

P.T.O.

Q3) a) Discuss main and operating characteristics curves for hydraulic turbine? **[4]**

b) In a De Laval turbine, steam is issued from the nozzle with a velocity of 1500 m/s whereas the mean blade velocity is 500 m/s. The nozzle angle is 20° and the inlet and outlet angles of blades are equal. The mass of the steam flowing through the turbine is at the rate of 1200 kg/hr. Assuming blade velocity coefficient k = 0.8, draw the velocity diagram and determine: **[6]**

i) The blade angles.

ii) The power developed by turbine.

iii) The blade efficiency.

OR

Q4) a) Define angular momentum and explain how it is used to determine the torque and work done in case of radial flow turbine runner. **[4]**

b) A Parsons turbine runs at 400 rpm with 50% reaction and it develops 75 kW of power per unit mass of steam flow per second. The exit angle of the blades is 20° and the steam velocity is 1.4 times the blade velocity. Find **[6]**

i) blade velocity and

ii) inlet angle of the blades.

Q5) a) Define the maximum suction lift. State the expression to calculate it. What factors affect its values? **[6]**

b) Following data relates to centrifugal pump: Eye and rim diameter = 10 cm and 20 cm respectively, outer width = 1.25 cm, vane angle at outer rim = 25°, speed = 3000rpm, constant flow velocity = 3 m/s, manometric efficiency = 78% and overall efficiency = 72%. Determine: **[12]**

i) Inlet vane angle.

ii) Discharge.

iii) Manometric head and

iv) Shaft Power.

v) Mechanical efficiency.

OR

Q6) a) Derive an expression for rise in pressure through impeller of a centrifugal pump. **[6]**

b) Power input to centrifugal pump is 50kW at the shaft while running the pump at 1440 rpm. The impeller tip diameter is 30 cm and the blade width at the tip is 1.5cm. The water flows rate is 110 lit/s. The vacuum gauge reading at the suction flange is - 20cm of mercury and at the delivery flange the pressure gauge reading is 370 kPa. The blade outlet angle is 65°. Calculate: **[12]**

i) Theoretical head.

ii) Ideal head.

iii) Hydraulic efficiency.

iv) Mechanical efficiency.

v) Overall efficiecny.

vi) Specific speed of the pump.

Assume radial entry and constant flow velocity.

Q7) a) Describe surging and choking in a centrifugal compressor. **[6]**

b) The impeller of a centrifugal compressor has the inlet and outlet diameter of 0.3 and 0.6 m, respectively. The intake is from the atmosphere at 100 kPa and 300 K, without any whirl component. The outlet blade angle is 75°. The speed is 10000 rpm and the velocity of flow is constant at 120 m/s . If the blade width at intake is 6 cm, calculate: **[10]**

i) Specific work.

ii) Exit pressure.

iii) Mass flow rate.

iv) Power required to drive compressor if the overall efficiency can be assumed at 0.7.

OR

Q8) a) Explain the stalling in centrifugal compressor. Also describe its effect on the compressor performance. **[6]**

b) A centrifugal compressor impeller admits 20 kg/s air at static state of 1 bar, 300 K and runs at 15000 rpm. Isentropic efficiency is 90% for the compression upto 5 bar total pressure. The air enters the impeller eye without prewhirl with the velocity of 120 m/s. Considering the ratio of whirl velocity to tip speed as 0.9 and the internal diameter of the impeller eye as 20 cm, determine: **[10]**

i) Rise in the total temperature in the compressor

ii) Impeller tip speed.

iii) Impeller tip diameter.

iv) Power required to drive compressor.

v) Outer diameter of the impeller eye.

Q9) a) Compare the effect of different factors affecting the stage pressure ratio in axial flow compressor. **[6]**

b) Determine the compressor speed, absolute velocity of the air leaving the stationary inlet guide vane for an axial flow compressor having following specifications: The first stage has a velocity diagram which is symmetric; the ratio of change of whirl velocity to axial velocity is 0.6; the first stage pressure ratio is 1.8; inlet pressure and temperature = 1.01 bar and 300 K, respectively; flow coefficient is 0.4; compressor efficiency = 85% and the mean radius is 30 cm. **[10]**

OR

Q10)a) Explain the construction and working of axial flow compressors. Also show it on h-s diagram. **[6]**

b) An axial flow compressor has the air entering at the pressure and temperature of 1.5 bar and 320 K, respectively. The degree of reaction is 50% and the compressor runs at 35000 rpm. Consider the blade height as 2.2 cm, blade angle at inlet =60°, change in the whirl velocity as 120 m/s, the mean blade radius of 6.5 cm and the turning angle of 30°. Find the pressure rise, mass of the air passing through the compressor, power input and air angle at inlet. Take Cp = 1.005 kJ/kgK and assume no losses in the compressor. **[10]**