Total No. of Questions : 10]

SEAT No. :

P3255

[Total No. of Pages : 4

[5353] - 118

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

TURBO MACHINES

(2012 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 non programmable scientific calculator is allowed.*
4) *Assume data wherever necessary and mention it.*
5) *Draw neat and suitable figures wherever necessary.*

Q1) a) A Pelton turbine running at 720 rpm uses 300 kg of water per second. If the head available is 425 m. The bucket deflects the jet through 165 deg. Determine the hydraulic efficiency. Also find the diameter of the runner and jet. Assume Cv = 0.97, the velocity of the bucket is 0.46 of the jet speed and blade velocity co. of 0.9. **[6]**

b) What is the location of cavitation in reaction turbine and discuss about it in brief. **[4]**

OR

Q2) a) Explain why governing is important in the turbines. **[4]**

b) A jet of water having a velocity of 30m/s enters on the series of moving vanes having velocity 15 m/s. The jet makes 30 deg. To the direction of motion of vane at inlet and leaves the vanes with 5 m/s at an angle of 60 deg. Draw the velocity triangles and find: i. vane tip angle at inlet and outlet for shock less flow, ii. Work done per kg of water **[6]**

Q3) a) Draw neat sketch of Francis turbine and label it. **[4]**

b) A Parsons reaction turbine at 400 rpm develops 5 MW using 6 kg/kW-hr of the steam. The exit angle of the blade is 20 deg. And the velocity of the steam is 1.35 times the blade velocity and pressure at exit is 1.2 bar and the dryness fractions is 0.95. Calculate for this 1. A suitable blade height, assuming Dm / hb = 12, where Dm-mean diameter and hb is blade height. **[6]**

OR

Q4) a) A Kaplan turbine runner has outer diameter of 4.5 m and the diameter of the hub is 2m. lt is required ton 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]**

b) Define following terms: nozzle efficiency, stage efficiency, blade efficiency, coefficient of discharge. **[4]**

Q5) a) Explain following heads in centrifugal pump **[8]**

i) Suction lift

ii) Delivery lift

iii) Centrifugal head

iv) Manometric head

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 0.031 m^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: 1. Manometric efficiency and 2.The overall Efficiency of the pump. **[8]**

OR

Q6) a) A centrifugal pump running at 800rpm is working against a total head of 20.2m. The external diameter of the impeller is 480mm and outlet width 60mm. lf the vanes angle at outlet is 40 deg and Manometric efficiency is 70%, Determine: i) Flow velocity at outlet ii) Absolute velocity of water leaving the vane iii)Angle made by the absolute velocity at outlet with direction of motion at outlet and iv)Rate of flow through pump. **[8]**

b) Discuss the significance of the effect of outlet blade angle on performance of centrifugal pump. **[8]**

Q7) a) Classify centrifugal compressor and discuss its applications. **[4]**

b) Differentiate between centrifugal and axial flow compressors. **[4]**

c) A gas compressor compresses the gas at the rate of 2Kg/s from inlet static pressure of 1 bar to a static pressure of 4bar.The power input to a compressor is 400kW.The velocity of air at entry to the impeller blades is 100m/s and at exit of the impeller is 160m/s. Determine the stagnation pressures and temperatures at inlet and exit of the compressor, diameter of the suction pipe required and adiabatic efficiency based on the static and total values. Assume $\gamma = 1.4$, Cp=1.05 kJ/kgK and R=300Nm/kgK. The temperature at inlet of the impeller is taken as 280 K. **[10]**

OR

Q8) a) A centrifugal compressor delivers 10 m^3/s of air when running at 10000 rpm. The air is drawn in at 1 bar and 300K and delivered at 4 bar. The isentropic efficiency is 80%.The blades are radial at outlet and constant flow velocity is 64 m/s. The outer dia. Of the impeller is twice the inner dia. And slip factor may be taken as 0.9. Calculate l.Temperature of air at outlet of impeller 2. Power required driving the compressor 3. Impeller diameters at inlet and outlet 4.Impeller blade angle at inlet 5. Diffuser blade angle at inlet. **[10]**

b) Discuss the performance characteristic curves of the centrifugal compressor. **[8]**

Q9) a) Show that for 50% Degree of Reaction of axial flow compressors blades are symmetrical. **[8]**

b) An axial compressor stage has following data; temperature 300 K and pressure 1 bar at entry, degree of reaction 50%, mean blade ring diameter 36 cm, rotational speed 18000 rpm. blade height at entry 6 cm, air angles at rotor and stator exit 250,axial velocity 180m/s, work done factor 0.88, mechanical efficiency 96.7 %, Determine 1) Air angles at the rotor and stator entry 2) The mass flow rate of air 3) The power required to drive the compressor 4) The loading coefficient, assume R = 287 J/kgK. **[8]**

OR

Q10) a) Draw neat sketch of axial flow compressor and Explain flow processes through Axial flow compressor with h-S diagram for single stage. **[8]**

b) An eight stage axial flow compressor takes in air at a temperature of 293k at the rate of 3 kg/sec. The pressure ratio is 6 and isentropic efficiency is 0.89. The compressor is designed for 50 % reaction. The blade speed for each stage may be assumed to be constant as 180 m/sec and the flow velocity is 100 m/sec. Determine the power required to drive the compressor and the direction of air at entry and exit from the rotor and stator. Assume that the total work is equally shared between the stages. Assume $\gamma = 1.4$ and Cp = 1 .005kJ/kg K. **[8]**