Total No. of Questions : 10]

SEAT No. :

P2925

[Total No. of Pages : 4

[5669]-514

T.E. (Mechanical Engineering)

TURBO MACHINES

(2015 Pattern) (Semester - I)

Time : 2½ 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 figure 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) 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) Determine wheel diameter and jet diameter of Pelton wheel which develop 1000 kW shaft power when running at 250 rev/min. Available head is 500 m. Assume velocity coefficient of 0.98, overall efficiency of 85% and ratio of peripheral speed to jet velocity of 0.45. **[6]**

OR

Q2) a) Explain the terms unit speed, unit discharge and unit power and derive expression for the same. **[6]**

b) A 15 mm diameter nozzle having $C_v = 0.97$, is supplied with water under a head of 30 m. The jet impinges on a fixed curved vane, water glides on the vane tangentially and being deflected through 165°. Calculate the force on the vane in the direction of the jet, if **[4]**

i) There is no friction

ii) The velocity of water leaving the vane is 0.8 of its impinging velocity.

Q3) a) Define following terms and explain their importance in selection and design of hydraulic turbines : **[4]**

i) Specific speed

ii) Run-away speed

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b) A turbine developing 5000 kW under a head of 16 m runs at a design speed of 200 rpm. It is proposed to use the same design altered to a suitable scale for a turbine giving 3000 kW under a head of 10 m. **[6]**

Calculate :

i) Scale ratio of new machine

ii) Design speed of new machine

OR

Q4) a) Compare Kaplan turbine and Propeller turbine. Explain which turbine is suitable, for part loading condition and why? **[5]**

b) An axial flow turbine has a vertical conical draft tube. Diameter of the tube at the upper end is 0.5 m and at the outlet is 0.7 m. The tube is running full with water flowing downwards, and is 8 m long with 3.5 m of its bottom length in tailwater. The frictional losses between the top and the bottom point is 0.2 times the velocity head at the top point where the water has a velocity of 6 m/s. Find the water pressure at the top point of the draft tube. **[5]**

Q5) a) State the different methods of compounding of steam turbine. Explain any one method in detail with neat sketch. **[6]**

b) For a certain stage of 50% reaction turbine mean rotor diameter is 1.35 m and speed ration is 0.69. The rotor speed is 3000 rpm and outlet blade angle is 55°, Find : **[10]**

i) Inlet blade angle

ii) Blade efficiency and maximum blade efficiency

OR

Q6) a) What is the need of governing system used in steam turbine? Explain the throttle governing system with neat sketch. **[6]**

b) Steam enters an impulse wheel having a nozzle of 20° at a velocity of 450 m/s. The exit angle of the moving blade is 20° and relative velocity of steam may be assumed to remain constant over the moving blades. If the blade speed is 180 m/s and mass flow rate of steam is 2.5 kg/s determine: **[10]**

i) Blade angle at inlet

ii) Work done per kg of steam

iii) Total power developed by the turbine

iv) Diagram efficiency

Q7) a) What did you understand by the term cavitation and NPSH in centrifugal pump? How cavitation can be avoided? Explain the term 'NPSH available' and 'NPSH required'. **[8]**

b) Centrifugal pump delivers water at a rate of 0.6 m^3/s against a head of 20 m. It runs at 1000 rpm. Water enters the impeller radially and the velocity of flow remains constant throughout at 3 m/s. The monomeric efficiency of pump is 80% and the loss of head due to friction over the impeller is $0.025V_2^2$ m of water. Assume inner diameter as half of the outer diameter. **[9]**

Determine :

i) Vane angle at inlet and outlet

ii) Diameter of impeller

iii) Area of flow at outlet

OR

Q8) a) Derive an expression for the minimum speed for starting a centrifugal pump. **[6]**

b) A certain centrifugal pump has a head-discharge relationship is as given in the table below :

Discharge, Q (lit/s)	0	10	20	30	40	50
Head H (m)	20.2	20.6	19.7	17.5	14.2	8.0

The pump delivers water through a 150 mm diameter and 500 m long pipeline. The coefficient of friction for the pipe is 0.025. The pump is to operate against a head of 15 m. Assuming the efficiency of the pump as 70 %, determine the discharge and power required. **[11]**

Q9) a) Explain the term surging and chocking in a centrifugal compressor. How does it affect the performance of compressor? Suggest method to minimize its effect. **[9]**

b) Explain the following terms : **[8]**

i) Losses in axial flow compressor

ii) Slip and pre whirl in centrifugal compressor

OR

Q10)a) Write advantages and disadvantages of axial flow compressor over centrifugal compressor. **[6]**

b) A centrifugal compressor is used as a supercharger for an aircraft engine developing 750 kW power having specific fuel consumption of 0.27 kg/kWh. The supercharger supplies air fuel mixture at 1.25 bar. The air fuel ratio is 17:1. Air enters the supercharger at pressure of 0.55 bar and temperature of 0°C. Assuming adiabatic efficiency of supercharger as 85 %, calculate volume flow rate of mixture to be supplied to the engine and power required to drive the supercharger. Take C_p = 1 kJ/kgK, R = 0.277 kJ/kgK. **[11]**

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