

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  $165^\circ$ . 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

**P.T.O.**

- 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 ratio is 0.69. The rotor speed is 3000 rpm and outlet blade angle is  $55^\circ$ , 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  $20^\circ$  at a velocity of 450 m/s. The exit angle of the moving blade is  $20^\circ$  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  $0.6 \text{ m}^3/\text{s}$  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:

- Vane angle at inlet and outlet
- Diameter of impeller
- 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 choking 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]

- Losses in axial flow compressor
- 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  $C_p = 1 \text{ kJ/kgK}$ ,  $R = 0.277 \text{ kJ/kgK}$ . [11]

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