

Total No. of Questions : 12]

SEAT No. :

P925

[Total No. of Pages : 7]

[4263] - 218

T.E. (Mechanical)
(Common to Mech. S/W)
TURBO MACHINES
(2008 Pattern) (Semester - II)

Time : 3 Hours]**[Max. Marks : 100]****Instructions to the candidates:-**

- 1) Answer any 3 questions from each section.
- 2) Answers to the two sections should be written in separate books.
- 3) Neat diagrams must be drawn wherever necessary.
- 4) Figures to the right indicate full marks.
- 5) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.
- 6) Assume suitable data, if necessary.

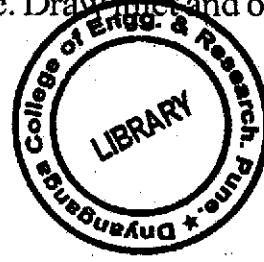
SECTION - I**Unit - I**

- Q1) a)** A jet of water having a velocity of 45m/s impinges without shock on a series of vanes moving at 15 m/s. The direction of motion of the vanes is inclined at 20 degrees to that of the jet, relative velocity at outlet is 0.9 of that at inlet, and absolute velocity of water at exit is to be normal to the motion of vanes. [8]

Determine:

- i) Vane angles at inlet and outlet.
 - ii) Work done on vanes per N (newton) of water supplied by the jet; and
 - iii) Hydraulic efficiency.
- b)** What do you mean by gross head, net head and efficiency of turbine? Explain the different efficiency of a turbine. Draw inlet and outlet velocity triangles for a pelton wheel. [8]

OR



P.T.O.

Q2) a) The following are the design particulars of a large Pelton turbine: [10]

Head at distributor = 630 m; discharge = $12.5 \text{ m}^3/\text{s}$; power = 65 MW; speed of rotation = 500 r.p.m.; runner diameter = 1.96 m; number of jets = 4; jet diameter = 192 mm; angle through which the jet is deflected by the buckets = 165° ; and mechanical efficiency of the turbine = 96%.

Determine the hydraulic power losses in the distributor nozzle assembly and the buckets.

b) Derive an expression for the force exerted by a jet of water on a moving inclined plate in the direction of plate. [6]

Unit - II

Q3) a) A reaction turbine works at 450 r.p.m. under a head of 120 m. Its diameter at inlet is 1.2 m and the flow area is 0.4 m^2 . The angles made by absolute and relative velocities at inlet are 20 degree and 60 degree respectively with the tangential velocity. [8]

Determine:

- The volume flow rate.
 - The power developed.
 - The hydraulic efficiency.
- b)** What do you understand by the characteristics curves of a turbine? Name it and explain any two characteristic curves. [8]

OR

Q4) a) A conical draft tube having inlet and outlet diameters 1.2 m and 1.8 m discharges water at outlet with a velocity of 3 m/s. The total length of the draft tube is 7.2 m and 1.44 m of the length of the draft tube is immersed in water. If the atmospheric pressure head is 10.3 m of water and loss of head due to friction in the draft tube is equal to 0.2 times the velocity head at outlet of the tube, determine: [8]

- i) pressure head at inlet
 - ii) Efficiency of the draft tube.
- b) Write a short notes on a) Governing of reaction turbine & Cavitation in turbine. [8]

Unit - III

- Q5) a) In an impulse turbine with a single row wheel the mean diameter of the blades is 1.05m and the speed is 3000 r.p.m. The nozzle angle is 18° , the ratio of blade speed to steam speed is 0.42 and the ratio of the relative velocity at outlet from the blades to that at inlet is 0.84. The outlet angle of the blade is to be made 3° less than the inlet angle. The steam flow is 10 kg/s. Draw the velocity diagram for the blade and derive the following: [10]

- i) Tangential thrust on the blades,
 - ii) Axial thrust on the blades,
 - iii) Resultant thrust on the blades,
 - iv) Power developed in the blades,
 - v) Blading efficiency.
- b) Derive an expression for maximum blade efficiency in a single stage impulse turbine. [8]

OR

Q6) a)

In a reaction turbine, the blade tips are inclined at 35° and 20° in the direction of motion. The guide blades are of the same shape as the moving blades, but reversed in direction. At a certain place in the turbine, the drum diameter is 1 metre and the blades are 10 cm high. At this place, the steam has a pressure of 1.75 bar and dryness 0.935. If the speed of this turbine is 250 r.p.m. and the steam passes through the blades without shock, find the mass of the steam flow and power developed in the ring of moving blades. [10]

b)

Explain the essential differences in the manner of expansion of steam in impulse and reaction turbines. Illustrate your answer by sketches of pressure, velocity and specific volume changes which occur as the steam passes over successive blades. [8]

SECTION - II

Unit - IV

Q7) a)

In a constant pressure open cycle gas turbine air enters at 1 bar and 20°C and leaves the compressor at 5 bar. Using the following data: Temperature of gases entering the turbine = 680°C , pressure loss in the combustion chamber = 0.1 bar, compressor efficiency = 85%, turbine efficiency = 80%, combustion efficiency = 85%, $\gamma = 1.4$, and $C_p = 1.024 \text{ kJ/kg K}$ for air and gas, find: [10]

i) The quantity of air circulation if the plant develops 1065 kW,

ii) Heat supplied per kg of air circulation,

iii) The thermal efficiency of the cycle,

mass of fuel may be neglected.

b)

For an actual Joule-Brayton cycle without any pressure drops, derive the condition for maximum plant output in terms of isentropic temperature ratio and compressor and turbine efficiencies. [6]

Q8) a) A turbojet engine consumes air at the rate of 60.2 kg/s when flying at a speed of 1000 km/h. Calculate: [10]

- i) Exit velocity of the jet when the enthalpy change for the nozzle is 230 kJ/kg and velocity coefficient is 0.96,
 - ii) Fuel flow rate in kg/s when air fuel ratio is 70:1,
 - iii) Thrust specific fuel consumption,
 - iv) Thermal efficiency of the plant when the combustion efficiency is 92% and calorific value of the fuel used is 42000 kJ/kg
 - v) Propulsive power
 - vi) Propulsive efficiency
 - vii) overall efficiency.
- b) Explain the working difference between propeller jet, turbo jet and turbo propeller. [6]

Unit - V

Q9) a) A centrifugal pump running at 800 r.p.m. is working against a total head of 20.2 m. The external diameter of the impeller is 480 mm and outlet width 60 mm. If the vanes angle at outlet is 40° and manometric efficiency is 70%, Determine [10]

- i) Flow velocity at outlet.
- ii) Absolute velocity of water leaving the vane
- iii) Angle made by the absolute velocity at outlet with the direction of motion at outlet and
- iv) Rate of flow through the pump.

- b) Explain Priming of a centrifugal pump and State the criteria for selection of a centrifugal pump for a given application. [8]

OR

- Q10)** a) The diameter and width of a centrifugal pump impeller are 300 mm and 60 mm respectively. The pump is delivering 144 litres of liquid per second with a manometric efficiency 85 percent. The effective outlet vane angle is 30° . If the speed rotation is 950 r.p.m. Calculate specific speed of the pump. Also define specific speed of a centrifugal pump and derive equation for the same. [12]
- b) Why is multistaging used for a centrifugal pump? Describe the methods used for multistaging. [6]

Unit - VI

- Q11)** a) In an eight stage axial flow compressor, the overall stagnation pressure ratio achieved is 5:1 with an overall isentropic efficiency of 92%. The inlet stagnation temperature and pressure are 290 K and 1 bar. The work is divided equally between the stages. The mean blade speed is 160 m/s and 50% reaction design is used. The axial velocity through the compressor is constant and is equal to 90 m/s. Calculate the blade angle and the power required. [10]
- b) Explain slip and prewhirl in connection to centrifugal compressors. [6]

OR

- Q12)** a) A centrifugal compressor running at 10000 r.p.m. delivers $660 \text{ m}^3/\text{min}$. 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 impeller and flow velocity of 62 m/s may be assumed throughout constant. The outer radius of impeller is twice the inner and the slip factor may be assumed as 0.9. The blade area coefficient may be assumed 0.9 at inlet, determine: [10]

- i) Final temperature of air,
 - ii) Theoretical power,
 - iii) Impeller diameter at inlet and outlet.
 - iv) Breadth of impeller at inlet.
 - v) Impeller blade angle at inlet.
 - vi) Diffuser blade angle at inlet.
- b) Explain surging, choking and stalling with reference to compressors. [6]

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