302049

Seat No.	

T.E. (Mechanical Engineering) (Semester – II) Examination, 2014
TURBOMACHINES
(2008 Course)

Time : 3 Hours Max. Marks : 100

Instructions *: 1) Answers to the* ***two*** *Sections should be written in* ***separate*** *answer books.*
2) Answer Q. ***1*** *or Q.* ***2****, Q.* ***3*** *or Q.* ***4****, Q.* ***5*** *or Q.* ***6*** *from Section* ***I****, Q.* ***7*** *or Q.* ***8****, Q.****9*** *or Q.* ***10****, Q.* ***11*** *or Q.* ***12*** *from Section* ***II****.*
3) Neat diagrams must be drawn ***wherever*** *necessary.*
4) Figures to the ***right*** *side indicate* ***full*** *marks.*
5) ***Use*** *of calculator, Steam Table, Mollier chart is* ***allowed****.*
6) Assume suitable data if ***necessary****.*

SECTION – I

1. a) Show that when a jet of water impinging normally on a series of curved vanes, maximum efficiency is obtained when the vane is semicircular in section and the velocity of the vane is half that of the jet. **9**

   b) A jet of water 5 cm diameter moving with a velocity of 25 m/sec strikes horizontally a single moving vane, moving in the direction of jet with a velocity of 16 m/sec. The vane deflects the jet through 130°. Find the axial force exerted by the jet on the vane. Also, find the velocity and direction of the water at outlet. Neglect friction. **9**

OR

2. a) Sketch a Pelton wheel bucket and explain the effect of its size, shape and number on its function. **8**

   b) A single jet Pelton wheel is supplied with water from a reservoir 300 m above the center of nozzle, through a pipe of 600 mm diameter and 5 km long. The friction factor for the pipe is 0.032. The jet has diameter of 80 mm and its velocity coefficient is 0.97. the wheel bucket speed is 0.47 times the jet speed and deflects the water through 160°, the relative velocity at outlet is 80% of that at inlet. The mechanical efficiency of the wheel is 80%. Determine – i) Shaft power of the wheel ii) Hydraulic efficiency and iii) Overall efficiency. **10**

3. a) Describe with the help of neat sketch the various components of Francis Turbine. **6**

   b) In an inward flow reaction turbine developing 185 kW under a head of 35 m, the inlet diameter is 1.5 times the outlet diameter. The guide blade angle is 20° at inlet and the blade angle at outlet is 25°. The area of flow at outlet is 4/3 times the area of flow at inlet. The water is discharged radially into the atmosphere. Determine the outlet area from guides, pressure head at inlet to wheel and discharge when there is a loss of 10% of velocity head in the guides and 20% of the outlet relative velocity head in the runner blades. **10**

OR

4. a) Compare Francis, Kaplan and Propeller turbine. Explain why Kaplan turbine is preferred where load on the turbine is fluctuating. **8**

   b) Calculate the efficiency of a Kaplan turbine developing 2900 kW under a net head of 5 m. It is provided with a draft tube with its inlet (diameter 3 m) set 1.6 m above the tailrace level. A vacuum gauge connected to the draft tube indicates a reading of 5 m of water. Assume draft tube efficiency as 78%. **8**

5. a) Why governing of steam turbines is necessary ? Explain any two methods of governing of steam turbines with neat diagrams. **8**

   b) In a certain stage of a reaction turbine, the steam leaves the fixed blade at a pressure of 3 bar, 0.98 dry and a velocity of 130 m/sec. the blades are 20 mm high and the discharge angle for both the blades is 20°. The ratio of the axial velocity of flow to the blade velocity is 0.7 at inlet and 0.76 at exit from moving blades. If the turbine uses 4 kg/sec of steam with 5% tip leakage, determine the mean blade diameter and power developed in the ring. **8**

OR

6. a) Write short note on necessity and methods of compounding of steam turbines. **8**

   b) A Parsons reaction turbine at 400 rpm develops 5 MW using 6 kg/kWh of steam. The exit angle of the blades are 20° and the velocity of steam is 1.35 times the blade velocity and pressure at exit is 1.2 bar with dryness fraction of 0.95. Calculate for this – i) A suitable blade height, assuming $D_m/h_b = 12$ and ii) Diagram power. **8**

SECTION – II

7. 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 the gases entering the turbine = 680°C, pressure loss in the combustion chamber = 0.1 bar compressor efficiency = 85%, turbine efficiency = 80%, combustion efficiency = 85% Take $\gamma = 1.4$ and CP = 1.024 kJ/kg K for air and gas, find :

   1) The quantity of air circulation if the plant develops 1000 kW,
   2) Heat supplied per kg of air circulation,
   3) The thermal efficiency of the cycle mass of the fuel may be neglected. **10**

   b) Explain the working of turbo jet and pulse jet engine. **6**

OR

8. 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**

   1) Exit velocity of the jet when the enthalpy change for the nozzle is 230 kJ/kg and velocity coefficient is 0.96.
   2) Fuel flow rate in kg/s when air fuel ratio is 70:1.
   3) Thrust specific fuel consumption.
   4) Thermal efficiency of the plant when the combustion efficiency is 92% and calorific value of the fuel used is 42000 kJ/kg.
   5) Propulsive power.
   6) Propulsive efficiency.
   7) Overall efficiency.

   b) Explain the inter cooling and reheating methods to improve thermal efficiency of gas turbine. **6**

9. a) Why is multistaging used for a centrifugal pump ? Describe the methods used for multistaging. **8**

   b) A centrifugal pump running at 800 RPM 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
   1) Flow velocity at outlet.
   2) Absolute velocity of water leaving the vane.
   3) Angle made by the absolute velocity at outlet with the direction of motion at outlet.
   4) Rate of flow through the pump. **10**

OR

10. a) A centrifugal pump impeller has an external diameter of 500 mm and a discharge area of $0.15\,m^2$. The vanes are set back at an angle of 30° to the tangent at exit. The diameter of suction and delivery pipe is 300 mm and 250 mm respectively. Pressure gauge at points on suction and delivery pipe fitted close to pump and at a height of 1.75 m above the level in supply sump showed gauge pressure heads of 3.6 m below and 20 m above the atmospheric pressure head respectively when the pump is delivering 225 liters of water per second at 820 rpm. If it requires 73.58 KW to drive the pump. Find : **10**
   1) The loss of head in suction pipe
   2) Manometric efficiency
   3) Overall efficiency.

   b) Explain priming of centrifugal pump and state the criteria for selection of centrifugal pump for given application. **8**

11. a) Represent and explain the processes involved in a centrifugal compressor on T-S diagram and derive the expression for isentropic efficiency based on total values. **6**

   b) Explain slip and Prewhirl in centrifugal compressors. **6**

   c) Define slip coefficient and pressure coefficient. **4**

OR

12. a) An axial flow compressor is required to deliver 50 kg/s of air at a stagnation pressure of 5 bar. At inlet to first stage the stagnation pressure is 1 bar and stagnation temperature is 300 K. The hub and tip diameters at this location are 0.436 m and 0.728 m. At mean radius, which is constant through all stages of the compressor, the reaction is 0.5 and absolute air angles at stator exit is 28.8° for all stages. The speed of rotor is 8000 rpm. Determine the number of similar stages needed, assuming polytropic efficiency is 0.89 and that the axial velocity at the mean radius is constant through the stages equal to 1.05 times the average axial velocity. **10**

   b) Explain surging, chocking and stalling with reference to compressors. **6**
