

2013

**STEAM TURBINE AND ITS AUXILIARIES**

*Time Allotted : 3 Hours*

*Full Marks : 70*

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words  
as far as practicable.*

**GROUP – A**

**( Multiple Choice Type Questions )**

1. Choose the correct alternatives for the following :

10x1 = 10

- i) Mixing up of CW water with DM water
  - a) increases pH value of the water
  - b) decreases turbidity of the water
  - c) decreases pH value of the water
  - d) Increases turbidity of the water.
- ii) Stage of a turbine means
  - a) one set of nozzles and two set of blades
  - b) one set of nozzles and one set of blades
  - c) one set of blades
  - d) none of these.
- iii) Two row pressure compounded impulse turbine is known as
  - a) DE-LAVAL turbine
  - b) Rateau staged turbine
  - c) Curtis staged turbine
  - d) none of these.
- iv) Barring gear is used to
  - a) rotate the turbine at low speed before start up or after shut down

- b) facilitate uniform heating or cooling
  - c) avoid sagging or hogging in a rotor
  - d) all of these.
- v) Vacuum in a condenser is created by
- a) Ejectors
  - b) Condensate extraction pump
  - c) Condensation of steam
  - d) all of these.
- vi) Deaerator
- a) provides storage for BFP suction
  - b) removes oxygen by mechanical deaeration
  - c) works as feed water
  - d) all of these.
- vii) Function of start-up oil is to reset
- a) control valve
  - b) stop valve
  - c) all protective devices
  - d) main trip valve.
- viii) Driving steam for ejectors are taken from
- a) extraction from LP turbine
  - b) HP turbine exhaust
  - c) PRDS
  - d) Gland steam header.
- ix) BFP discharge pressure is
- a) less than drum pressure
  - b) more than safety valve set pressure
  - c) more than MS pressure
  - d) always less than MS pressure.
- x) Nozzle used in a steam turbine is of
- a) converging type
  - b) diverging type

- c) converging-diverging type
- d) none of these.

**GROUP – B**

**( Short Answer Type Questions )**

Answer any *three* of the following.  $3 \times 5 = 15$

2. Explain the requirement of HP LP bypass system in a thermal power plant.
3. Draw the schematic diagram of a Turbine Lubricating Oil System.
4. Show that for a convergent divergent nozzle  $M = 1$  occurs only at the throat.
5. Find the expression for Diagram Work for an impulse turbine.
6. Write a short note on Automatic Turbine Run Up System.

**GROUP – C**

**( Long Answer Type Questions )**

Answer any *three* of the following.  $3 \times 15 = 45$

7. a) Why is condensor flood test performed ? 2
- b) Explain the working principle of a centrifuge and deaerator. 5
- c) A surface condensor receives 250 T/hr of steam at  $40^\circ\text{C}$  with 12% moisture. The cooling water enters at  $32^\circ\text{C}$  and leaves at  $38^\circ\text{C}$ . The pressure inside the condensor is found to be 0.078 bar. The velocity of circulating water is 1.8 m/s. The condensor tubes are 25.4 mm o.d. and 1.25 mm thickness. Taking the overall heat transfer coefficient as  $2600 \text{ W/m}^2\text{K}$ , determine
  - i) the rate of flow of cooling water
  - ii) the rate of air leakage into the condensor shell
  - iii) the length of the tubes

iv) the number of tubes.  $2 + 2 + 2 + 2$

8. a) Explain Nozzle efficiency, Velocity co-efficient and Coefficient of discharge. 3

b) The velocity of steam entering a simple impulse turbine is 1000 m/s and the nozzle angle is  $20^\circ$ . The mean peripheral velocity of blades is 400 m/s and the blades are symmetrical. If the steam is to enter the blades without shock, what will be the blade angles? Neglecting the friction effects on the blades, calculate the tangential force on the blades and the diagram power for a mass flow of 0.75 kg/s. Estimate also the axial thrust and diagram efficiency.

$2 + 2 + 2 + 2$

c) In a stage of an impulse turbine provided with a single row wheel, the mean diameter of the blade ring is 800 mm and the speed of rotation is 3000 rpm. The steam issues from the nozzles with a velocity of 300 m/s and the nozzle angle is  $20^\circ$ . The rotor blades are equiangular and the blade friction factor is 0.86. What is the power developed in the blading when the axial thrust on the blades is 140 newtons. 4

9. a) Air at 7.8 bar and  $180^\circ\text{C}$  expands through a convergent divergent nozzle into space at 1.03 bar. The flow rate of air is 3.6 kg/s. Assuming isentropic flow throughout and neglecting the inlet velocity, calculate the throat and exit areas of the nozzles.  $3 + 3$

b) Steam is expanded in a set of nozzles from 10 bar.  $300^\circ\text{C}$  to 2 bar. Are the nozzles convergent or divergent? Neglecting the initial velocity, find the minimum area of the nozzles to flow 1 kg/s of steam. Assume isentropic expansion.  $1 + 3$

- c) Explain supersonic nozzle and subsonic diffuser. 5
10. a) Why are the reaction blades aerofoil shaped ? 2
- b) What is degree of reaction ? What is reheat factor and condition line for a multistage turbine ? 5
- c) What is approach and cooling efficiency of a cooling tower ? 3
- d) How is the high pressure steam prevented from leaking out of the clearance between rotor and casing ? Explain with sketch. 5
11. a) Explain the effectiveness of a Curtis stage. Why is compounding necessary ? 3
- b) What are nozzle governing and throttle governing ? Write down the advantages of each governing. 4
- c) With a sketch, describe the Hydraulic Governing System. 8

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