Ref. No.: Ex/PE/PE/B/T/323A/2024

B.E. Power Engineering, 3rd Year, 2nd Semester Examination, 2024

Thermal Power Plant Systems

Time: Three Hours **Full Marks: 100**

Group A: CO1 (15 Marks)

1. Answer the following questions briefly (any three questions)
   a) Why equipment layout of a thermal power plant is critical during the initial design? Briefly describe about the philosophy for the design of a layout (drawing a schematic diagram of the layout).
   b) What is the function of a Deaerator in a thermal power plant? Why Deaerator is located at a higher elevation? Explain the reason for this design.
   c) Draw a schematic sectional view of a utility boiler and its auxiliaries and briefly explain the function of each component.
   d) Draw a schematic view of boiler flue gas circuit considering various equipment indicating the range of operational temperature. What do you mean by SCAPH in a flue gas system?

Marks: 3 × 5 = 15

Group B: CO2 (30 Marks)

2. Answer the following questions briefly (any four questions)
   a) Using a schematic diagram, describe the pulverized fuel-fired system in a thermal power plant. What are the advantages of a pulverized fuel-fired system?
   b) Briefly describe about the practical high-pressure heater operation from the perspective of terminal temperature difference (TTD).
   c) For a steam power plant, describe about the open-type and closed-type feed water heaters with an example. What are the basic differences between them?
   d) Describe about the basic principle of ESP (drawing schematic diagram). What are factors affecting the ESP performance?
   e) Why reheat regenerative feed heating system is popular in a steam power plant? How it influence the cycle performance (describe using TS diagram).

Marks: 4 × 4 = 16

3. A steam power plant with inlet steam to the h.p. turbine at 90 bar and 500°C, and condensation at 40°C produces 500 MW. It has one stage of reheat optimally placed which raises the steam temperature back to 500 °C. One closed feedwater heater with drains cascaded back to the condenser receives bled steam at the reheat pressure, and the remaining steam is reheated and then expanded in the l.p. turbine. The h.p. and l.p. turbines have isentropic efficiencies of 92% and 90%, respectively. The isentropic efficiency of the pump is 75%. Calculate (a) the mass flow rate of steam at the turbine inlet in kg/s, (b) the cycle efficiency, and (c) the cycle work ratio. Use TTD = – 1.6 °C.

OR

A regenerative steam power cycles operate between 20 bar of 300°C and 0.01 bar. Two feed water heaters are used to extract the steam at 5 bar and 1 bar, respectively. Determine (a) the

[Turn over

quality of steam at the turbine outlet, (b) mass of bled steam from each heater per kg of steam entering to the turbine, (c) net work done, (d) Cycle efficiency, and (e) specific steam consumption. Assume all the processes are ideal and neglect the work done by the pump.

Marks: 14

Group C: CO3 (35 Marks)

4. Answer the following questions briefly (any four questions)
   a) What do you mean by HP-LP bypass system in a conventional utility boiler turbine system? Explain the functions using a schematic diagram.
   b) Why lubrication system is critical for turbine operation. Describe about the turbine lubrication system with various auxiliaries.
   c) Using a schematic diagram, describe about the auxiliary steam system in a conventional utility boiler. What are the sources of auxiliary steam?
   d) What do you mean by turbine gland sealing steam system (describe using a schematic diagram)?
   e) Describe about the various methods of governing the steam turbine (using a schematic diagram).

   Marks: 4 × 5 = 20

5. A textile factory requires 10 t/h of steam for process heating at 3 bar saturated and 1000 kW of power, for which a back pressure turbine of 70% internal efficiency is to be used. Find the steam condition required at the inlet of the turbine.

   OR

   In a reheat regenerative vapour power cycle, steam enters to the turbine at 150 bar, 600°C and reheated at 20 bar, 600°C at the same temperature. One feed water heater is used to extract steam at the pressure of 5 bar and the remaining steam is expanded to a condenser pressure of 0.1 bar. Find the fraction of extracted steam for regeneration, thermal efficiency of the cycle and mass flow rate of steam in kg/h, if the cycle produces 120 MW. Neglect all the losses and work done by the pump.

   Marks: 15

Group D: CO4 (20 Marks)

6. Answer the following questions briefly (any four questions)
   a) Describe about the ash handling system of a utility boiler (draw a schematic diagram).
   b) What are the different types of water used in a conventional steam power plant? Briefly describe about their function during the cycle operation.
   c) What are the characteristics of cooling tower performance? What is NDCT and what is the advantage of NDCT?
   d) What is the function of condenser in a a steam power plant? What is the role of a steam jet air ejector in a surface condenser?
   e) In the absence of cooling water, how steam condensing plant can operate? State the basic operational principle using a schematic diagram.

   Marks: 4 × 5 = 20