Ref. No.: Ex/PE/PC/B/T/312/2025

B.E. Power Engineering, 3rd Year, 1st Semester Examination, 2025

Thermal Power Generation

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

Group A: CO1 (25 Marks)

1. Answer the following questions briefly (any three questions)
   a) What is the significance of "superheated steam" in thermal power generation? What is its effect on cycle efficiency? Describe using a T-S diagram.
   b) Explain the importance of steam temperature and pressure in the efficiency of a thermal power plant. Describe using a T-S diagram.
   c) Explain the difference between a subcritical and supercritical thermal power plant. Describe using a T-S diagram. Discuss their implications for practical applications.
   d) What is meant by the optimal degree of regeneration in a vapor power cycle? Provide an explanation using a T-s diagram. Discuss their implications for practical applications.

   Marks: 3 × 4 = 12

2. A thermal power plant operates using a Rankine cycle to generate electricity. The steam is produced in a boiler at a pressure of 8 MPa and a temperature of 500°C. The steam is then expanded in a turbine to a condenser pressure of 10 kPa. The feedwater enters the pump at 10°C and is heated to the boiler pressure before entering the boiler. The heat rejection in the condenser is transferred to a cooling tower. Assume turbine and pump efficiency 85% each. Determine (a) the enthalpies at key points in the Rankine cycle (at the entrance and exit of the boiler, turbine, and condenser), (b) the work output of the turbine and the work input to the pump, (c) the thermal efficiency of the Rankine cycle, (d) the heat loss to the condenser per kg of steam and the total heat supplied by the boiler. **Marks: 13**

   OR

   In a reheat steam Steam at 20 bar, 360°C is expanded in a steam turbine to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. (a) Assuming ideal process, find the net work and the cycle efficiency for per kg of steam. (b) If the turbine and the pump each have 80% efficiency, find the % of reduction in the net work and cycle efficiency. **Marks: 13**

Group B: CO2 (35 Marks)

3. Answer the following questions briefly (any five questions)
   a) Provide a brief description of the pulverized fuel-fired system, accompanied by a schematic diagram. What are the key advantages of using a pulverized fuel-fired system?
   b) What do you mean by DNB in an evaporator? State their impact on steam generation.
   c) What is meant by the circulation ratio (CR) in a vapor power cycle? Explain it with the help of a density-pressure diagram. What does a circulation ratio (CR) of 10 signify?
   d) What are the environmental impacts of thermal power generation? Discuss the main pollutants and their effects.
   e) Briefly describe, about the the different types of boilers used in thermal power plants.

[Turn over

f) What role does a steam drum play in a vapor power cycle? Additionally, what are priming and foaming in a steam drum? **Marks: 5 × 4 = 20**

4. Describe the function of a feedwater pump in a thermal power plant? Discuss various methods for controlling the temperature of superheated steam, and illustrate your explanation with a schematic diagram. **Marks:3 + 12 = 15**

OR

In In a reheat cycle, steam at 500°C expands in an HP turbine till it is saturated vapour. It is reheated up to temperature of 400°C and then expands in the LP turbine to 40°C. If the maximum moisture content at the turbine exhaust is limited to 15%, find (a) the reheat pressure, (b) the boiler pressure, (c) the net specific work output, (d) the cycle efficiency and (e) the steam rate. Assume all processes are ideal. **Marks: 15**

Group C: CO3 (28 Marks)

5. Answer the following questions briefly (any four questions)
   a) Describe the concept of "condensing" and "back-pressure" turbines, and explain their respective applications.
   b) What are the key factors that affect the performance and efficiency of a steam turbine?
   c) How does the steam pressure and temperature influence the performance of a steam turbine?
   d) How is the degree of reaction defined for a turbine? What is a 50% reaction turbine?
   e) Explain the concept of a "turbine stage" and how the number of stages affects the efficiency of turbine? **Marks: 4 × 4 = 16**
6. In a two-stage velocity-compounded IT, steam exits from nozzle at 600 m/sec at 16°. Mean blade velocity is 120 m/sec. Exit angles for first-moving blades is18°, fixed guide blades is 22° and second row of moving blades is 36°. For mass flow rate of steam 10 kg/sec and blade friction coefficient is 0.85, determine (a) the tangential thrust, (b) the axial thrust, (c) the power developed and (d) the diagram efficiency. **Marks: 12**

OR

Steam issues from the nozzle of a simple impulse turbine with a velocity of 610 m/sec. The nozzle angle is 20° and the diameter of the rotor is 62 cm and runs at 9500 rpm. The blade outlet angle is 30° and the friction factor is 0.8. Calculate the power developed per kg of steam and diagram efficiency. **Marks: 12**

Group D: CO4 (12 Marks)

7. Answer all the questions
   a) Explain the role of a condenser in a thermal power plant.
   b) What are the factors that influence the efficiency of a condenser in a thermal power plant?
   c) What is the role of a steam jet air ejector in a surface condenser? How it operates?

Marks: 4 × 3 = 12