Ref. No.: Ex/PE/PC/B/T/312/2024(S)

# B.E. Power Engineering, 3rd Year, 1st Semester Supplementary Examination, 2024

## 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 are the factors affecting the cycle efficiency of a practical steam power plant?
   b) What are the basic differences between sub-critical and super-critical cycles in a steam power plant? Explain using a T-s diagram. State their impact on practical application?
   c) What do you mean by an optimum degree of reheat in a vapor power cycle? How it is connected with the regenerative feed heating cycle? Explain using a T-s diagram. State their impact on practical application.
   d) Define specific steam consumption (SSC) and heat rate (HR). **Marks: 3 × 4 = 12**
2. A cyclic steam power plant is to be designed for a steam temperature at turbine inlet of 360°C and the exhaust pressure of 0.08 bar. After isentropic expansion of steam in the turbine, the moisture content at the turbine exhaust is not to exceed 15%. Determine the maximum allowable steam pressure at the turbine inlet, and calculate the Rankine cycle efficiency for these steam condition. Estimate also the mean temperature of heat addition. **Marks: 13**

   OR

   In In a Rankine cycle, steam inlet to the turbine is (a) dry saturated steam at 10 bar, (b) superheated steam 200°C of 10 bar. The steam is exhausted from the turbine at 0.5 bar. In each of the above case calculate (i) condition of steam after adiabatic expansion, (ii) Rankine efficiency, (iii) specific steam consumption (SSC), (iv) heat rate (HR). **Marks: 13**

### Group B: CO2 (35 Marks)

3. Answer the following questions briefly (any four questions)
   a) Using a schematic diagram, provide a brief description of the pulverized fuel-fired system in a large scale utility boiler. What are the benefits of pulverized fuel-fired system?
   b) Define the circulation ratio (CR) in a vapor power cycle? In which type of boiler CR is important and why? Explain using a density-pressure diagram?
   c) In which type vapor power cycle, steam drum is needed and why? Explain the basic function of the steam drum. In which vapor power cycle steam drum is not required and why?
   d) Using a schematic diagram, write-down a brief explanation of the various firing mechanisms in a pulverized fuel-fired boiler.
   e) Briefly describe about the function of soot blowers. How they operates in a furnace? What is the significance of furnace purging? **Marks: 5 × 4 = 20**
4. What are the causes of Reheater, Superheater, and Economiser tube leakage? Elaborate different methods of superheated steam temperature control (use schematic diagram). **Marks:3 + 12 = 15**

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OR

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 (30 Marks)

5. Answer the following questions briefly (any three questions)
   a) What do you mean by choked flow in a convergent-divergent nozzle? Derive an expression to support answer.
   b) What do you mean by turbine compounding? Why it is necessary? What are the type of compounding – briefly describe.
   c) What is reheat factor in a steam turbine? What are the significance of reheat factor?
   d) What are the difference between impulse turbine and reaction turbine? **Marks: 5 × 3 = 15**
6. The velocity of steam leaving the nozzle of an impulse turbine is 900 m/sec and the nozzle angle is 20°. The blade velocity is 300 m/sec and the blade friction factor is 0.7. Calculate for a mass flow rate of 1 kg/sec and symmetric blading (a) the blade inlet angle, (b) the driving force on the wheel, (c) the axial thrust, (d) the diagram power and (e) the diagram efficiency.

   OR

   In the case of an impulse turbine, velocity of steam at the inlet of the turbine is 500 m/sec, blade mean speed is 200 m/sec. Steam leaves from the moving blade at an angle of 25°. Nozzle angle is 20°. Neglecting the effect of friction through the moving blades, calculate (a) inlet angle of moving blade, (b) exit velocity and blade angle, (c) work done per kg of steam, (d) axial thrust and power for a steam flow rate of 2.5 kg/sec and (e) diagram efficiency. **Marks: 15**

## Group D: CO4 (10 Marks)

7. Answer all the questions
   a) What is the role of steam condenser in a steam power plant? How it is connected with the power generation in the steam power plant? When condenser is not required?
   b) What is the role of a steam jet air ejector in a surface condenser?
   c) Write down about the sources of air leakage in the condenser and its effects.

   **Marks: 4 + 2 + 4 = 10**