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

B.E. Power Engineering, 3rd Year, 1st Semester 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 is the mean temperature of heat addition in a vapor power cycle? What is its effect on cycle efficiency? Describe using a T-S diagram.
   b) What are the different methods for increasing the mean temperature of heat addition in a vapor power cycle? Describe using a T-S diagram.
   c) What do you understand by the externally irreversible and internally irreversible Rankine cycle? What is the penalty due to irreversibility? Describe using a T-S diagram.
   d) 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. **Marks: 3 × 4 = 12**
2. Find the efficiency of a Rankine cycle if the steam inlet to the turbine is (a) dry saturated steam at 10 bar exhausted from the turbine at 0.5 bar and (b) if the exhaust pressure is reduced to 0.1 bar. Find the mean temperature of heat addition in each case. **Marks: 13**

   OR

   In a reheat steam cycle, the initial steam pressure and the maximum temperature are 150 bar and 550°C, respectively. If the condenser pressure is 0.1 bar, the moisture at the condenser inlet is 15%, and assuming the ideal process, determine (a) the reheat pressure (b) the cycle efficiency, and (c) the steam rate (SSC). **Marks: 13**

Group B: CO2 (35 Marks)

3. Answer the following questions briefly (any five questions)
   a) What do you understand about the circulation ratio (CR) in a vapor power cycle? Explain using a density-pressure diagram. What is the meaning of circulation ratio (CR) = 10?
   b) Why the downcomer is located outside the furnace and has a large diameter? Explain with physical significance.
   c) Briefly describe about the pulverized fuel-fired system (use a schematic diagram). What are the advantages of a pulverized fuel-fired system?
   d) Briefly describe about the different firing systems (use schematic diagram) in a pulverized fuel-fired boiler.
   e) Briefly describe about the different types of water wall arrangements (use schematic diagram).
   f) What is the function of a steam drum in a vapor power cycle? What is priming and foaming in a steam drum? **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 single heater generative cycle, the steam enters the turbine at 30 bar at 400°C and the exhaust pressure is 0.10 bar. The feed water heater is a direct contact type which operates at 5 bar. Find (a) the efficiency and the steam rate of the cycle, (b) the increase in mean temperature of heat addition, efficiency and steam rate, as compared to the Rankine cycle (without regeneration). Neglect the work done by the pump. **Marks: 15**

Group C: CO3 (30 Marks)

5. Answer the following questions briefly (any four questions)
   a) What do you mean by stagnation state for a fluid flow? State their impact on the fluid properties (like temperature and pressure).
   b) How is the degree of reaction defined for a turbine? What is a 50% reaction turbine?
   c) What do you understand about the critical pressure ratio of a steam nozzle? Derive the expression.
   d) What are the effects of area change on subsonic and supersonic flow in a nozzle?
   e) Why are reaction blades unsymmetrical? What is the reheat factor and condition line in a turbine? **Marks: 4 × 4 = 16**
6. How is the number of stages in a turbine estimated? Derive the condition for maximum efficiency of an impulse turbine. **Marks: 4 + 10 = 14**

OR

Steam is supplied from the boiler to the nozzle of the impulse stage of a turbine at 15 bar and 300°C and discharged it at 10 bar. The nozzle efficiency is 95% and the nozzle angle is 20°. The blade exit angle is 5° less than the inlet angle. The blade friction factor is 0.9. Calculate for a steam flow of 600 kg/h (a) the axial thrust (b) the diagram power (c) the diagram efficiency and (d) stage efficiency. **Marks: 14**

Group D: CO4 (10 Marks)

7. Answer all the questions
   a) Write down about the surface condenser and its function. Write down about the sources of air leakage in the condenser and its effects.
   b) What is the role of a steam jet air ejector in a surface condenser?
   c) Describe about the dry-type condenser. Where it is applicable and why?

Marks: 4 + 2 + 4 = 10