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## Question Paper Code : 80919

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2024.

Fifth/Seventh Semester

Mechanical Engineering

ME 8595 — THERMAL ENGINEERING – II

(Common to Mechanical Engineering (Sandwich))

(Regulations 2017)

Time : Three hours　　　　Maximum : 100 marks

(Approved steam tables with Mollier chart and Psychrometric chart may be approved)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define Steam Nozzle and its types.

2. Show the effect of friction on flow through a steam nozzle on a Mollier chart.

3. Compare fire tube and water tube boilers.

4. State the functions of any two mountings used in boilers.

5. Draw the velocity diagram of an impulse turbine.

6. Define the terms diagram efficiency and degree of reaction.

7. Distinguish between recuperative and regenerative type heat exchangers.

8. List down the applications of the cogeneration principle.

9. State the effect of superheating and subcooling on the vapor compression refrigeration cycle.

10. State the principle of thermoelectric refrigeration.

PART B — (5 × 13 = 65 marks)

11. (a) Derive the equation for the maximum discharge of steam through a nozzle.

Or

(b) A convergent-divergent nozzle receives steam at 7 bar and 200°C and expands it isentropically to 3 bar. Neglect the inlet velocity and calculate the exit area required for a mass flow rate of 0.1 kg/s.

(i) when the flow is in equilibrium throughout, (6)

(ii) when the flow is super saturated with $pv^{1.3}$ = constant. (7)

12. (a) Explain any two mountings and accessories used in boilers with a neat sketch.

Or

(b) Explain the construction and working of the Lancashire boiler with a neat sketch.

13. (a) The steam at 4.9 bar and 160°C is supplied to a single-stage impulse turbine at a mass flow rate of 30 kg/min from where it is exhausted to a condenser at a pressure of 19.6 kPa. The blade speed is 300 m/s. The nozzles are inclined 25° to the plane of the wheel and the outlet blade angle is 35°. Neglecting friction losses, determine :

(i) theoretical power developed by the turbine, (5)

(ii) diagram efficiency, and (4)

(iii) stage efficiency. (4)

Or

(b) A Parson reaction turbine running at 400 rpm with 50% reaction develops 75 kW per kg of steam- The exit angle of the blade is 20° and the steam velocity is 1.4 times the blade velocity - Determine

(i) Blade velocity, and (6)

(ii) Blade inlet angle. (7)

14. (a) Describe the construction and working of recuperative and regenerative type heat exchangers with a neat sketch.

Or

(b) Discuss cogeneration, state the need for cogeneration systems and explain with examples.

15. (a) Describe the working of the vapor compression refrigeration cycle and explain the effect of superheating and subcooling on the performance of the cycle.

Or

(b) Explain the working of vapor absorption refrigeration cycle with a neat sketch.

PART C — (1 × 15 = 15 marks)

16. (a) Consider the cogeneration plant, shown in Figure Steam enters the turbine at 7 MPa and 500°C. Some steam is extracted from the turbine at 500 kPa for process heating. The remaining steam continues to expand to 5 kPa. Steam is then condensed at constant pressure and pumped to the boiler pressure of 7 MPa. At times of high demand for process heat, some steam leaving the boiler is throttled at 500 kPa and is routed to the process heater. The extraction fractions are adjusted so that steam leaves the process heater as a saturated liquid at 5 kPa. It is subsequently pumped to 7 MPa. The mass flow rate of steam through the boiler is 15 kg/s. Disregarding any pressure drops and heat losses in the piping and assuming the turbine and the pump to be isentropic, determine :

(i) the maximum rate at which process heat can be supplied, (4)

(ii) the power produced and the utilization factor when no process heat is supplied, and (4)

(iii) the rate of process heat supply, when 10 percent of the steam is extracted before it enters turbine and 70 percent of the steam is extracted from turbine at 500 kPa for process heating, (4)

(iv) utilization factor for case (iii). (3)

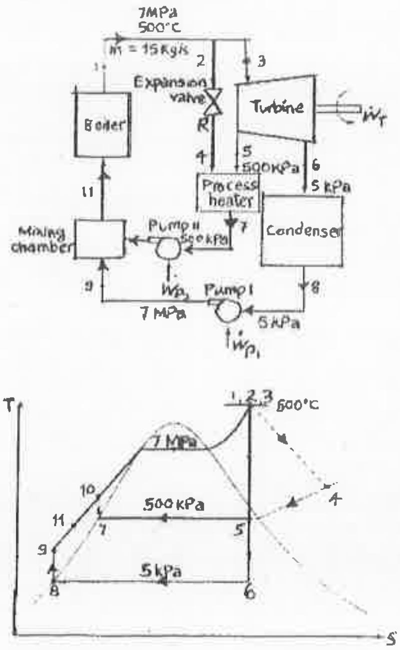


Figure 16 (a) Schematic and T-s diagram

Or

(b) A restaurant having a capacity of 100 seats is to be air-conditioned when outdoor conditions are 30°C DBT and 70% RH. Desired inside conditions are 23°C DBT and 55% RH. The quantity of outdoor air supplied is 0.5 $m^3$/min/person. The desired conditions are achieved by cooling, dehumidifying, and then heating. Calculate

(i) the Capacity of the cooling coil, (4)

(ii) the Capacity of the heating coil, (4)

(iii) the amount of water removed by the dehumidifier, and (4)

(iv) the bypass factor of the heating coil, if its surface temperature is 35°C. (3)