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Question Paper Code : 10928

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2025.

Fifth/Seventh Semester

Mechanical Engineering

ME 8595 – THERMAL ENGINEERING – II

(Common to : Mechanical Engineering (Sandwich))

(Regulations 2017)

Time : Three hours

Maximum : 100 marks

Use of approved steam tables is permitted.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State the relation between velocity of steam and heat during any part of a steam nozzle.
2. Define critical pressure ratio.
3. What are the salient features of Benson boiler?
4. List the accessories used in a boiler.
5. Highlight the fundamental difference between the operation of impulse and reaction steam turbines.
6. What are the different methods of governing steam turbine?
7. State the applications of residual heat recovery.
8. What is meant by tri-generation cycle?
9. Define RSHF line.
10. What are the general comfort conditions during summer and winter?

PART B — ($5 \times 13 = 65$ marks)

11. (a) Steam enters a convergent divergent nozzle at 2 MPa and 400°C with a negligible velocity and mass flow rate of 2.5 kg/s and it exits at a pressure of 300 kPa. The flow is isentropic between nozzle entrance and throat, and overall nozzle efficiency is 93%. Determine
- (i) Throat area and (7)
 - (ii) Exit area. (6)

Or

- (b) Dry saturated steam at 3.5 bar is supplied to a convergent-divergent nozzle whose throat area is 4.4 cm². The exit pressure is 1.1 bar. Determine the maximum possible discharge through nozzle per minute and area of the nozzle at exit when the flow is maximum. Assume the flow as frictionless adiabatic.
12. (a) With a neat sketch, explain the working principle of Loeffler boiler and discuss its relative merits and demerits.

Or

- (b) A boiler unit generates steam at 25 bar, 400°C from feed water supplied to boiler at 40°C. Coal used in boiler has calorific value of 32,500 kJ/kg and it is used at the rate of 630 kg/hr for steam generation rate of 5230 kg/hr.
- (i) Determine the overall efficiency of boiler and equivalent evaporation of boiler unit at 100° C in kg/hr.
 - (ii) Determine the saving of coal in kg/hr if an economiser fitted to the boiler to raise feed water temperature up to 85° increases the overall efficiency of boiler unit by 8% for all other things remaining same.
13. (a) Explain the pressure compounded impulse turbine showing pressure and velocity variations along the axis of the turbine.

Or

- (b) Briefly classify steam turbines and explain simple reaction turbine in detail with a neat sketch.

14. (a) Explain how conventional steam power plant can be used as residual heat recovery system with a neat sketch.

Or

- (b) Steam is generated in the boiler of a cogeneration plant at 12 bar and 350°C at a rate of 32 kg/s. The plant is to produce power while meeting the process steam requirements for a certain industrial applications. Five-sixth of the steam leaving the boiler is throttled to a pressure of 6 bar and is routed to the process heater. The rest of the steam is expanded in a turbine to a pressure of 2 bar and is also routed to the process heater. Saturated water leaves the process heater at 250° C. Neglecting the pump work, Determine the
- (i) net power produced (4)
 - (ii) rate of process heat supply and (4)
 - (iii) utilization factor of this plant. Assume isentropic efficiency of turbine as 83%. (5)

15. (a) Explain the construction and working of vapour-compression refrigeration system with a neat sketch.

Or

- (b) Draw a neat diagram of air conditioning system requires in winter season. Explain the working of different components in the circuit.

PART C — (1 × 15 = 15 marks)

16. (a) Steam expands in a turbine from 40 bar and 450°C to 0.07 bar isentropically. Assuming ideal conditions, determine the mean diameter of the wheel if the turbine was of
- (i) a single impulse stage
 - (ii) single 50% reaction stage,
 - (iii) four pressure stages ,
 - (iv) one two-row Curtis stage and
 - (v) four 50% reaction stages.

Take the nozzle angle as 20° and speed (N) as 3500 rpm.

Or

(b) The following data were obtained in a boiler trial.

Feed water supplied per hour. = 690 kg at 28°C

Steam produced 0.97 dry at 8 bar.

Coal fired per hour = 91 kg of calorific value 27,255 kJ/kg

Ash and unburnt coal collected beneath fire bars = 7.5 kg/hr of calorific value 3700 kJ/kg

Mass of flue gases per kg of coal burnt = 17.4 kg

Temperature of flue gases = 325° C

Room temperature = 17° C

Specific heat of flue gases = 1.005 kJ/kgK

Estimate the boiler efficiency and draw up a heat balance sheet.