02-12-2023 - FN.

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 70904

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2023.

Fifth/Seventh Semester

Mechanical Engineering

ME 8595 — THERMAL ENGINEERING – II

(Common to Mechanical Engineering (Sandwich))

(Regulations 2017)

Time : Three hours Maximum : 100 marks

(Steam table and Psychrometric chart are to be permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Mention any four effects of super saturation in a steam nozzle.

2. How super saturated expansion occurs in steam nozzles?

3. List any two types of boilers, based on its classifications.

4. What is the purpose of fusible plug?

5. What are the advantages and limitations of velocity compounding in impulse turbine?

6. Define reheat factor. Why is its magnitude always greater than unity?

7. List any five applications of heat pipe.

8. Define the terms :

   (a) cogeneration, (1)

   (b) heat-to-power ratio. (1)

9. State the properties of ideal refrigeration process.

10. What is the function of throttling valve in vapor compression refrigeration system?

(b) It is required to design an air-conditioning system for an industrial process for the following conditions: Hot and wet summer conditions:

Outdoor conditions = 32°C DBT and 65% RH.

Required air inlet conditions = 25°C DBT and 60% RH.

Amount of free air circulated = 250 m^3/min.

Coil dew temperature =13°C.

The required condition is achieved by first cooling and dehumidifying and then by heating.

Calculate the following:

(i) The cooling capacity of the cooling coil and its by-pass factor. (5)

(ii) Heating capacity of the heating coil in kW and surface temperature of the heating coil if the by-pass factor is 0.3. (5)

(iii) The mass of water vapor removed per hour. Solve this problem with the use of psychrometric chart. (3)

PART C — (1 × 15 = 15 marks)

16. (a) A refrigerating plant works between temperature limits of –5 °C and 25 °C. The working fluid is ammonia with dryness fraction of 0.62 at the entry of compressor. If the machine has a relative COP of 55%, calculate the amount of ice formed during a period of 24 hrs. The ice is to be formed at 0°C from water at 15°C and 6.4 kg of ammonia is circulated per minute. Take specific heat of water = 4.187 kJ/kgK and latent heat of ice = 335 kJ/kg. Show the process on the chart.

Temperature (°C)	Enthalpy kJ/kg		Entropy kJ/kgK	
25	298.8	1166.15	1.07345	3.9121
–5	158.5	1279.85	0.6298	4.7738

Or

(b) Why the different mounting and accessories are required for boiler application? Explain in detail. Also, explain the functionality of mounting and accessories along with its location and neat sketch.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Derive the equations for mass flow rate of steam. (6)

(ii) Dry saturated steam enters a steam nozzle at a pressure of 15 bar and is discharged at a pressure of 2 bar. If the dryness fraction of discharge steam is 0.96, what will be the final velocity of steam? Neglect the initial velocity of steam. If 10% of heat drop is lost in friction, find the percentage reduction in the final velocity. (7)

Or

(b) Dry saturated steam at a pressure of 8 bar enters a convergent divergent nozzle and leaves it at a pressure of 1.5 bar, if the flow is isentropic and corresponding expansion index is 1.133, find the ratio of cross section area at exit to that of throat for maximum discharges.

12. (a) (i) Explain the characteristic features and working of Benson boiler with a neat sketch. (7)

(ii) In a boiler test, 1250 kg of coal is consumed in 24 hrs. Mass of water evaporated is 13000 kg and mean effective pressure is 7 bar. Feed water temperature is 40°C and heating value of coal is 30,000 kJ/kg. Taking enthalpy of 1 kg of steam at 7 bar as 2570 kJ, find equivalent evaporation per kg of coal and boiler efficiency. (6)

Or

(b) The following observation were recorded during a boiler trail : Fuel used = 65 kg/hr, mass of steam = 540 kg/hr at 10 bar, moisture in fuel is 2% by mass, the mass of dry flue gases is 9 kg of fuel, the lower calorific value is 32000 kJ/kg, the temperature of flue gases is 325°C, temperature of boiler is 28°C, feed water temperature is 50°C, the dryness fraction of the steam is 0.95, specific heat of gas is 1 kJ/kg°C and specific heat of superheated steam is 2.3 kJ/kg°C. Determine the following:

(i) Boiler efficiency (5)

(ii) Equivalent evaporation (5)

(iii) Prepare the energy balance sheet. (3)

13. (a) The following data refer to a single stage impulse turbine: isentropic nozzle enthalpy drop = 210 kJ/kg, Nozzle efficiency = 90% Nozzle angle = 25°, ratio of blade speed to whirl component of steam = 0.5, blade velocity coefficient = 0.9, velocity of steam entering the nozzle = 20 m/s. Find,

(i) blade angle at inlet and outlet if the steam enters the blades and leaves the blade in an axial direction, (4)

(ii) blade efficiency, (3)

(iii) power developed, (3)

(iv) axial thrust if the steam flow rate is 10 kg/s. (3)

Or

(b) (i) Explain the process of compounding of impulse turbine with relevant schematic sketch. (8)

(ii) Explain the process of throttle governing in turbines. (5)

14. (a) Explain the working principle of heat pipe and residual heat recovery process with relevant sketch.

Or

(b) In a cogeneration steam power plant, boiler generates steam at 60 bar and 450°C, which is supplied to turbine for expansion. Steam at 6 bar is extracted from a turbine for a process heating and remainder continues to expand upto a constant pressure of 0.5 bar. The mass flow rate of the steam is 15 kg/s. If the amount of steam extracted for process heating is 5 kg/s, which is condensed at 6 bar from the process reheater. Find the following:

(i) power output in turbine, (2)

(ii) process heat utilized in kW, (2)

(iii) η_{reg}, (2)

(iv) specific steam consumption (2)

(v) work ratio (2)

(vi) heat rejected in kW. Neglect the pump work. (3)

15. (a) (i) Explain the working of Ammonia water vapor absorption refrigeration system in detail. (8)

(ii) Write a brief note on winter air conditioning system with a neat sketch. (5)

Or