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

Question Paper Code : 40836

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Fifth/Seventh Semester

Mechanical Engineering

ME 8595 — THERMAL ENGINEERING — II

[Common to Mechanical Engineering (Sandwich)]

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the function of divergent nozzle?

2. What are the major effects of friction in nozzle?

3. What are the disadvantages of solid fuels?

4. What is the significance of factor of evaporation in boilers?

5. How does pressure and velocity change as the flow proceeds though the runner of the impulse turbine?

6. What is meant by diagram efficiency?

7. List the benefits of waste heat recovery.

8. Differentiate a recuperative heat exchanger from a regenerative heat exchanger.

9. What is the basic working principle of vapour compression refrigeration cycle?

10. What is GSHF?

PART B — (5 × 13 = 65 marks)

11. (a) (i) Explain various types of nozzles. (5)

(ii) Describe the flow of steam through nozzles and hence deduce the expression for a critical pressure ratio. (8)

Or

(b) (i) Explain the supersaturated flow in nozzles and their effects. (5)

(ii) A convergent-divergent nozzle is required to discharge 350 kg of steam per hour. The nozzle is supplied with steam at 8.5 bar and 90% dry and discharges against a back pressure of 0.4 bar. Neglecting the effect of friction, find the throat and exit diameters. (8)

12. (a) (i) Briefly explain the working of a water-tube boiler and list their merits and demerits. (5)

(ii) Compare the boiler mountings with accessories and give one examples for each. (4+4)

Or

(b) The following data was obtained in a steam 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 27,200 kJ/kg, ash and unburnt coal collected from beneath the fire bars 75 kg/hour of calorific value 2760 kJ/kg, mass of flue gases per kg of coal burnt 173 kg, temperature of flue gases 325°C, room temperature 17°C, and the specific heat of the flue gases 1026 kJ/kg K.

Estimate the boiler efficiency, the percentage heat carried away by the flue gases, the percentage heat loss in ashes, and the percentage heat loss unaccounted for.

13. (a) (i) Mention the differences between Impulse and Reaction Turbines. (5)

(ii) Derive the value of blade speed ratio for maximum efficiency of impulse turbine. (8)

Or

(b) Describe the various methods of compounding with suitable diagrams. (13)

14. (a) (i) Explain the various sources of waste heat and their quality. (5)

(ii) Explain the advantages and disadvantages of various co-generation systems. (8)

Or

(b) (i) Explain the functioning of heat pipes. (5)

(ii) Describe the working of Fixed Bed Regenerators and Rotary Bed Regenerators. (8)

15. (a) A cold storage plant is required to store 20 tonnes of fish. The fish is supplied at a temperature of 30°C. The specific heat of fish above freezing point is 2.93 kJ/kg K. The specific heat of fish below freezing point is 1.26 kJ/kg K. The fish is stored in colds storage which is maintained at –8°C. The freezing point of fish is –4°C. The latent heat of fish is 235 kJ/kg. If the plant requires 75 kW to drive it.

Assume actual C.O.P. of the plant as 0.3 of the Carnot C.O.P.

(i) Find the capacity of the plant. (5)

(ii) Calculate the time taken to achieve cooling. (8)

Or

(b) (i) Explain the working of Thermoelectric cooling with its merits and demerits. (5)

(ii) List different parts of a cooling tower and their function and hence explain the working of natural and forced draught cooling towers. (8)

PART C — (1 × 15 = 15 marks)

16. (a) Consider a Parson's stage with a rotor (at mid-height of blades) diameter of 1.2 m, operating at a speed of 3000 rpm, with the steam entry angle of steam be 20°.

Steam enters the stator at 12 bar, 300°C and an isentropic enthalpy drop of 50 kJ/kg is chosen per row of blades. The isentropic efficiency of each row is assumed as 0.84.

(i) Plot the process of expansion in the turbine on the h-s diagram and find the pressure at the exit of stator and rotor. (8)

(ii) Draw the combined velocity triangles and label all the components of the velocity and find the specific work delivered. (7)

Or

(b) The following are the Cogeneration Gas turbine Parameters :

Capacity of gas turbine generator: 4000 kW

Plant operating hours per annum 8000 hrs.

Plant load factor : 90%

Heat rate as per standard given by gas.turbine supplier : 3049.77 kCal / kWh

Waste heat boiler parameters — unfired steam output: 10 TPH

Steam temperature :200°C

Steam pressure :8.5 kg /cm^2.

Steam enthalpy :676.44 kCal / kg.

Fuel used : Natural gas

Calorific value — LCV :9500 kCal/ $5m^3$

Price of gas : Rs. 3000/1000 Sm^3

Capital investment for total co-generation plant : Rs. 1300 Lakhs

Plant Load Factor (PLF) : 90%

Estimate the cost of fuel per annum and cost of power per kWh.(15)

Take 1 kCal = 4.2 kJ.

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