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Reg. No. :

**Question Paper Code : 90865**

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

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. State the relation between velocity of steam and heat during any part of a steam nozzle.



2. What are the factors reducing the final velocity of steam in nozzle flow?

3. How do boiler accessories differ from boiler mountings?

4. What are the essentials of a good steam boiler?

5. Differentiate an impulse and a reaction turbine.

6. What methods are used in reducing the speed of the turbine rotor?

7. What is meant by combined cycle cogeneration?

8. State the applications of residual heat recovery.

9. What is the significance of RSHF in summer air conditioning?

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

PART B — (5 × 13 = 65 marks)

11. (a) Steam having pressure of 10.5 bar and 0.95 dryness is expanded through a convergent-divergent nozzle and the pressure of steam leaving the nozzle is 0.85 bar. Find the velocity at the throat for maximum discharge conditions. Index of expansion may be assumed as 1.135. Calculate mass rate of flow of steam through the nozzle. (13)

Or

(b) Define critical pressure ratio of a nozzle and discuss why attainment of sonic velocity determines the maximum mass rate of flow through steam nozzle. (13)

12. (a) Calculate the mass of flue gases flowing through the chimney when the draught produced is equal to 1.9 cm of water. Temperature of flue gases is 290°C and ambient temperature is 20°C. The flue gases formed per kg of fuel burnt are 23 kg. Neglect the losses and take the diameter of the chimney as 1.8 m. (13)

Or

(b) Explain with neat sketches the construction and working of any of the water tube boilers. (13)



13. (a) Explain the pressure compounded impulse steam turbine showing pressure and velocity variations along the axis of the turbine. (13)

Or

(b) The following data relate to a stage of reaction turbine (13)

Mean root diameter = 1.5 m,

Speed ratio = 0.72

Blade outlet angle = 20°

Rotor speed = 3000 rpm

(i) Determine the diagram efficiency

(ii) Determine the percentage increase in diagram efficiency and rotor speed if the rotor is designed to run at the best theoretical speed, the exit angle being 20°.

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14. (a) Explain how conventional steam power plant can be used as residual heat recovery system with a neat sketch. (13)

Or

(b) Explain with neat sketches the working of any one type of recuperators. (13)

15. (a) An air refrigeration open system operating between 1 MPa and 100 kPa is required to produce a cooling effect of 2000 kJ/min. Temperature of the air leaving the cold chamber is -5°C and at leaving the cooler is 30°C. Neglect losses and clearance in the compressor and expander. Determine: (13)

(i) Mass of air circulated per min.

(ii) Compressor work, expander work, cycle work:

(iii) C.O.P and power in kW required.

Or

(b) Draw a neat diagram of air conditioning system required in winter season. Explain the working of different components in the circuit. Is it possible to use steam for such air conditioning system. (13)



PART C — (1 × 15 = 15 marks)

16. (a) A steam turbine develops 184 kW, with a consumption of 16.45 kg/kWh. The pressure and temperature of the steam entering the nozzle are 11.8 bar and 220°C. The steam leaves the nozzle at 1.18 bar. The diameter of the nozzle at the throat is 7 mm. Find the number of the nozzles. If 8% of the total enthalpy drop is lost in friction in diverging part of the nozzle, determine the diameter at the exit of the nozzle and exit velocity of the leaving steam. (15)

Or

(b) In a standard vapour compression refrigeration cycle, operating between an evaporator temperature of $-10^{\circ}C$ and a condenser temperature of 40°C, the enthalpy of refrigerant , Freon-12, at the end of compression is 220 kJ/kg. (15)

Show the cycle diagram of T-s plane.

Calculate:

(i) The C.O.P of the cycle

(ii) The refrigerating capacity and the compressor power assuming the refrigerant flow rate of 1kg/min.

| T (°C) | p(MPa) | $h_f$(kJ/kg) | $h_g$(kJ/kg) |
|---|---|---|---|
| -10 | 0.2191 | 26.85 | 183.1 |
| 40 | 0.9607 | 74.53 | 203.1 |