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Question Paper Code : 50781

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

Fifth/Sixth Semester

Mechanical Engineering

CME 390 — THERMAL POWER ENGINEERING

(Common to : Mechanical Engineering (Sandwich))

(Regulations 2021)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define Flash point and fire point.

2. Write a short note on turbulent flame.

3. List out the merits and demerits of direct method of boiler efficiency.

4. What are the salient features of packaged boiler?

5. What is the effect of clearance volume on the power required and work done in a reciprocating air compressor?

6. What are the factors to be considered for the selection of different types of compressors?

7. List out the properties of ideal refrigerant.

8. What are the advantages and disadvantages of air refrigeration system?

9. Define degree of reaction.

10. Define sensible heat factor and latent heat.

PART B — (5 × 13 = 65 marks)

11. (a) Explain the classification of fuels and its properties.

Or

(b) What is the difference between proximate analysis and ultimate analysis of coal?

12. (a) Explain with neat sketches of the following boiler mountings :

(i) Water level indicator (7)

(ii) Pressure gauge. (6)

Or

(b) The steam used by the turbine is 5.4 kg/kWh at a pressure of 50 bar and temperature of 350°C. The efficiency of the boiler is 82% with feed water at 150°C. How many kg of coal having C.V. of 28100 kJ are required per kWh of power produced? If the cost of coal/tonne is Rs.500. What is the fuel cost/k Wh?

13. (a) A vapour compression refrigeration system uses R-12 as refrigerant and the liquid evaporates in the evaporator at –15°C. The temperature of this refrigerant at the delivery from the compressor is 15°C when the vapour is condensed at 10°C. Find the COP and refrigeration effect, if

(i) There is no undercooling (6)

(ii) Liquid is cooled by 5°C before expansion by throttling. (7)

Or

(b) Air enters a two stage compressor at 1 bar, 30°. The mass rate of air is 25 kg/min. The delivery pressure is 11.2 bar. The law of compression in both L.P. and H.P. cylinders are same as $PV^{1.25} = C$. Assume perfect intercooling and optimum work condition. The mechanical efficiency of the compressor is 90 %. Find the motor power required and ratio of L.P. cylinder diameter to H.P. cylinder diameter. Assuming the stroke length of the two stages are same.

14. (a) A 300 kJ/min refrigeration, system operates on a vapor-compression. refrigeration cycle with refrigerant 134a as the working fluid, and an isentropic efficiency for the compressor is 85%. The refrigerant enters the compressor as a saturated vapour at 140 kPa and is compressed to 800 kPa. Determine :

(i) The quality of the refrigerant at the end of the throttling process, (5)

(ii) The coefficient of performance and (4)

(iii) The power input to the compressor. (4)

Or

(b) A Ammonia refrigerating system is designed to work between 0°C and 40°C. It is proposed to replace Ammonia (NH_3) refrigerant by R-134a refrigerant in a refrigerating plant of 9 TR capacity operating between the same temperature limits with sub cooling by 5°C before entering the expansion valve. Calculate the percentage change in

(i) Mass flow rate in refrigerant (4)

(ii) The power required to drive the compressor (5)

(iii) COP for the two refrigerants suggested. (4)

15. (a) The atmospheric air at 30°C DBT and 75% relative humidity enters a cooling coil at the rate of 200 m^3/min. The coil dew point temperature is 14°C and by-pass factor of the coil is 0.1. Determine

(i) Temperature of the air leaving the cooling coil (3)

(ii) The capacity of the cooling coil in TR (3)

(iii) The amount of water vapour removed per minute (4)

(iv) The sensible heat factor. (3)

Or

(b) An air conditioning plant is required to supply 60 m^3 of air per minute at a DBT of 21°C and 55% RH. The outside air is at DBT of 28°C and 60% RH. Determine the mass of water drained and capacity of the cooling coil. Assume the air conditioning plant first to dehumidify and then to cool the air.

PART C — (1 × 15 = 15 marks)

16. (a) A 20 tonnes vapour compression refrigeration system using Freon-12 operates between an evaporator pressure of 1.004 bars and a condenser pressure of 13.663 bars. The system uses 10°C of super heat. Calculate the mass flow rate, COP, degree of sub cooling and power input. The refrigerant leaving the condenser in saturated liquid and when leaving the evaporator it is dry saturated vapour. The compression is isentropic. The properties of Freon-12 are shown in the table.

Pressure bar	Temp°C	h_f (kJ/kg)	h_{fg} (kJ/kg)	S_f kJ/kg.K	S_g kJ/kg.K	$C_{p.f.}$ kJ/kg.K	$C_{p.v.}$ kJ/kg.K
1.004	–30	8.854	174.076	0.371	0.7165	–	0.579
13.663	55	90.201	207.766	0.3194	0.6777	1.074	–

Or

(b) A conference room of 60 seating capacity is to be air conditioned for comfort conditions of 22°C dry bulb temperature and 55% relative humidity. The outdoor conditions are 32°C dry bulb temperature and 22°C wet bulb temperature. The quantity of air supplied is 0.5 m^3/min/person. The comfort conditions are achieved first by chemical dehumidification and by cooling coil Determine :

(i) Dry bulb temperature of air at exit of dehumidifier (6)

(ii) Capacity of dehumidifier; Capacity and surface temperature of cooling coil, if the by-pass factor is 0.30. (9)