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Question Paper Code : 40801

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2024.

Fifth/Sixth Semester

Mechanical Engineering

CME 390 – THERMAL POWER ENGINEERING

(Common to : Mechanical Engineering (Sandwich))

(Regulations 2021)

Time : Three hours Maximum : 100 marks

(Use of Steam Table and Thermal Science Data book is permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the two types of calorific values for fuels?

2. Define Latent heat of vaporization.

3. List four common mountings on a boiler.

4. Name the key parameters that affect the performance of a boiler.

5. List the three efficiency metrics used to evaluate air compressors.

6. Write the application of a multistage air compressor.

7. How superheat and sub-cooling affect the performance of a refrigeration system?

8. List key components of a vapor compression refrigeration cycle.

9. Name the four psychrometric processes used in air conditioning.

10. How the cooling load is calculated in air conditioning?

PART B — (5 × 13 = 65 marks)

11. (a) Explain the process of determining the proximate analysis of a fuel. Discuss its significance in evaluating fuel quality.

Or

(b) Explain the concept of the calorific value of fuels. Discuss how the knowledge of calorific value is applied in selecting fuels for various applications.

12. (a) Describe the essential mountings and accessories in a boiler. Discuss their roles in ensuring safe and efficient boiler operation.

Or

(b) Describe the operation and significance of a safety valve in a boiler system. Discuss how it contributes to boiler safety and operation.

13. (a) (i) Explain the principles of multistage air compression with intercooling. (7)

(ii) Discuss how intercooling influences the efficiency and performance of air compressors. (6)

Or

(b) Following data relate to a performance test of a single-acting 14 cm × 10 cm reciprocating compressor:

Suction pressure = 1 bar

Suction temperature = 20 °C

Discharge pressure = 6 bar

Discharge temperature = 180 °C

Speed of compressor = 1200 r.p.m.

Shaft power = 6.25 kW

Mass of air delivered = 1.7 kg/mm

Calculate the following :

(i) The actual volumetric efficiency ;

(ii) The indicated power ;

(iii) The isothermal efficiency ;

(iv) The mechanical efficiency ;

(v) The overall isothermal efficiency ;

14. (a) (i) Describe the principles of an air cycle refrigeration system and its advantages. (8)

(ii) Discuss the applications where air cycle refrigeration is preferable over vapor compression systems. (5)

Or

(b) (i) A Carnot refrigerator requires 1.3 kW per tonne of refrigeration to maintain a region at low temperature of – 38 °C.

Determine : (1) C.O.P. of Carnot refrigerator, (2) Higher temperature of the cycle, (3) The heat delivered and C.O.P. when this device is used as heat pump. (8)

(ii) A cold storage is to be maintained at – 5 °C while the surroundings are at 35 °C. The heat leakage from the surroundings into the cold storage is estimated to be 29 kW. The actual COP of the refrigeration plant used is one third that of an ideal plant working between the same temperatures. Find the power required to drive the plant. (5)

15. (a) (i) Discuss the concept of cooling towers in air conditioning. (7)

(ii) Explain the different types and their role in maintaining the efficiency of air conditioning systems. (6)

Or

(b) The sling psychrometer in a laboratory test recorded the following readings:

Dry bulb temperature = 35 °C

Wet bulb temperature = 25 °C

Calculate the following:

(i) Specific humidity

(ii) Relative humidity

(iii) Vapour density in air

(iv) Dew point temperature

(v) Enthalpy of mixture per kg of dry air

Take atmospheric pressure = 1.0132 bar.

PART C — (1 × 15 = 15 marks)

16. (a) Analyze the performance parameters of a specific boiler type (e.g., fire-tube) and propose design modifications to improve efficiency. Discuss the potential impact on energy savings.

Or

(b) Consider a single-acting reciprocating compressor subjected to a performance test.

The following operating parameters are provided:

Operating Conditions:

Suction Pressure: 0.8 bar

Suction Temperature: 25 °C

Discharge Pressure: 5 bar

Discharge Temperature: 160 °C

Compressor Speed: 1500 revolutions per minute (r.p.m.)

Shaft Power: 8.5 kilowatts (kW)

Mass Flow Rate of Air Delivered: 2.2 kilograms per minute (kg/min)

Your task is to conduct a comprehensive analysis and calculation to assess the performance of this reciprocating compressor. This includes the following aspects:

(i) Actual Volumetric Efficiency (5)

(ii) Indicated Power (5)

(iii) Isothermal Efficiency (5)