Total No. of Questions : 10]

SEAT No. :

PF-12332

[Total No. of Pages : 4

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S.E. (Mechanical)
PCC-202-MEC : ENGINEERING THERMODYNAMICS
(2024 Pattern) (Semester - III)

Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) ***Solve Q1orQ2, Q3 or Q4, Q5 or Q6, Q7or Q8, Q9orQ10.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of Scientific calculator, Steam tables & Mollier chart is allowed.***
5) ***Assume suitable data, wherever necessary.***

Q1) a) Define state, path, process and cycle. Explain the concepts of point function and path function with suitable examples. **[6]**

b) Explain the Zeroth Law of Thermodynamics. Discuss its significance in defining temperature and describe how thermocouples use this principle for temperature measurement. **[8]**

OR

Q2) a) State and explain the First Law of Thermodynamics for a closed system. Describe Joule's experiments and how they established the equivalence of heat and work. **[6]**

b) Air flows steadily at the rate of 0.5 kg/s through an air compressor, entering at 7 m/s velocity, 100 kPa pressure and 0.95 m^3/kg volume. It leaves at 5 m/s velocity, 700 kPa pressure and 0.19 m^3/kg volume. The internal energy of air leaving is 90 kJ/kg greater than that of the air entering. Cooling water in the compressor jackets absorbs heat from the air at the rate of 5 kW. (i) Compute the rate of shaft work input to the air in kW. (ii) Find the ratio of inlet pipe diameter to outlet pipe diameter. **[8]**

Q3) a) State and explain with neat diagram Kelvin-Planck & Clausius Statements of the second law of thermodynamics. **[7]**

P.T.O.

b) Air of mass 2.0 kg undergoes a polytropic process by law $PV^{1.25}$ = Constant from initial pressure P_1 = 200 kPa, V_1 = 0.4 m^3 to final state where final volume V_2 is 0.8 m^3. Use R=0.287 kJ/kg.K and γ=1.4.

Calculate : **[7]**

i) Final Pressure.

ii) Initial and Final Temperature.

iii) Word done

iv) Change in internal energy

OR

Q4) a) Represent the following ideal gas processes on P-V and T-S diagram. **[6]**

i) Isobaric Process.

ii) Isochoric Process.

iii) Isothermal Process.

b) A reversed-Carnot refrigerator must maintain the cold space at -5°C while ambient is 25°C. Required cooling is = 5 kW. Determine **[8]**

i) COP of Refrigerator.

ii) Power required to drive the compressor.

iii) Heat rejected to the surroundings.

Q5) a) Prove the Clausius Inequality for reversible and irreversible heat engine cycles. **[8]**

b) Derive an expression for increase in unavailable energy when heat is transferred through finite temperature difference. **[6]**

OR

Q6) a) An iron cube at temperature of 450 °C is dropped into insulated bath containing 10kg of water at 30°C. The water finally reaches 60°C at a steady state. Find the entropy changes for the iron cube and water. Is the process reversible? If so, why? **[8]**

b) Explain the concept of Available energy and Unavailable energy. **[6]**

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Q7) a) State various methods of improving the efficiency of Rankine cycle. **[6]**

b) Find the enthalpy of 1 kg of steam at 12 bar when **[8]**

i) Saturated liquid condition.

ii) Steam is dry saturated

iii) Steam is 22% dry,

iv) Steam is 50% dry

v) Steam is superheated to 250°C,

vi) Sub cooled to 100°C (C_p = 2.25 kJ/kg K)

OR

Q8) a) Defme dryness fraction of steam. Explain separating and throttling calorimeter with neat sketch. **[6]**

b) A thermal power plant working on Rankine cycle has a boiler pressure of 120 bar and condenser pressure of 5 kPa. Steam is superheated in the super heater to 400 °C. Find per kg of steam generated by boiler. **[8]**

i) Network output

ii) Rankine efficiency

iii) Specific steam consumption

Q9) a) Explain the Boiler Draught and how they are classified. **[6]**

b) In a boiler test, 1250 kg of coal are consumed in 24 hours. The mass of water evaporated is 13000 kg and the mean effective pressure is 7 bar. The feed water temperature was 40°C, heating value of coal is 30000 kJ/Kg. The enthalpy of 1 kg of steam at 7 bar is 2570.7 kJ. Determine : **[8]**

i) Equivalent evaporation per kg of coal;

ii) Efficiency of the boiler.

OR

Q10)a) Give the function and location of the following? **[6]**

i) Economiser

ii) Super heater

iii) Air pre heater

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b) The following results obtained from boiler trial:

Feed water per hour = 700 kg at 27°C

Steam pressure = 8 bar of dryness Fraction 0.97

Coal consumption = 100 kg/hr

C.V. of coal = 25000kJ/kg

Un-burnt coal collected = 7.5 kg/hr (CV = 2000 kJ/Kg)

Flue gas formed per kg of fuel = 17.3 kg at 325°C (Cp of flue gas = 1.025 kJ/kg.K)

Room temperature = 16°C

C_p of Water = 4.18 KJ/kg .K

Draw heat balance sheet on kJ/min basis and calulate Boiler Efficiency. **[8]**

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