Total No. of Questions : 10]

SEAT No. :

PE-5792

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S.E. (Mechanical Engineering)

PCC-202-MEC : ENGINEERING THERMODYNAMICS

(2024 Pattern) (Semester - III)

Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) ***Solve Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q.7 or Q.8. Q.9 or Q.10.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right side indicate full marks.***
4) ***Assume suitable data if necessary.***
5) ***Use of Scientific calculator, Steam tables & Mollier chart is allowed.***

Q1) a) What is Perpetual Motion Machine of the First Kind (PMM-I)? Explain why it is impossible based on the First Law of Thermodynamics. **[6]**

b) Differentiate between macroscopic and microscopic approaches in thermodynamics. Explain their importance with suitable examples. **[8]**

OR

Q2) a) Explain the Zeroth Law of Thermodynamics. Discuss its significance in defining temperature and describe how thermocouples use this principle for temperature measurement. **[6]**

b) At the inlet of a certain nozzle the enthalpy of a fluid passing is 2800 kJ/kg and the velocity is 50 m/s. At the discharge the enthalpy is 2600 kJ/kg. The nozzle is horizontal and there is negligible heat loss from it. Find: **[8]**

i) The velocity at the exit of the nozzle

ii) If the inlet area is 900 cm^2 and specific volume at inlet is 0.187 m^3/kg, find the mass flow rate,

iii) If the specific volume at the nozzle exit is 0.498 m^3/kg, find the exit area of the nozzle.

P.T.O.

Q3) a) Explain the concept of Heat Engine, Refrigerator and Heat pump with schematic diagram. **[6]**

b) A certain gas occupies a space of 0.3 m^3 at a pressure of 2 bar and temperature 77 °C. It is heated at constant volume until the pressure is 7 bar. Determine **[8]**

i) Temperature at the end of process.

ii) Mass of the gas.

iii) Change in internal energy.

iv) Heat transfer.

v) Work done.

Given Cp = 1.005 kJ/kg.K. Cv = 0.712 kJ/kg.K.

OR

Q4) a) Define Ideal Gas and Explain ideal gas laws Boyle's law, Charle's law, Avogadro's Law. **[7]**

b) A Camot engine operates between 800 K and 400 K. The engine absorbs 2000 kJ of heat per cycle. Find: **[7]**

i) Carnot efficiency,

ii) Work output,

iii) Heat rejected.

Q5) a) Prove that entropy is a property of the system. **[7]**

b) Derive maximum useful work available during non-flow system. **[7]**

OR

Q6) a) 25 kg of copper block, C_p 0.387 kJ/Kg K at 100°C is dropped in 20 litres of water at 30 °C. Assume perfect heat transfer and no lost due to the surroundings. Find the final equilibrium temperature reached for water and copper block and entropy generation. **[7]**

b) Explain the concepts of available energy, unavailable energy, and dead state in thermodynamics. Represent these concepts on a T-S diagram. **[7]**

Q7) a) Explain briefly effect of varying boiler pressure, condenser pressure and superheat pressure on the performance of Rankine Cycle. **[6]**

b) A sample of steam at 200 °C and a pressure of 7 bar is first expanded at a constant enthalpy to 3 bar and then at constant entropy to 0.5 bar with the help of Mollier chart or diagram. Determine the change of entropy and enthalpy during the process. **[8]**

OR

Q8) a) Define the following terms and write their equations. **[6]**

i) Enthalpy of latent heat

ii) Enthalpy of sensible heat

iii) Enthalpy of superheat

iv) Degree of superheat

v) Critical point

vi) Enthalpy of Steam

b) Determine the efficiency of Simple Rankine cycle working pressure of 2 MPa and condenser pressure of 10.0 kPa steam leaves the boiler and enters the turbine as dry saturated. Determine of Efficiency of Rankine cycle. **[8]**

Q9) a) Explain the necessity of providing draught in a boiler. Draw & explain working of the Natural draught. **[6]**

b) A steam generator evaporates 18000 kg/hr of steam at 12.5 bar and quality of is 0.97 dry; from feed water at 105 °C, when coal is fired at the rate of 2040 kg/hr. If the HCV of the coal is 27400 KJ/kg, Determine: **[8]**

i) The heat rate of boiler in kJ/hr;

ii) The equivalent evaporation;

iii) The thermal efficiency of the Boiler

OR

Q10)a) Explain the function of Boiler Accessories. Explain with neat sketches any one of the accessories. **[6]**

b) The following data refer to a boiler plant consisting of an economizer, a boiler and a superheater. **[8]**

Mass of water evaporated per hour = 5940 kg

Mass of coal burnt per hour = 675 kg

LCV of coal =31600 kJ/kg

Pressure of steam at boiler stop valve = 14 bar

Temperature of feed water entering economizer = 32 °C

Temperature of feed water leaving economizer = 115 °C

Dryness fraction of steam leaving boiler and entering superheaer = 0.96

Temperature of steam leaving superheater = 260 °C

Specific heat of superheated steam = 2.33 kJkg.K

Deermine (i) Percentage of heat in coal utilized in economizer, boiler and superheater (ii) Overall efficiency of boiler plant.

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