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Sr. No 013301

December 2023

B.Tech (ME)- III SEMESTER

Thermodynamics (PCC-ME-301-21)

Time: 3 Hours | Max. Marks:75

Instructions:
1. *It is compulsory to answer all the questions (1.5 marks each) of Part -A in short.*
2. *Answer any four questions from Part -B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*
4. *Use of steam table is allowed.*

PART -A

Q1 (a) Define the term state, path, process? (1.5)

(b) How does the resistance thermometer measure temperature? (1.5)

(c) What is a throttling process? (1.5)

(d) What are the causes of irreversibility of a process? (1.5)

(e) What do you understand by the entropy principle? (1.5)

(f) What is an unsteady flow process? (1.5)

(g) What do you mean by the dryness fraction of a steam? Give its value for dry saturated steam. (1.5)

(h) Why do isobars on Mollier diagram diverge from one another in superheated region? (1.5)

(i) Draw Carnot cycle on p-V and T-s diagram. (1.5)

(j) Write the assumptions made while deriving the expression for the air standard efficiency of otto cycle. (1.5)

PART -B

Q2 (a) An ideal gas is heated at constant volume until its temperature is 3 times the original temperature. It is then expanded isothermally till it reaches original pressure. The gas is then cooled at constant pressure till it is restored to the original state. Determine the net work done by the gas per kg. Initial temperature is 350 K. Express answer in terms of gas constant R. (8)

(b) Differentiate between heat and work. Show that both are path function. (7)

Q3 (a) In a new temperature scale say ^0P, the boiling and freezing points of water at one atmosphere are 300 ^0P and 100 ^0P respectively. Correlate this scale with the centigrade. What is the reading of 0 ^0P and 200 ^0P on the centigrade scale? (7)

(b) State and prove Carnot theorem. (8)

Q4 (a) Derive energy equation for a steady flow system. Also list the assumptions made while deriving steady flow energy equation. (7)

(b) In a boiler and steam turbine plant under steady flow conditions, following observations were recorded: (8)
Rate of water inflow to the boiler=7500 kg/h

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Specific enthalpy of water at inlet=832 kJ/kg
Velocity of water at inlet to boiler=345 m/min
Water enters the boiler at an elevation=5 m
Specific enthalpy of steam leaving the boiler=3123 kJ/kg
From boiler steam enters the turbine and velocity of steam at turbine exit=55 m/s
Steam leaves the turbine at an elevation=1 m
Specific enthalpy of steam at turbine exit=2638 kJ/kg
Total heat losses from the turbine and the boiler to the surrounding=90020 kJ/h
Determine the power output of the turbine.

Q5 (a) Determine if the steam is wet or superheated in the following states: (10)
(i) p=6 bar, h=2690 kJ/kg
(ii) p=8 bar, v=0.2 m^3/kg
(iii) p=7.5 bar, t=300 ^{0}C.
Also determine dryness fraction in case of wet steam and degree of superheat for superheated steam.

(b) Explain the difference between an ideal gas and a real gas. What are the reasons of deviation of a real gas from an ideal gas? (5)

Q6 (a) Two kg of air at 500 kPa, 80 ^{0}C expands adiabatically in a closed system until its volume is doubled and its temperature becomes equal to that of the surroundings which is at 100 kPa, 5 ^{0}C. For this process, determine (10)
(i) the maximum work
(ii) the change in availability
(iii) the irreversibility.
For air, take c_v=0.718 kJ/kg K, u=c_vT where c_v is constant, and pV=mRT where p is pressure in kPa, V volume in m^3, m mass in kg, R a constant equal to 0.287 kJ/kgK and T temperature in K.

(b) Establish the equivalence of Kelvin-Planck and Clausius statements. (5)

Q7 (a) An ideal diesel engine has a diameter of 15 cm and stroke 20 cm. The clearance volume is 10 % of the swept volume. Determine the compression ratio and the air standard efficiency of the engine if the cut-off takes place at 6 % of the stroke. (10)

(b) Explain Brayton cycle and derive its efficiency expression in term of pressure ratio. (5)

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