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Paper Code : PC-ME301 Thermodynamics

UPID : 003491

Time Allotted : 3 Hours

Full Marks :70

The Figures in the margin indicate full marks.
Candidate are required to give their answers in their own words as far as practicable

Group-A (Very Short Answer Type Question)

1. Answer *any ten* of the following : [1 x 10 = 10]

   (I)   Define saturation temperature.

   (II) Define 1st law of thermodyamics.

   (III) What is a thermal energy reservoir?

   (IV) Can entropy ever decrease?

   (V)   What are the processes involved in Brayton Cycle?

   (VI) What is the definition of Pressure?

   (VII) What is pyrometer ?

   (VIII) What is sublimation?

   (IX) Does the amount of mass entering a control volume have to be equal to the amount of mass leaving during an unsteady-flow process?

   (X)   What is adiabatic process?

   (XI) Write down three characteristics of Entropy.

   (XII) What are the methods to improve the efficiency of Rankine Cycle?

Group-B (Short Answer Type Question)

Answer *any three* of the following : [5 x 3 = 15]

2. How do the energies of a flowing fluid and a fluid at rest compare? Name the specific forms of energy associated with each case. [5]

3. Establish the relation between COP of Refrigerator and Heat Pump. [5]

4. Entropy of a saturated liquid at 227 degree Celsius is 2.6KJ/KG.K and its latent heat of vaporization is 1800KJ/KG, then the entropy of saturated vapor at 227 degree Celsius would be_____. [5]

5. During a regeneration process, some steam is extracted from the turbine and is used to heat the liquid water leaving the pump. This does not seem like a smart thing to do since the extracted steam could produce some more work in the turbine. How do you justify this action? [5]

6. A cylinder contains 0.92kg of steam at 1.5mpa. If the volume of steam 0.1 m^3 , determine enthalpy and internal energy of steam per kg. [5]

Group-C (Long Answer Type Question)

Answer *any three* of the following : [15 x 3 = 45]

7. (a) What is the physical significance of h_{fg}? Can it be obtained from a knowledge of h_f and h_g? How? [5]

   (b) What is quality? Does it have any meaning in the superheated vapor region? [5]

   (c) Can quality be expressed as the ratio of the volume occupied by the vapor phase to the total volume? Explain. [5]

8. (a) Would you expect the temperature of air to drop as it undergoes a steady-flow throttling process? Explain. [5]

   (b) Would you expect the temperature of a liquid to change as it is throttled? Explain. [5]

   (c) Helium is contained in a 2m^3 rigid volume at 50 degree Celsius and 200Kpa. Calculate the heat transfer needed to increase the pressure to 800kpa. [5]

9. (a) The drinking water needs are met by cooling tap water in a refrigerated water fountain from 23 to 6 degree Celsius at an average rate of 10 kg/h. if the COP of the refrigerant is 3.1, the required power input to this refrigerator is _____ [5]

(b) Is it possible for a heat engine to operate without rejecting any waste heat to a low-temperature reservoir? Explain. [5]

(c) Consider a pan of water being heated (a) by placing it on an electric range and (b) by placing a heating element in the water. Which method is a more efficient way of heating water? Explain. [5]

9. (a) A lump of steel weighing 30kg at a temperature of 427 degree Celsius is dropped in 150kg of oil at 27 degree Celsius. The specific heats of steel and oil are 0.46kj/kg.k and 2.5 KJ/KG.K respectively. Estimate the entropy change of steel, the oil and the system containing oil and lump of steel in KJ/K. [8]

(b) Is an isothermal process necessarily internally reversible? Explain your answer with an example. [5]

(c) Is it possible to create entropy? Is it possible to destroy it? [2]

11. (a) Two different fuels can be used in a heat engine operating between the fuel burning temperature and a low temperature of 350K. Fuel A burns at 2500K delivering 52000KJ/KG and costs 1.75 per Kg. Fuel B burns at 1700K delivering 40000KJ/KG and costs 1.50 per kg. Which fuel do you use and why ? [7]

(b) A mechanic claims to have developed a car engine that runs on water instead of gasoline. What is your response to this claim? [4]

(c) Describe an imaginary process that satisfies the first law but violates the second law of thermodynamics. [4]

$$COP_{ref} = \frac{Q_e}{W_{in}}$$ *** END OF PAPER ***

Q_e is heat removal from refrigerated space

W_{in} is the work output, for h P COP is defined as ratio of heat delivered to the desired heat output

$$COP_{hP} = \frac{Q_h}{W_{in}}$$ when Q_h = heat delivered to hot reservoir

in both ease, a higher COP indicates better efficiency

The energy of a flowing fluid (ke) and a fluid at rest (PE)

perpetual motion machine

Cus

$$H = U + PV$$

18.