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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

May 2023 Semester End Main Examinations

Programme: B.E. **Semester: III**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 22CH3PCTD1 **Max Marks: 100**
Course: Process Engineering Thermodynamics-I **Date: 08.05.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.
3. Use of steam tables is permitted.

UNIT - I

1	a)	Explain the significance of heat and work. Justify that both are path functions.	**10**
	b)	State and explain the phase rule with examples.	**05**
	c)	Differentiate between thermodynamic process and cycle. What are the different types of thermodynamic processes?	**05**

UNIT - II

2	a)	Justify $\oint dQ = \oint dW$ in a reversible cycle using Joule's paddle wheel experiment.	**10**
	b)	Water at 368 K is pumped from a storage tank at the rate of 6.94 kg/s. The motor for the pump supplies work at the rate of 2 hp. The water passes through a heat exchanger, where it gives up heat at the rate of 42,000 J/min and is delivered to a second storage tank at the elevation of 20 m from the first storage tank. What is the temperature of the water delivered to the second tank. Assume enthalpy of water at 0℃ is zero and specific heat of water is constant al 4.2 kJ/kg K.	**10**

OR

3	a)	Define enthalpy. Explain the working principle of calorimeter.	**08**
	b)	Explain reversable processes with examples.	**05**
	c)	Calculate the change in internal energy and enthalpy for 1 mol water, as it is vaporized at the constant temperature of 373 K and constant pressure of 101.3 kPa. The specific volumes of liquid and vapour at these conditions are 1.04×10^{-3} and 1. 675 m^3/kmol respectively; 1030 kJ of heat is added to water for this change.	**07**

UNIT - III

4 a) Draw and explain the pressure versus temperature diagram for a pure fluid. **05**

b) Calculate the compressibility factor and molar volume of gaseous methane at 300 K and 600 bar by using the following equations. Experimental values of Van der Walls constants are, **10**

$a = 0.2285$ N m^4/mol^2; and $b = 4.25 \times 10^{-5}$ m^3/mol.

i. Ideal gas equation ii. van der Waals equation

c) What is the significance of Virial equation? Write the Virial equation terminated after second and third coefficients. **05**

UNIT – IV

5 a) Derive equations for the calculation of internal energy change, heat and work interactions during isothermal, adiabatic, isobaric and isochoric reversible processes. **10**

b) 1 kmol of air at 389 K and 8 bar pressure under goes the following reversible processes. **10**

a. It is expanded reversibly under isothermal conditions.
b. It is cooled to 279 K at constant volume to 2 bar pressure.

Assume air to be an ideal gas with specific heat capacity equals to 29.3 J/mol K, calculate the work, heat transferred, changes in internal energy and enthalpies.

OR

6 a) What is polytropic process? **04**

b) Prove that $dW = (RT_1 - RT_2)/(\gamma - 1)$ for an adiabatic process. **08**

c) 1 kmol of a gas for which PV= nRT is originally at 305 K and 1 bar. It is then heated at constant pressure to a temperature of 400 K and compressed isothermally to a volume equal to its initial volume. Assume that Cp = 30 kJ/kmol K. For each of the processes, determine the conditions at the intermediate state and change in internal energy, enthalpy and work and heat interactions. **08**

UNIT – V

7 a) State and prove the Carnot's second theorem. **10**

b) A 40 kg steel casting at 723 K is cooled in 150 kg oil in an insulated tank at 298 K and Calculate the final equilibrium temperature, change in entropy of the casting and the oil. What is the entropy generated? The heat capacity of oil is 2.5 kJ/kg K and that of the steel is 0.5 kJ/kg. **10**

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