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

Autonomous Institute Affiliated to VTU

December 2023 Supplementary Examinations

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

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) Define state and path functions with example. **06**

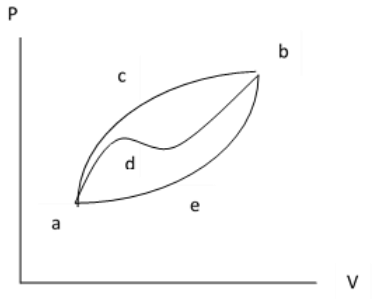
b) A manometer fluid of specific gravity 2.95 is used to measure a pressure of 1.15 bar at a location where barometer pressure of 760 mm Hg. What height will the manometer fluid indicate? **07**

c) Differentiate between thermodynamic process and cycle. What are the different types of thermodynamic processes? **07**

UNIT - II

2 a) Explain Joule's Paddle wheel experiment and prove that $\oint dQ = \oint dW$ over a reversable cycle. **10**

b) Consider the following P-V diagram. **10**



When a system is taken from state a to state b along the path acb, 100 J of heat flows into the system and the system does 40 J of work.
a) How much heat flows into the system along the path aeb if work done by the system is 20 J?
b) The system return from b along the path bda to a. If work done on the system is 30 J, does the system absorb or liberate heat? How much?

OR

3 a) Calculate the internal energy and enthalpy changes that occur when air is changed from initial state of 277 K and 10 bar where its molar volume is 2.28 m^3/kmol to a final state of 333 K and 1bar. Assume for air that PV/T is constant and C_V = 21 and C_P = 29.3 kJ/kmol-K? **10**

b) Derive an expression for first law of thermodynamic applied to steady state flow system. Reduce the equation to $\Delta H=dQ$. **10**

UNIT - III

4 a) Explain PT diagram for a pure material. **06**

b) How do you explain the physical significance of the virial coefficients? **06**

c) Calculate the volume occupied by one mole of oxygen at 300 K and 100 bar using **08**

i. The ideal gas laws
ii. The van der Waals equation.

Take a = 0.1378 N m^4/mol^2 and b = 3.18×10^{-5} m^3/mol.

OR

5 a) Show that $dW = RT \ln \frac{V2}{V1}$ for an isothermal process. **06**

b) One mole of an ideal gas expands from P1 = 8 bar, T1 = 600 K to P2 = 1bar by the following processes **10**

a) Constant volume process
b) Constant temperature process
c) Adiabatic process

Assume CP = (7/2)R and CV = (5/2)R and mechanically reversible processes. Calculate W, Q, ΔU and ΔH for each of the processes and sketch the process on PV diagram.

c) What is polytropic process? **04**

UNIT - IV

6 a) Prove that $dW= (RT_1 – RT_2)/(\gamma - 1)$ for an adiabatic process. **10**

b) A stationary mass of gas is compressed from initial state of 0.3 m^3 and 0.105 MPa to final state of 0.15 m3 and 0.105 MPa. There is a transfer of 37.6 kJ of heat from the gas during the process. How much is the change in internal energy of the gas? **10**

UNIT – V

7 a) 10 kg of water at 375 K is mixed adiabatically with 30 kg of water at 275 K. What is the change in entropy? C_P of water = 4.2 kJ/kg **04**

b) Show that $\Delta S = R \ln \frac{V2}{V1}$ **04**

c) Explain concept of entropy and derive Clausius inequality. **12**

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