1T00533 - S.E.(Chemical Engineering)(SEM-III)(Choice Base Credit Grading System) (R- 19) (C Scheme) / 50724 - Chemical Engineering Thermodynamics I
QP CODE: 10031595 DATE: 01/06/2023

Time: 3 Hours **Total Marks: 80**

N.B.:

(i) Question No.1. is compulsory.
(ii) Attempt any three questions out of remaining five questions.
(iii) Assume suitable data and justify the same.
(iv) Figures to the right indicate full marks

Q 1 Explain any **Four**. 20

(a) Maxwell Equations
(b) Concept of Heat Engine and Heat Pump
(c) T-H diagram
(d) First law of thermodynamics for non-flow process
(e) Joule Thomson effect

Q 2 (a) One kilo mole of a gas for which PV= nRT, where R=8.314 kJ/kmol K is originally at 300K and 1 bar. It is then heated at constant pressure to a temperature of 400K and compressed isothermally to a volume equal to its initial volume. Assume that Cp = 30 kJ/kmol K. Find ΔU, ΔH, Q, W. 12

(b) Oil at 500K is to be cooled at a rate of 5000 kg/hr in a countercurrent exchanger using cold water available at 295 K. A temperature approach of 10K is to be maintained at both ends of the exchanger. The specific heats of oil and water are respectively 3.2 and 4.2 kJ/kg K. determine the total entropy change in the process. 08

Q 3 (a) Explain the concept of exergy and get the expression to calculate exergy loss when the system changes its state 10

(b) What do you understand by an equation of state? What are the limiting conditions to be satisfied by such equations? 10

Q4 (a) Derive an expression for Clausius Inequality. 10

(b) Calculat the molar volume of ammonia at 373 K and 10 bar using Redlich-Kwong equation. Given that 10

T_c = 405.5 K, P_c = 112.8 bar.

Q5 (a) Carbon dioxide at 1 bar and 300 K is to be compressed to a pressure of 10 bar in a single stage compressor at a rate of 100 m^3/h. Assuming that CO_2 behaves as an ideal gas, calculate the temperature of the gas after compression and the work required. Take $\gamma = 1.3$ 10

(b) The vander Waals equation of state is given by: 10

$$\left(P + \frac{a}{v^2}\right)(v - b) = RT$$

Where a & b are constants characteristics of gas. Derive expressions for a & b in terms of critical temperature & critical pressure.

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Q 6 (a) Derive the expression for reversible isothermal compression. 10

$W_s = RT\ \ln(\frac{P_1}{P_2})$

(b) Show that the fugacity of a Vander Waals gas is given by the equation 10 $\ln f = \frac{b}{V-b} - \frac{2a}{RTV} + \ln\frac{RT}{V-b}$

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