P P SAVANI UNIVERSITY

Fourth Semester of B. Tech. Examination

May 2019

SECH2070 Chemical Engineering Thermodynamics-I

20.05.2019, Monday **Time: 09:00 a.m. To 11:30 a.m.** **Maximum Marks: 60**

Instructions:

1. The question paper comprises of two sections.
2. Section I and II must be attempted in separate answer sheets.
3. Make suitable assumptions and draw neat figures wherever required.
4. Use of scientific calculator is allowed.

SECTION – I

Q - 1	**Answer the following (Any Five)**	**[05]**
(i)	What do you mean by meta stable equilibrium?	
(ii)	State the mathematical relation of first law of thermodynamics.	
(iii)	Define: Activity	
(iv)	Explain Gibbs free energy.	
(v)	Give significance of phase diagrams.	
(vi)	Define: Fugacity coefficient	
(vii)	State the applications of second law of thermodynamics.	
Q - 2 (a)	Explain first law of thermodynamics for flow process.	**[05]**
Q - 2 (b)	Iron filings are contained in a cylinder in an atmosphere of oxygen. It combines with oxygen according to the following reaction. $2\ Fe + (3/2)\ O_2 \Rightarrow Fe_2O_3$ The pressure inside the cylinder is maintained at 101 kPa. The temperature is kept constant at 298 K by removing heat. For 2 mol iron reacted, calculate *Q, W,* and D*U* given that 831.08 kJ of heat is liberated in the process.	**[05]**
	OR	
Q - 2 (a)	Explain the concept of enthalpy in detail.	**[05]**
Q - 2 (b)	Briefly explain phase equilibrium criteria.	**[05]**
Q - 3 (a)	With a neat diagram, explain PVT behavior of pure material.	**[05]**
Q - 3 (b)	Explain equation of state and the concept of ideal gas.	**[05]**
	OR	
Q - 3 (a)	Explain constant volume and constant pressure process for ideal gases.	**[05]**
Q - 3 (b)	Calculate the change in internal energy, change in enthalpy, work done, and the heat supplied in the following processes: (a) An ideal gas is expanded from 5 bar to 4 bar isothermally at 600 K. (b) An ideal gas contained in a vessel of 0.1 m3 capacity is initially at 1 bar and 298 K. It is heated at constant volume to 400 K. (Assume that C_P = 30 J/mol K.)	**[05]**
Q - 4	**Attempt any one.**	**[05]**
(i)	With a neat diagram explain Boiling Point Diagram.	
(ii)	State & Explain: 1. Wohl's three suffix Equation 2. Margules Equation	

SECTION – II

Q - 1	**Answer the following: (Any Five)**	**[05]**
(i)	State the driving force for chemical equilibrium.	
(ii)	Define: Refrigeration capacity.	
(iii)	State Van Laar equation.	
(iv)	Explain the concept of throttling valve.	
(v)	Define: Power	
(vi)	What is the purpose of refrigeration?	
(vii)	State and explain the concept of refrigeration.	
Q - 2 (a)	Explain properties of solution.	**[05]**
Q - 2 (b)	Briefly explain determination of partial molar properties.	**[05]**

OR

Q - 2 (a)	The fugacity of component 1 in binary liquid mixture of components 1 and 2 at 298 K and 20 bar is given by $f_1 = 50x_1 - 80\,x_1^2 + 40\,x_1^3$ where f is in bar and x_1 is the mole fraction of component 1. Determine: (a) The fugacity f_1 of pure component 1 (b) The fugacity coefficient f_1 (c) The Henry's law constant K_1	**[05]**
Q - 2 (b)	Explain: Types of thermodynamic diagrams	**[05]**
Q - 3 (a)	State and explain: 1. Redlich–Kwong Equation 2. Redlich–Kwong–Soave Equation	**[05]**
Q - 3 (b)	What is vapour recompression cycle. Explain with a neat diagram.	**[05]**

OR

Q - 3 (a)	A valve on a well-insulated steam pipe carrying saturated steam at 1000 kPa is found leaking. The temperature of the steam escaping from the leak is measured to be 398 K. Determine the quality of steam flowing through the pipe. The following data are taken from the steam tables: Enthalpy of saturated vapour at 1000 kPa = 2778 J/kg; Enthalpy of saturated liquid at 1000 kPa = 763 kJ/kg; Enthalpy of superheated steam at 398 K and 101.3 kPa = 2726 kJ/kg.	**[05]**
Q - 3 (b)	A vapour-compression cycle using ammonia as refrigerant is employed in an ice manufacturing plant. Cooling water at 288 K enters the condenser at a rate of 0.25 kg/s and leaves at 300 K. Ammonia at 294 K condenses at a rate of 0.50 kg/minute. Enthalpy of liquid ammonia at 294 K is 281.5 kJ/kg. The compressor efficiency is 90%. Saturated ammonia vapour at 258 K and enthalpy of 1426 kJ/kg enters the compressor. What is the power requirement of the compressor and refrigeration capacity in tons?	**[05]**
Q - 4	**Attempt any one.**	**[05]**
(i)	Explain the concept of heat pumps with diagrams.	
(ii)	Explain Carnot refrigeration cycle with TS diagram.	

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