10/06/2025 SE CHEMICAL SEM-III C-SCHEME CET-I QP CODE: 10085049

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

Q1 Explain **any Four**: **20**

(a) Carnot cycle and its principle
(b) Exergy and its applications
(c) Fugacity and fugacity coefficient
(d) First law of thermodynamics for closed system
(e) Maxwell Equations

Q2 (a) Two kilograms of CO_2 gas is contained in a piston-cylinder assembly at a pressure of 6.5 bar and a temperature of 300K. the piston has a mass of 5000kg and a surface area of $1m^2$. The friction of the piston on the walls is significant and cannot be ignored. The atmospheric pressure is 1.01325 bar. The latch holding the piston in position is suddenly removed and the gas is allowed to expand. The expansion is arrested when the volume is double the original volume. Determine the work appearing in the surrounding. **10**

(b) Explain Kelvin and Clausius statement of second law of thermodynamics **10**

Q3 (a) Oil at500K is to be cooled at a rate of 5000kg/h in a counter current exchanger using cold water available at 295K. a temperature approach of 10 K 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 total entropy change in the process. **10**

(b) Derive the Clausius inequality. **10**

Q4 (a) Carbon dioxide at 1 bar and 300K is to be compressed to a pressure of 10 bar in a single stage compressor at a rate of $100m^3/h$. assuming that CO_2 behaves as an ideal gas, calculate the temperature of the gas after compression and the work required. **10**
Take $\gamma = 1.3$

(b) Prove that a Carnot engine has the maximum efficiency and that the efficiency is independent of the working fluid. **10**

Q5 (a) Using Virial equation of state calculate the molar volume and compressibility factor of isopropanol vapor at 473 K and 10 bar. The virial coefficients are: $B = -3.88\times10^{-4}$ m^3/mol ; $C = -2.6\times10^{-8}$ m^6/mol^2 **10**

(b) Prove that compressibility factor at critical point (Z_c) for a Vander Waals gas is equal to $\frac{3}{8}$. **10**

Q6 (a) Calculate the fugcity of methane gas at 322K and 55 bar, given that the critical constants are 190.7 K and 46.4 bar. **10**

(b) Explain T-S diagram with its applications **10**