BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE (BITS) PILANI – Pilani Campus

Mid-Semester Exam | CLOSE BOOK | Date: 10.10.2023| Time: 30 min. | Total Marks: 30

First Semester, 2023 – '24 | CHE F213 | Chemical Engineering Thermodynamics

ID | **Name** | **Section** |

1. (a) Carry out entropy balance across a control volume for flowing streams. Derive the mathematical expression for lost work for an irreversible process.
   (b) Write functional form of compressibility factor with pressure and volume. Under what conditions, the any system will deviate from non-ideality to ideality?

2. Derive First law of thermodynamics for closed and mechanically reversible thermodynamic systems.
   A piston/cylinder contains air at 600 kPa, 290 K and a volume of 0.01 m^3. A constant pressure process gives 54 kJ of work out. Find the final volume and temperature of the air.

3. (a) Validate under what conditions the acentric factor is zero. Write mathematical expressions for two parameters and three parameter model.
   (b) Plot Temp-specific volume and Pressure- specific volume diagram for pure substances,

4. An insulated tank of volume 2 m^3 is divided into two equal compartments by a thin and rigid partition. One compartment contains an ideal as at 400 K and 300 kPa, while the other is completely evacuated. Now the partition is suddenly removed and the gases are allowed to mix. The equilibrium is reestablished by equalizing the pressure and temperature. Estimate the change in entropy.

5. Calculate the standard heat of formation of methane given the following experimental results at 25^{o}C and 1 atm.

   $2H_2\,(g) + O_2\,(g) \longrightarrow 2\,H_2O\,(l)$ $\quad \Delta H_1 = -483.6$ kJ/gmol H_2

   $C(\text{graphite}) + O_2\,(g) \longrightarrow CO_2\,(g)$ $\quad \Delta H_2 = -393.5$ kJ/gmol C

   $CH_4\,(g) + 2\,O_2\,(g) \longrightarrow CO_2\,(g) + 2\,H_2O\,(l)$ $\quad \Delta H_3 = -802.3$ kJ/gmol CH_4

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE (BITS) PILANI – Pilani Campus

Mid-Semester | OPEN BOOK | Date: 10.10.2023| Time: 60 min. | Total Marks: 60

First Semester, 2023 – '24 | CHE F213 | Chemical Engineering Thermodynamics

ID | **Name** | **Section** |

1. A 25-ohm resistor at steady state draws a current of 10 amperes. Its temperature is 310 K; the temperature of the surroundings is 300 K. What is the total rate of entropy generation?

2. Calculate the acentric factor for ethanol. The vapor pressure of ethanol can be estimated from the following equation:

$$\log_{10} P^{sat} = 8.1122 - (1592.864)/(t+226.184)$$

where P^{sat} is in mm Hg and t is in ^{o}C. The critical constant for ethanol are T_c= 513.9 K & P_c = 61.48 bar.

3. A 30 m^3 tank contains 14 m^3 of liquid n-butane in equilibrium with its vapor at 25°C. Estimate the mass of n-butane vapor in the tank. The vapor pressure of n-butane at the given temperature is 2.43 bar.

4. What is the entropy change of the gas, heated in a steady-flow process at approximately atmospheric pressure when 800 kJ is added to 10 mole of ethylene initially at 200°C?