BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

Chemical Engineering Thermodynamics (CHE F213), Mid Semester Examination

Date – 01/11/2022 Part - A (Close Book) Maximum Marks = 40

Name : ID

1. A rigid tank of volume 100 liters contains nitrogen at 27^0C and 1 bar. The contents of the tank are heated to a temperature of 350 K. Assume nitrogen to be an ideal gas with a C_v value of (5/2)R. Determine the heat transfer and the final pressure of nitrogen in the tank. [**7**]

2. One mole of air (ideal gas with $C_p/C_v = \gamma = 1.4$) is confined in a cylinder at 27^0C and 1 bar pressure. The gas is initially heated at constant volume and then compressed at constant pressure. The final state of the gas at the end of the compression is 27^0C and 10 bar pressure. Determine the total work transfer to the gas (Assume all processes to be reversible). [**7**]

3. Using Gibb's phase rule, answer the following for a pure component: [**5**]

Condition of pure component	Degrees of freedom
Triple point	
Superheated vapor	
Saturated liquid	
Subcooled liquid	
Critical point	

4. A closed and rigid vessel is initially filled with a mixture of saturated liquid water and saturated water vapor at 100 kPa. On supplying heat to the system, the mixture was found to pass through the critical point. Specific volumes of saturated water and saturated steam at 100 kPa are 0.001043 m^3/kg and 1.694 m^3/kg respectively. Critical volume of water is 0.00317 m^3/kg. Determine the ratio of the volume of saturated water vapor to the volume of saturated liquid water with which the vessel was initially filled. [**8**]

Name : **ID**

5. Using the mathematical definitions of volume expansivity (β) and isothermal compressibility (κ) for a gas, derive expressions for β and κ for an ideal gas in terms of P, V and T. [**6**]

6. Starting with the mathematical definition of Gibbs energy (G), show that the value of G when given as a function of variables T (temperature) and P (pressure) leads to the determination other property values of V (specific volume), H (enthalpy), S (entropy) and U (internal energy). [**7**]

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

Chemical Engineering Thermodynamics (CHE F213), Mid Semester Examination

Date – 01/11/2022 Part - B (Open Book) Maximum Marks = 50

1. It is required to raise the temperature of 1 kmol of ethylene at constant pressure from 300 K to 400 K by condensing saturated steam at 200^0C. Determine the mass of steam required. [**20**]
2. One kmol of butane is compressed isothermally at 300 K from 0.5 m^3/mol to 0.1m^3/mol. Determine the amount of work to be done on the gas and the amount of heat removed from the gas. Assume that the behaviour of butane gas is well described by Vander Waal's equation of state. [**30**]