SY

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

Winter End Semester Examination – Nov 2019

Course: B. Tech in Chemical/Petrochemical Engineering **Sem: IV**

Subject: Chemical Engineering Thermodynamics –I (BTCHC 402) **Max Marks: 60**

Date: 28//2019 **Duration:3 Hr.**

Instructions to the Students:

1. *Solve ANY FIVE questions out of the following.*
2. *The level of question/expected answer as per OBE or the Course Outcome (CO) on which the question is based is mentioned in front of the question.*
3. *Use of non-programmable scientific calculators is allowed.*
4. *Assume suitable dada wherever and mention it clearly.*

Marks

Q.1 Solve any Two of the following. **2x6=12**

A) Differentiate between intensive and extensive state variable with suitable examples

B) Liquid water at 453.15 K and 1002.7 kPa has an internal energy of 762.0 kJ/kg and a specific volume of 1.128 cm^3/gm

(i) What is its enthalpy

(ii) The water is brought to the vapor state at 573.15 and 1500 kPa, where its internal energy is 2784.4 kJ/kg and its specific volume is 169.7 cm^3 /gm Calculate ΔU, and ΔH for the process

C) Derive an equation of first law of thermodynamics Energy balance equation non flow processes

Q.2 Solve any Two of the following. **2x6=12**

A) Three moles of nitrogen at 303.15 K (30°C), contained in a rigid vessel, is heated to 523.15 K (250°C). How much heat is required if the vessel has a negligible heat capacity? If the vessel weighs 100 kg and has a heat capacity of 0.5 kJ /kg ^{0}C (Cv= 20.8 and Cp = 29.1 J/mol C for nitrogen gas)

B) One kilogram of air is heated reversibly at constant pressure from an initial state of 300 K and 1 bar until its volume triples. Calculate W, Q, ΔU, and ΔH for the process. Assume for air that P V/ T = 83.14 bar cm^3 / mol K and Cp = 29 J/mol K

C) One mole of air, initially at 423.15 K and 8 bar, undergoes the following mechanically reversible changes. It expands isothermally to a pressure such that when it is cooled at constant volume to 323.15 K. its final pressure is 3 bar. Assuming air is an ideal gas for which C_P = (7/2) R and C_V = (5/2) R, Calculate W, Q, ΔU and ΔH

Q.3 Solve any One of the following. **1x12=12**

A) (i)What is an adiabatic process? Write the expression for work done during reversible adiabatic process

(ii) How much heat is required when 10000 kg of CaCO3 is heated at atmospheric pressure from 323.15 to 1153.15 K (50 to 880 ^{0} C)

For CaCO3: $A := 12.572$ $B = 2.637 \cdot 10^{-3}$ $D = -3.120 \cdot 10^{5}$

B) Derive an equation for an entropy change of ideal gas

Q.4 Solve any Two of the following. **2x6=12**

A) State and explain second law of thermodynamics , state mathematical equation for it

B) What is sensible heat effect, what are latent heats, why they important ?

C) One mole of an ideal gas with $C_V = (5/2)$ R and $C_P = (7/2)$ R is compressed adiabatic ally in a piston cylinder device from 2 bar and 25 ^{0}C to 7 bar. The process is irreversible and requires 35 % more work than reversible adiabatic compression from the same initial state to the same final pressure. What is the entropy change of the gas?

Q.5 Solve any One of the following. **1x12=12**

A) (i) What are the various steps involved in a Carnot cycle? Derive an expression for the efficiency of a Carnot cycle.

(ii) A vessel contains 1 kg of H20 as liquid and vapor in equilibrium at 1000 kPa. If the vapor occupies 70% of the volume of the vessel, determine H and *S* for the 1 kg of Water

$V_{liq} := 1.127 \cdot \frac{cm^3}{gm}$ $H_{liq} := 762.605 \cdot \frac{J}{gm}$ $S_{liq} := 2.1382 \cdot \frac{J}{gm \cdot K}$

Data $V_{vap} := 194.29 \cdot \frac{cm^3}{gm}$ $H_{vap} := 2776.2 \cdot \frac{J}{gm}$ $S_{vap} := 6.5828 \cdot \frac{J}{gm \cdot K}$

B) (i) Discuss selection criteria of good refrigerant

(ii) State thermodynamic diagrams and any one diagram in detail

Q.6 Solve any One of the following. **1x12=12**

A) (i) Derive the following equation

$$\boxed{dU = C_V\, dT + \left[T\left(\frac{\partial P}{\partial T}\right)_V - P\right] dV}$$

(ii) With the help of temperature-entropy diagram and flow diagram, explain the working of a single stage vapor compression refrigeration system

B) (i) Derive the Maxwell's relations.

(ii) A refrigeration system requires 1.5 kW of power for a refrigeration rate of 4 kW.

(a) What is the coefficient of performance?

(b) How much heat is rejected in the condenser?

PAPER END