Seat No.: ________ Enrolment No.________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III (OLD) EXAMINATION – WINTER 2018

Subject Code:131404 **Date:05/12/2018**

Subject Name:Food Engineering Thermodynamics

Time:10:30 AM TO 01:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Standard Steam Tables and Psychrometric Chart can be used**

Q.1 **(a)** What are ideal gases? In what way real gases differ from ideal behaviour? A container of 0.5 m^3 contains nitrogen gas at 5 atmosphere pressure and 17 ^oC. Calculate the mass of gas in kg. Assume ideal gas behaviour. [Take R = 8.314 J/mol K] **07**

(b) State the law of corresponding states. Hundred kilogram of CO_2 gas is stored in a 10 liter sealed container at 2 ^oC. Calculate the pressure of the gas in kPa using compressibility factor of z = 0.82. [Take M = 44 and R = 8.314 J/mole K] **07**

Q.2 **(a)** State Zeroth law of thermodynamics. Convert 77 ^oF in ^oC and Kelvin. Explain with a neat diagram the principle and working of any one thermometer. **07**

(b) Explain Joule-Kelvin effect. Prove that for an ideal gas undergoing a throttling process, $\mu_{j,T} = 0$ **07**

OR

(b) Define enthalpy. Prove that $C_p - C_v = \bar{R}$ for ideal gases. **07**

Five moles of SO_2 gas at 300K is heated reversibly at a constant pressure of 2 bar until its volume doubles. Calculate

(i) The work done.

(ii) Change in internal energy and enthalpy.

[Assume ideal behaviour , Cv = 32 J/mol K, R = 8.314 J/mol k]

Q.3 **(a)** Explain first law of thermodynamics for a closed system operating in a cycle. Prove that the work done by the system during an isentropic process is given by **07**

$$W = \frac{1}{\gamma - 1}(P_1 V_1 - P_2 V_2) .$$

(b) What is SFEE? A steam turbine developing 600 kW receives a flow of 25 tonne/h of steam @ 110 m/s. The exit velocity of steam is 325 m/s. The inlet pipe is located 1.5 m above the outlet pipe. Using SFEE, calculate the change in enthalpy. **07**

OR

Q.3 **(a)** What is first law of thermodynamics? Prove that for a reversible adiabatic process $TV^{\gamma-1}$ = Constant. **07**

(b) What is Gibb's phase rule? Explain different types of thermodynamic equilibrium. Calculate the thermodynamic degrees of freedom of pure water at its critical point. **07**

Q.4 **(a)** Explain Clausius statement of second law of thermodynamics with the help of a neat schematic diagram. **07**

Prove that $\oint(\frac{dQ}{T}) < 0$ for any irreversible cyclic process.

(b) Explain Carnot theorems. A Carnot heat engine operates between a source temperature of 620 ^{0}C and a sink temperature of 37 ^{0}C. The work output is 20 kW. Calculate the amount of heat rejected to sink. **07**

OR

Q.4 **(a)** Explain the operation of a heat pump with help of a schematic diagram. A heat pump is operating between 5 °C and 30 °C at a COP of 50 % of the maximum possible COP. If the net heating effect generated is 5 kW, calculate the power requirement. **07**

(b) Explain Kelvin-Plank statement of second law of thermodynamics with the help of a neat schematic diagram. Show that for any reversible thermodynamic process: $\left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$ **07**

Q.5 **(a)** Draw a neat labeled P-v diagram of a pure substance (water) showing its various states. Show that the specific volume of wet steam is given by, **07**

$v = v_g + (1–x)\, v_{fg}$.

Determine the following using steam tables for saturated steam at 5 bar pressure:

(i) Saturation temperature in °C
(ii) Entropy in kJ/kg K
(iii) Latent heat of vaporization in kJ/kg
(iv) Specific volume in m^3/kg

(b) Explain the following processes on a Psychrometric Chart: **07**

(i) Sensible heating (ii) Cooling and Dehumidification.

The following data are available for the atmospheric air:
Temperature = 40 °C, Atmospheric Pressure = 760 mm Hg and RH = 80%. Using Psychrometric Chart determine the following:

(i) Mass of air in kg.
(ii) DPT in °C
(iii) WBT in °C
(iv) Enthalpy
(v) Specific volume

OR

Q.5 **(a)** Explain phase diagram of a pure substance (Water) on a T-s diagram. **07**

Using Steam Tables determine the following for saturated steam at 150 °C:

(i) Specific enthalpy (ii) Latent heat of vaporization (h_{fg})
(iii) Density (iv) Specific entropy

(b) Define the following in relation to moist air: **07**

i. Dry bulb temperature
ii. Wet bulb and temperature
iii. Adiabatic saturation temperature

Air at a certain location having a barometric pressure of 760 mm Hg, air is at DBT and WBT of 35 ^{o}C and 26 ^{o}C respectively. Determine the following using Psychrometric Chart:

(i)	Absolute humidity	(ii) Relative humidity	
(iii)	Relative humidity	(iv) Dew point temperature	

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