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GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– III (New) EXAMINATION – WINTER 2019

Subject Code: 2131404 Date: 03/12/2019

Subject Name: Food Engineering Thermodynamics

Time: 02:30 PM TO 05:00 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 normal range Psychrometric Chart can be used**

Q.1	**(a)**	Why gases deviate from ideal behavior? A 50 liters capacity vessel contains CO_2 gas at 77 ^oC and 3 bar pressure. Calculate the mass of CO_2 in kilogram.	**03**
	(b)	Two kilogram of methane gas was injected into a 100 liter vessel containing nitrogen at 0.9 bar absolute pressure and 27 ^oC under isothermal conditions. Calculate the partial pressure of methane gas and the total pressure in the container in bar. [M = 16 g/mol]	**04**
	(c)	Answer the following: i. Explain the law of corresponding states. ii. Write Van der Waal's gas equation and give SI units. iii. Define open system. iv. If vacuum is 600 mmHg, calculate absolute pressure in kPa. v. Calculate the specific gas constant for a gas mixture containing 80% N_2 and 20% O_2 by weight. vi. Name different types of thermometers. vii. Show that $C_p - C_v = \bar{R}$ for ideal gases.	**07**
Q.2	**(a)**	State Zeroth law of thermodynamics. Discuss different temperature scales and their interrelationships.	**03**
	(b)	Ten kilogram of O_2 gas is heated reversibly at constant pressure from an initial state of [T = 330 K, P= 1.6 bar] until its volume doubles. Calculate (i) The expanded work in kJ (ii) Change in internal energy and enthalpy in kJ. [Take Cp = 35J/mol K, R = 8.314 J/mol k]	**04**
	(c)	State first law of thermodynamics for a closed system. Ten kilogram of an ideal gas at 113 ^oC and 8 bar pressure expands isentropically four times its initial volume. Calculate the work done during the process in kJ. [C_p = 1.005 kJ/kgK, C_v = 0.715 kJ/kgK]	**07**
		OR	
	(c)	Derive SFEE for a fluid stream entering and leaving a turbine in terms of work and energy transfer per unit mass. Specify the assumptions made.	**07**
Q.3	**(a)**	What is Gibb's phase rule? Calculate the degrees of freedom of water at its triple point.	**03**
	(b)	Calculate the approximate pressure at which water would boil at 180 ^oC. It is known that water boils at 100 ^oC at 1.01325 bar. [Take R = 8.314 J/mol K, h_{fg} (at 100 ^oC) = 2258 kJ/kg]	**04**
	(c)	Explain Joule-Kelvin effect with the help of a T-P diagram.	**07**
		OR	
Q.3	**(a)**	What is Gibb's phase rule? Calculate the degrees of freedom of water at its critical point.	**03**

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(b) *Show that for a reversible process* **04**

$$\left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$$

(c) Prove that for any gas undergoing a throttling process, the Joule-Kelvin coefficient is given by $\mu_{j,T} = \frac{1}{C_P}\left[T\left(\frac{\partial v}{\partial T}\right)_P - v\right]$ **07**

Q.4 **(a)** Explain Carnot cycle showing all the state points and explain the significance of this cycle. **03**

(b) Explain the following: **04**
(i) Clausius inequality.
(ii) Thermal reservoirs

(c) Explain Kelvin-Plank and Clausius statements of second law of thermodynamics & prove that they are in fact equivalent. **07**

OR

Q.4 **(a)** Explain the concept and importance of available and unavailable energy **03**

(b) Prove that $\oint(\frac{dQ}{T}) < 0$; for any cyclic irreversible process. **04**

(c) Explain Clausius statement of second law of thermodynamics. A heat pump is operating between − 5°C and 25 °C. It delivers a COP which is 50% of the maximum possible COP. If it is delivering 5kW of heat into the warm room, calculate the power requirement to drive the unit. **07**

Q.5 **(a)** Prove that specific humidity of moist air is given by $\omega = 0.622\left(\frac{p_w}{p_o - p_w}\right)$ **03**

(b) The weather report on a certain date was recorded as given below: **04**
A. Atmospheric pressure = 760 mm Hg
B. Ambient Temperature = 38 °C
C. RH = 60%

Using Psychrometric Chart, calculate the DPT, WBT, Specific enthalpy and absolute humidity of the atmospheric air.

(c) Explain P-V and T-s phase diagram of a pure substance (water). Using Steam Tables determine the following for saturated steam at 2MPa pressure: **07**
(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

OR

Q.5 **(a)** Define the following terms for moist air: **03**
(i) Wet bulb temperature
(ii) Relative humidity
(iii) Dry bulb temperature

(b) Air at a certain place is at 40 °C abd has a barometric pressure of 1 bar. If p_w of water vapours present in the air is 20 mm Hg, calculate the following: **04**
i. DBT
ii. Specific humidity
iii. Relative humidity
iv. DPT

(c) Explain phase diagram of a pure substance (water) on a P-v diagram. Ten kg of wet steam at 120 °C containing 80% of dry steam is allowed to completely condense to water at 92 °C. Calculate the amount of heat released in kJ. **07**

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