Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III (NEW) - EXAMINATION – SUMMER 2017

Subject Code: 2131404 **Date: 05/06/2017**

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. **Use of Steam Tables and normal range Psychrometric chart is permitted.**

Q.1		**Answer the following in short:**	**14**
	1	Calculate vacuum in mm Hg if absolute pressure is 70 kPa?	
	2	What are extensive properties? Give examples.	
	3	What do you understand by adiabatic process?	
	4	What is Gibb's phase rule?	
	5	Define specific heats and mention their SI units.	
	6	What is compressibility factor of gases?	
	7	Draw a block diagram representing a heat engine.	
	8	Write SI units of Van der Waals constants 'a' and 'b'	
	9	Explain the law of corresponding states.	
	10	What is SI unit of universal gas constant?	
	11	Differentiate between closed and isolated systems with examples	
	12	What is triple point of water?	
	13	Convert 27 ^oC in ^oF.	
	14	Define pure substance.	
Q.2	**(a)**	Define ideal gas. A 500 litre capacity vessel of contains N_2 gas at 6 bar pressure & 27 ^oC. Calculate the mass of nitrogen gas in kilogram assuming ideal behaviour.	**03**
	(b)	Explain the reasons for deviation of gases from ideal behaviour. What correction factors were introduced by Van *der* Waal to explain the behaviour of real gases?	**04**
	(c)	Show that $C_p - C_v = \overline{R}$ for ideal gases. An ideal gas is heated reversibly at constant pressure from an initial state of 1200 K & 2 bar until its volume increases by 50%. Calculate (i) The work done in kJ/kg (ii) Change in internal energy and enthalpy in kJ/kg. [Cp = 42 J/mol K, R = 8.314 J/mol K , M= 44]	**07**
		OR	
	(c)	Show that $C_p - C_v = 0$ for solids and liquids. Nitrogen gas is compressed from initial volume of 1 m^3 to a final volume of 0.5 m^3 at a constant pressure of 2.5 bar. During the process 250 kJ heat was removed from the system. Calculate the work done and the change in internal energy assuming ideal gas behaviour.	**07**
Q.3	**(a)**	State Zeroth law of thermodynamics & illustrate concept of temperature measurement.	**03**
	(b)	State first law of thermodynamics. Prove that **"PV^{γ} =** constant" for an ideal gas.	**04**
	(c)	State Kelvin-Plank statement of second law of thermodynamics with a neat diagram. A heat engine is operating between two reservoirs maintained at 267 ^0C and 18^0C. The heat input to the engine is 50 kW and the heat rejection is 30 kW. Calculate the thermal efficiency of the heat engine and compare it with the maximum possible efficiency.	**07**
Q.3	**(a)**	List various types of thermometers and state their principles of operation.	**03**

(b) An ideal gas is allowed to expand isothermally in a reversible manner. Prove that the work done per mole is given by $W = RT \ln \frac{V_2}{V_1}$. **04**

(c) Explain Clausius statement of 2nd law of thermodynamics with a neat diagram. A heat engine operating between two reservoirs maintained at 600 K and 300 K. The engine is producing a net work output of 25 HP. If the thermal efficiency of the engine is 50% of the Carnot efficiency, calculate heat input and outflow to the engine in kW. **07**

Q.4 (a) If P, V, T and S are point functions, prove that $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_v$. **03**

(b) Explain the following: **04**
(i) PMM1 And PMM2
(ii) Carnot theorems

(c) (i) Prove that $\oint \left(\frac{dQ}{T}\right) < 0$ for a cyclic irreversible process. **07**

(ii) Show that the entropy change of a system is given by $(ds) \geq \frac{dQ}{T}$.

Q.4 (a) If P, V, T and S are point functions, prove that $\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial S}\right)_V$ **03**

(b) Explain the following: **04**
(i) Clausius inequality
(ii) Joule-Kelvin effect

(c) Define steady and non-steady flow processes. A steam turbine developing 500 kW receives a steam flow of 25 ton/h at a velocity of 96 m/s. The exit velocity of steam is 300 m/s. The inlet pipe of turbine is 4 m above its exhaust pipe. Using S.F.E.E, calculate the change in enthalpy. **07**

Q.5 (a) Calculate the degrees of freedom of water **03**
(i) At its critical. (ii) At its triple point (iii) At NTP

(b) Determine the following using Steam Tables for saturated steam at 10 bar pressure: **04**
(i) Saturation temperature.
(ii) Specific Entropy in kJ/kg K
(iii) Latent heat of vaporization in kJ/kg
(iv) Enthalpy of saturated vapours in kJkg.

(c) Define the following: (i) Dry bulb temperature (ii) Dew point temperature **07**
(iii) Absolute humidity (iv) WBT
Given that atmospheric air is at 1.01325 bar, 30 ^oC DBT, 60% RH.
Calculate DBT, DPT & specific enthalpy.

Q.5 (a) Explain the types of equilibrium and state conditions of stability. **03**

(b) Explain the following terms: (i) Steam Quality (ii) Sublimation **04**
Using steam tables, calculate the specific enthalpy, specific volume of steam at 8 bar and 0.80 dryness fraction.

(c) Prove that by $\omega = 0.622 \left(\frac{p_w}{p_o - p_w}\right)$. The weather report of a city is given below: **07**

Atmospheric pressure = 760 mm Hg, Ambient Temperature = 30 ^oC, RH = 70%.
Calculate the DBT, WBT, specific enthalpy and absolute humidity using Psychrometric Chart.

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