Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– III(NEW) EXAMINATION – WINTER 2022

Subject Code:3131905 Date:24-02-2023

Subject Name: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. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	Discuss perpetual motion machines of first kind with neat sketch.	**03**
	(b)	Explain zeroth law of thermodynamics.	**04**
	(c)	Show the equivalence of Clausius and Kelvin Plank statement of second law of thermodynamics.	**07**
Q.2	**(a)**	Carnot cycle is not practical – Justify the statement.	**03**
	(b)	Briefly discuss about thermodynamic equilibrium.	**04**
	(c)	A cylinder contains 0.45 m^3 of gas at $1x10^5$ N/m^2 and 80°C. The gas is compressed to a volume of 0.13 m^3. The final pressure being $5x10^5$ N/m^2. Assume $\gamma = 1.4$, R = 294.2 J/kg °C. Calculate mass of gas, index of compression n, increase in internal energy of gas and heat rejected by gas during compression.	**07**
		OR	
	(c)	A reversible refrigerator is used to maintain a temperature of 0° C in a refrigerator space when it rejects heat to the atmosphere at 27° C. The heat removal rate from refrigerator space is 1500 kJ/min. Find out the COP and work input required. (ii) If the reversible heat engine used to run the above refrigerator, calculate overall COP of the system, heat engine receives heat from source at 400° C and rejects heat to atmosphere.	**07**
Q.3	**(a)**	Define the following terms: (i) Available energy (ii) Unavailable energy (iii) Dead state	**03**
	(b)	Prove that entropy is a property of system.	**04**
	(c)	5 kg of water at 30° C is mixed with 1 kg of ice at 0° C. The process of mixing is adiabatic and the system is open to atmosphere. Make calculations for the temperature of mixture and the change of entropy for the spontaneous mixing process. Take specific heat of water = 4.187 kJ/kg K and latent heat of ice = 335 kJ/kg.	**07**
		OR	
Q.3	**(a)**	Define and explain reversible process.	**03**
	(b)	State the types of irreversibility. What is their effect?	**04**
	(c)	Derive the relevant equation to get maximum work from a finite body and thermal energy reservoir.	**07**
Q.4	**(a)**	Show simple Vapour Compression Refrigeration (VCR) cycle on *P-h* and *T-s* diagram. State the processes involved.	**03**
	(b)	Explain variables affecting efficiency of Rankine cycle.	**04**

(c) In an engine working on Otto cycle, air has a pressure of 1 bar and temperature 30° C at the entry. Air is compressed with a compression ratio of 6. The heat is added at constant volume until the temperature rises to 1500 °C. Determine (i) air standard efficiency (ii) pressure and temperature at the end of compression (iii) heat supplied (iv) mean effective pressure. **07**

Take C_V= 0.718 kJ/kg K, R = 0.287 kJ/kg K.

OR

Q.4 **(a)** State the assumptions made for analysis air standard cycle. **03**

(b) Compare Otto, Diesel and Dual cycles for **04**

(i) Same compression ratio and heat supplied

(ii) Same maximum pressure and temperature

(c) An ammonia refrigerator works between – 6.7 °C and 26.7 °C. The vapour is dry-saturated at the end of compression. Calculate (i) theoretical COP (ii) Power required to drive the compressor if the cooling capacity of the refrigerator is 5 tons. **07**

Use of the following properties of NH_3.

Temp (°C)	Sp Enthalpy (kJ/kg)		Sp Entropy (kJ/kg-K)	
	Liquid (h_f)	Saturated Vapour (h_g)	Liquid (s_f)	Saturated Vapour (s_g)
-6.7	-29.26	1262.36	-0.1087	4.7401
26.7	124.56	1291.62	0.4264	4.3263

Q.5 **(a)** Efficiency of Carnot cycle is independent of working fluid – Justify. **03**

(b) State the factors affecting the performance of simple VCR cycle **04**

(c) Explain the minimum air requirement for incomplete combustion of carbon to carbon monoxide by mass and volume. **07**

OR

Q.5 **(a)** Compare Carnot and Rankine cycle. **03**

(b) Explain the following terms: **04**

(i) Adiabatic flame temperature

(ii) Enthalpy of reaction

(iii) Enthalpy of formation

(iv) Stoichiometric air fuel ratio

(c) Derive air standard efficiency of Diesel cycle. **07**

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