Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code: 3131905 Date: 30/11/2019

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. **Usage of steam table is permitted.**

			Marks
Q.1	**(a)**	Explain the concept of quasi-static process.	**03**
	(b)	Write short note on thermodynamic equilibrium.	**04**
	(c)	State and prove Carnot's theorem.	**07**
Q.2	**(a)**	Explain zeroth law of thermodynamics.	**03**
	(b)	Write down Kelvin-Planck and Clausius statements of 2nd Law of thermodynamics.	**04**
	(c)	In an air compressor air flows steadily at the rate of 0.5 kg/s through an air compressor. It enters the compressor at 6 m/s with a pressure of 1 bar and a specific volume of 0.85 m^3/kg and leaves at 5 m/s with a pressure of 7 bar and a specific volume of 0.16 m^3/kg. The internal energy of the air leaving is 90 kJ/kg greater than that of the air entering. Cooling water in a jacket surrounding the cylinder absorbs heat from the air at the rate of 60 kJ/s. Calculate : (i) The power required to drive the compressor ; (ii) The inlet and output pipe cross-sectional areas.	**07**
		OR	
	(c)	Two Carnot engines work in series between the source and the sink temperatures of 550 K and 350 K. If both engines develop equal power, starting from basic principle determine the intermediate temperature.	**07**
Q.3	**(a)**	Prove that entropy is the property of system.	**03**
	(b)	A heat engine receives heat at the rate of 1500 kJ/min and gives an output of 8.2 kW. Determine : (i) The thermal efficiency ; (ii) The rate of heat rejection	**04**
	(c)	300 kJ/s of heat is supplied at a constant fixed temperature of 290°C to a heat engine. The heat rejection takes place at 8.5°C. The following results were obtained : (i) 215 kJ/s are rejected. (ii) 150 kJ/s are rejected. (iii)75 kJ/s are rejected. Classify which of the result report a reversible cycle or irreversible cycle or impossible results	**07**
		OR	
Q.3	**(a)**	Define the following terms: (i) Available energy (ii) Unavailable energy (iii)Dead state	**03**
	(b)	State the types of irreversibility. What is their effect?	**04**

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(c) A system at 500 K receives 7200 kJ/min from a source at 1000 K. The temperature of atmosphere is 300 K. Assuming that the temperatures of system and source remain constant during heat transfer find out : **07**

(i) The entropy produced during heat transfer ;

(ii) The decrease in available energy after heat transfer

Q.4 **(a)** Compare Carnot and Rankine cycle. **03**

(b) How actual vapour cycle differs from ideal vapour cycle? Explain in detail. **04**

(c) In a steam power cycle, the steam supply is at 15 bar and dry and saturated. The condenser pressure is 0.4 bar. Calculate the Carnot and Rankine efficiencies of the cycle. Neglect pump work. **07**

OR

Q.4 **(a)** Explain the effect of sub-cooling of liquid on performance of Vapour Compression Refrigeration system. Also show the effect on *p-h* diagram. **03**

(b) Discuss with *T-s* diagram, the effect of superheat and condenser pressure variation on performance of Rankine cycle. **04**

(c) An engine of 250 mm bore and 375 mm stroke works on Otto cycle. The clearance volume is 0.00263 m^3. The initial pressure and temperature are 1 bar and 50°C. If the maximum pressure is limited to 25 bar, find the following: **07**

(i) The air standard efficiency of the cycle.

(ii) The mean effective pressure for the cycle.

Q.5 **(a)** Draw block diagram of Vapour Compression Refrigeration system. Write down all four processes only. Also show these processes on *p-h* diagram. **03**

(b) Compare Otto, Diesel and Dual cycle for same compression ratio and heat supplied. Also show comparison on *p-v* and *T-s* diagram. **04**

(c) A refrigerating system operates on the reversed Carnot cycle. The higher temperature of the refrigerant in the system is 35°C and the lower temperature is – 15°C. The capacity is to be 12 tonnes. Neglect all losses. Determine: **07**

(i) Co-efficient of performance.

(ii) Heat rejected from the system per hour.

(iii)Power required

OR

Q.5 **(a)** Define the following terms related to combustion process: **03**

(i) HCV

(ii) LCV

(iii)Enthalpy of formation

(b) Derive an equation for air standard efficiency of Otto cycle. **04**

(c) Explain the minimum air requirement (Stoichiometric Air Requirement) for complete combustion of following fuel by mass and by volume: **07**

(i) Hydrogen

(ii) Methane

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