Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code: 2131905 Date: 05/12/2018

Subject Name: 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 table with Mollier chart is allowed.**

Q.1 **(a)** Define heat, thermodynamic work and critical point. **03**

(b) What is thermodynamic system? Explain its all types with suitable examples. **04**

(c) Derive the general energy equation and deduce it for steady flow energy equation. Apply the same to nozzle. **07**

Q.2 **(a)** Write down statement of first law of thermodynamics for 1) an isolated system, 2) a system undergoing a cycle and 3) a system undergone a specific process. **03**

(b) What is entropy? Prove that it is a point function and hence property of the system. **04**

(c) Steam is leaving a 4 litre Pressure cooker whose operating pressure is 150 kPa. It is observed that the amount of liquid water in the cooker has decreased by 0.6 litre in 40min. after the steady operating conditions are established. And the cross section area of the exit opening is 8 mm^2. Determine (a) Temperature and other properties of steam, (b) mass of water decreased (c) mass flow rate of steam (d) exit velocity of steam (e, f) the total and flow energies of the steam per unit mass and (g) The rate at which energy leaves the cooker by steam. **07**

OR

(c) Prove the Carnot theorem applied to reversible heat engine. Also write down statements of its corollaries. **07**

Q.3 **(a)** Prove the equivalency of Kelvin Plank and Clausius statements of second law of thermodynamics. **03**

(b) Explain the Clausius inequality. **04**

(c) 4 kg of ice at -4 ^{O}C is exposed to the atmosphere which is at 20^{O}C. The ice melts and comes into equilibrium with the atmosphere. Draw T-s plot for the system, determine the entropy increase of the universe and comment about the process. **07**

Can water convert back into ice at -4 ^{O}C naturally? Why? If it happened, what will be the change in entropy of system for this case?

For ice, specific heat = 2.09 kJ/ kg K and latent heat of fusion =333 kJ/kg.

For water, specific heat = 4.18 kJ/ kg K.

OR

Q.3	**(a)**	Define following terms: 1) dead state 2) high grade energy 3) irreversibility.	**03**
	(b)	Two Carnot engines work in series between source and sink temperature of 1200K and 300K. Find out the intermediate temperature if 1) Both engines having same efficiency 2) Both engines develop equal power.	**04**
	(c)	By burning a fuel, the rate of heat release is 500 kW at 2000 K. What would be the first law and second law efficiencies if 1) energy is absorbed in a metallurgical furnace at the rate of 480 kW at 1000 K 2) energy is absorbed at the rate of 450 kW for generation of steam at 500 K and 3) energy is absorbed in a chemical process at the rate of 300 kW at 320 K. Take ambient temperature 300 K. What is the inference that you can draw from this example?	**07**
Q.4	**(a)**	Draw P-v, T-s plot of Carnot vapor cycle indicating all the processes. Also state its limitations.	**03**
	(b)	Draw neat schematic and explain the working of simple Brayton cycle.	**04**
	(c)	A Thermal power plant operates on ideal reheat type Rankine cycle with inlet of steam to high pressure turbine at 150 bar and 550^{O}C. The dry steam at exit is being reheated at 40 bar to 550^{O}C and supplied to low pressure turbine. Condenser works at 0.1 bar. Draw the T-s and h-s plot for the same and determine 1) quality at outlet of low pressure turbine 2) cycle efficiency 3) steam rate 4) heat rate and 5) work ratio.	**07**

OR

Q.4	**(a)**	Draw the P-v and T-s plot for the Diesel cycle indicating all the processes and write down formula for its thermal efficiency.	**03**
	(b)	What is the mean temperature of heat addition? Explain its significance.	**04**
	(c)	In an air standard Otto cycle**,** the temperatures at the beginning and end of the isentropic compression are 316K and 596K respectively. Determine the air standard efficiency and compression ratio. Also calculate the heat supplied, heat rejected and net power produced, if the maximum temperature during cycle is 3 times that of after isentropic compression.	**07**
Q.5	**(a)**	Define effectiveness of regeneration, mole fraction and characteristic gas constant.	**03**
	(b)	Draw the P-v, T-s plot and compare Otto, Diesel and Dual cycle for same compression ratio and heat rejection.	**04**
	(c)	Explain Dalton's law of partial pressure and Gibbs-Dalton law applied to mixture of gases.	**07**

OR

Q.5	**(a)**	Draw the neat schematic of regeneration type Rankine cycle with two feed water heaters indicating clearly all components and mass flow of steam.	**03**
	(b)	Explain in brief reduced properties of gas and critical compressibility factor.	**04**
	(c)	Explain Vander Waal's equation of state.	**07**