Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– III EXAMINATION – SUMMER 2020

Subject Code: 3131905 **Date:02/11/2020**

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. **Use of Steam table and refrigeration property table is permissible.**

Marks

Q.1 **(a)** State and define different thermodynamic systems **03**

(b) Describe quasi-static process. **04**

(c) A reversible heat engine operates between two reservoirs at temperature of 600ºC and 40ºC. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40ºC and -20ºC. The heat transfer to the heat engine is 2000 kJ and the net work output of combined engine refrigerator plant is 360 kJ. Evaluate the heat transfer to the refrigerant and net heat transfer to the reservoir at 40ºC. **07**

Q.2 **(a)** State first law for a closed system undergoing (i) cycle and (ii) a change of state. **03**

(b) Show that the COP of a heat pump is greater than the COP of refrigerator by unity. **04**

(c) The mass rate of flow into a steam turbine is 1.5 kg/s, and the heat loss from the turbine is 8.5 kW. The following data are known for the steam entering and leaving the turbine. Determine power output from turbine. **07**

	Inlet Conditions	Exit Conditions
Pressure	2.0 MPa	0.1 MPa
Temperature	350°C	
Quality		100%
Velocity	50 m/s	100 m/s
Elevation above reference plane	6 m	3 m
$g = 9.8066$ m/s^2		

OR

(c) Nitrogen enters a diffuser at 100 kPa, 300 K, with a velocity of 250 m/s and the exit velocity is 25 m/s. If nitrogen can be considered as an ideal gas with C_p=1.042 kJ/kg K, Find the exit temperature of Diffuser. **07**

Q.3 **(a)** State and prove Clausius theorem. **03**

(b) Suppose that 1 kg of saturated water vapor at 100ºC is condensed to a saturated liquid at 100ºC in a constant-pressure process by heat transfer to the surrounding air, which is at 25ºC. What is the net increase in entropy of the water plus surroundings? **04**

(c) Explain principle of increase of entropy. Apply it for the heat transfer through a finite temperature difference. **07**

OR

Q.3	**(a)**	Define following terms (i) Availability (ii) Irreversibility and (iii) Dead state.	**03**
	(b)	Explain Guoy-Stodola theorem.	**04**
	(c)	5 kg of air at 550 K and 4 bar is enclosed in a closed system.(i) Determine the availability of the system if the surrounding pressure and temperature are 1 bar and 290 K respectively. (ii) If the air is cooled at constant pressure to the atmospheric temperature, determine the availability and effectiveness. Assume specific heats remain constant during process. For air consider C_p= 1.005 kJ/kgK and C_v= 0.718 kJ/kgK.	**07**
Q.4	**(a)**	State the assumptions made for the analysis of air standard cycle	**03**
	(b)	For the same compression ratio and heat rejection, which cycle is most efficient: Otto, Diesel or Dual? Explain with p-v and T-s diagram.	**04**
	(c)	In a steam power cycle, the dry saturated steam supplied at 15 bar. The condenser pressure is 0.4 bar. Calculate the Carnot and Rankine efficiencies of the cycle. Neglect pump work.	**07**

OR

Q.4	**(a)**	Draw the sketch of Rankine cycle p-V, T-s and h-s diagram (consider Inlet and exit to turbine is superheated and saturated steam respectively).	**03**
	(b)	Explain simple regenerative Rankine cycle.	**04**
	(c)	An air standard Diesel cycle has a compression ratio of 20, with an inlet state of 95 kPa, 290 K, and a maximum cycle temperature of 1800 K. If air can be assumed to be an ideal gas with R= 0.287 kJ/kg.K and Cv= 0.717 kJ/kg.K, Determine net specific work output of the cycle.	**07**
Q.5	**(a)**	Draw open cycle gas turbine diagram and represent simple Brayton cycle on T-s and p-V diaram.	**03**
	(b)	Explain Bomb calorimeter with neat sketch.	**04**
	(c)	An ice-making machine operates on ideal vapour compression refrigeration cycle using refrigerant R-12. The refrigerant enters the compressor as dry saturated vapour at – 15°C and leaves the condenser as saturated liquid at 30°C. Water enters the machine at 15°C and leaves as ice at – 5°C. For an ice production rate of 2400 kg in a day, determine the power required to run the unit. Find also the C.O.P. of the machine. Use refrigerant table only to solve the problem. Take the latent heat of fusion for water as 335 kJ/kg. Assume Cp_{ice}=2.0935 kJ/kgK and Cp_{water}=4.187 kJ/kgK.	**07**

OR

Q.5	**(a)**	Draw the T-s and P-h diagram of VCR cycle when inlet to compressor is superheated vapour and condenser outlet is sub-cooled liquid.	**03**
	(b)	Discuss factors affecting performance of VCR cycle.	**04**
	(c)	Calculate the amount of theoretical air required for the combustion of 1 kg of acetylene (C_2H_2) to CO_2 and H_2O.	**07**