Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER–II • EXAMINATION – SUMMER - 2017

Subject Code: 2722112 **Date: 30/05/2017**

Subject Name: Exergy Analysis of Thermal Systems

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 tables is permitted**

Q.1 **(a)** Answer the following. (each question carry 2 marks) **08**

1. Explain the concept of effective temperature
2. Calculate maximum possible work if 10 kg of copper (c = 0.4 kJ/kg K) is cooled from 600K to 400K.
3. Calculate maximum work that can be extracted from 1 m^3 of vacuum available at 0 K.
4. Justify: Exergy is always a positive value.

(b) A thermal power installation, operated between source and sink temperatures of 1500K and 300K has size constraint of 10 kW/K. Calculate maximum work output and loss of maximum work output due to size constraint for heat input of 1 MW. **06**

Q.2 **(a)** An adiabatic turbine is supplied with air at the rate of 0.033 kg/s, 3.5 kPa and 303 K. The air is expand to 1 bar 238 K and then discharge to atmosphere. Environmental temperature and pressure are 283 K and 1 bar respectively. Take air to be perfect gas with C_p=1.005 kJ/kgK and ν=1.4. Calculate second law efficiency of expansion process in the turbine. **07**

(b) Explain exergy analysis of single stage expansion process with its Temperature-Entropy and Exergy-Enthalpy diagram. **07**

OR

(b) Derive the expression of second law efficiency for single stage adiabatic compression process. Also explain effect of non-adiabatic compression process on the second law efficiency. **07**

Q.3 **(a)** Draw T-s plot to demonstrate irreversibility of turbine and condenser of Rankine cycle and explain the same. **07**

(b) How regeneration, reheating and intercooling improve the exegetic efficiency of gas turbine power plants. **07**

OR

Q.3 For ideal Rankine cycle with superheat and reheat, boiler pressure = 80 bar, condenser pressure = 0.1 bar and maximum cycle temperature is 450°C. Assuming reheat pressure equal to 10, 20 and 45 bar, show that there exists an optimum reheat pressure P_i for which the efficiency of the cycle reaches maximum. **14**

Q.4	**(a)**	Draw T-s plot for ideal Brayton cycle which receive heat from source at temperature T_H and reject heat to sink at temperature T_L. Explain mean temperature of heat addition and mean temperature of heat rejection and hence write equation of thermal efficiency of Brayton cycle in terms of them. Also write equation of overall entropy generation and entropy generation between source and heater, and sink and cooler.	**07**
	(b)	An air preheater is used to heat up the air used for combustion by cooling the outgoing products of combustion from a furnace. The rate of flow of the products is 10 kg/s, and the products are cooled from 300°C to 200°C, and for the products at this temperature c_p = 1.09 kJ/kg K. The rate of air flow is 9 kg/s, the initial air temperature is 40°C. (a) What is the irreversibility for this process? (b) If the heat transfer from the products were to take place reversibly through heat engines, what would be the finally temperature of the air? What power would be developed by the heat engines? Take T_0 = 300K.	**07**
		OR	
Q.4		Show that the optimal position of the feed water heater (i) is the one that split the feed enthalpy rise evenly between heaters (i – 1) and (i +1).	**14**
Q.5	**(a)**	Explain rate of exergy destruction and second law efficiency for evaporative cooler.	**07**
	(b)	Refrigerant 134a is to be compressed from 0.14 MPa and 263 K (h_1=246.36 kJ/kg, s_1=0.97 kJ/kgK) to 0.8 MPa and 325 K (h_2=286.36 kJ/kg, s_2=0.98 kJ/kgK) in a compressor. Taking environmental condition to be 293 K and 95 kPa. Determine exergy change of refrigerant during compression process.	**07**
		OR	
Q.5	**(a)**	With T-s diagram explain external irreversibility for VCR cycle.	**07**
	(b)	Write all necessary equations and explain exergy economic analysis of (a) boiler (b) steam turbine.	**07**

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