Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER II– EXAMINATION – WINTER - 2016

Subject Code: 2722112 Date: 21/11/ 2016

Subject Name: Exergy Analysis of Thermal Systems

Time: 2:30 pm to 5:00 pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks**

Q.1 **(a)** For ideal Rankine cycle with exit to turbine is always two-phase state and the condenser temperature is practically equal to ambient temperature show that heat engine efficiency of the cycle is $\eta = \frac{b_2 - b_1}{h_2 - h_1}$. Notations have usual meaning **07**

(b) Air enters an adiabatic compressor at atmospheric conditions of 1 bar, 15°C and leaves at 5.5 bar. The mass flow rate is 0.01 kg/s and the efficiency of the compressor is 75%. After leaving the compressor, the air is cooled to 40°C in an after cooler. Calculate: (a) the power required to drive the compressor, and (b) the rate of irreversibility for the overall process (compressor and cooler). **07**

Q.2 **(a)** Explain exergy analysis and derive second law efficiency for Evaporative cooling process. **07**

(b) 1.5 kg of a gas flows through turbine unit from its initial pressure and temperature 6 bar and 1300K respectively and exhaust pressure and temperature 1.2 bar and 900K respectively. Calculate second law efficiency of turbine. Take for the gas C_p = 1.15 kJ/kg K, R = 0.29 kJ/kg K. **07**

OR

(b) Explain relation between rational efficiency and conventional combustion efficiency for steam boiler. **07**

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

(b) Explain how regenerative heat exchanger, reheaters and intercoolers reduces external irreversibility of gas turbine power plants. **07**

OR

Q.3 For an ideal Brayton cycle with pressure ratio 4.5, average source and sink temperatures are 877°C and 27°C respectively. Mass flow rate of air through the cycle is 110 kg/s. Temperature of air inlet to compressor is 350K. Calculate minimum entropy generation rate. Also calculate entropy generation rate between source and heater and sink and cooler. **14**

Q.4 **(a)** Draw T-s plot for Brayton cycle and 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. **07**

(b) A boiler is required to produce 5000 kg/hr of steam at 10 bar 300°C from water at 150°C. Combustion gases are cooled from 1100°C to **07**

500°C. Assuming c_{pg} = 1 kJ/kg K, Determine the total exergy destruction and the second law efficiency of the process.

OR

Q.4 Explain Haywood's formulation for optimal position of feed heaters. Also show that optimum location of inlet to the boiler is given by $\frac{h_B - h_n}{h_B - h_0} \cong \frac{1}{n+1}$ **14**

Q.5 **(a)** Explain irreversibility for condenser and evaporator of vapor compression refrigeration system with T-s diagram. **07**

(b) With suitable example, explain exergy economic analysis of power plant installation. **07**

OR

Q.5 **(a)** For VCR cycle, employed to produce very low temperature and consists of counter flow heat exchanger between high and low pressure streams, show that it requires a refrigerant for which at room temperature $\left(\frac{\partial h}{\partial P}\right)_T < 0$ and this is equivalent to $\mu_J > 0$. **07**

(b) Explain exergy analysis for multi stage adiabatic compression without intercooling. **07**

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