King Saud University

College of Engineering, Mechanical Engineering Department

Thermodynamics ME 374 1, first Midterm Exam. One and half hour exam, 6-6-1435H, 6-4-2014G. Thermodynamics property tables are allowed. Assume any necessary assumptions.

Question # 1

1- Water enters an adiabatic heat exchanger as a saturated liquid at 300 ^oC and leaves with a quality of 90%. The heat supplied to the water stream from a flue gas flow rate of 20 kg/s with an average specific heat of 1.04 kJ/kg K. The gas temperature decreases from 650 ^oC to 400 ^oC. T_o = 27 ^oC. Determine (a) the water flow rate; (b) the availability supplied in kW; (c) the availability recovered in kW; (d) the second law efficiency; (e) the entropy generation in kW/K; (f) the irreversibility or lost exergy in kW and (g) show the process of generating steam on P-v and T-S diagrams.

2- Draw a schematic of the heat exchanger in part 1 showing the system boundary you select to solve the problem. If the system boundary includes only the water tubes then write the first law of thermodynamics in this case but do not solve the problem.

Question #2

1- The compression ratio of an air standard Otto cycle is 9.5. At the start of the isentropic compression process, the air is at 100 kPa, 17 ^oC, and 600 cm^3. The temperature at the end of the isentropic expansion is 800 K. Using the constant specific heat values of air at room temperature (300 K), determine: (a) the pressure and temperature at each point of the cycle; (b) the mass of air; (c) the amount of heat added and rejected in kJ; (d) the thermal efficiency of the cycle; (e) the mean effective pressure of the cycle and finally draw the cycle on P-v and T-s diagrams.

2- Draw the air standard Brayton cycle on P-v and T-s Diagrams and show that its thermal efficiency is given by:

$$\eta_{\text{th,Brayton}} = 1 - \frac{1}{r_p^{(k-1)/k}}$$

Where r_p is the pressure ratio and k is the specific heat ratio.