ROSE-HULMAN Institute of Technology
Department of Mechanical Engineering

ME301 – Thermodynamics II Fall 2013-2014

Section: □ 01 (8th hour)
□ 02 (9th hour)

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Name

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CM

Exam 1

Sep 30, 2014

Problem 1	______/ 50
Problem 2	______/ 25
Problem 3	______/ 25
Total	______/ 100

Show all work for full credit.

Open book, property tables. Computer use for computational purposes or EES properties. One 8 ½ × 11″ handwritten equation sheet—one side, hand-written, no worked examples or homework.

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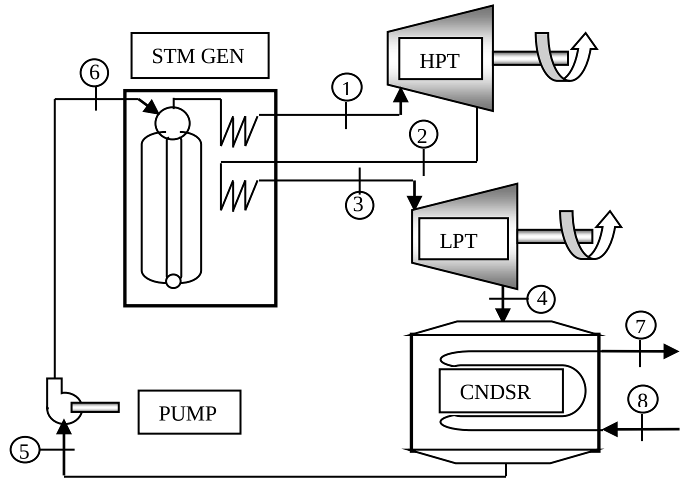
Problem 1 (50 pts)

Consider the reheat **STEAM** cycle at the right. Partial data are provided in the table below. Kinetic and potential energies are negligible.



(a) [10 pts] Determine the **net work out** per unit mass of steam in kJ/kg.

(b) [10 pts] Determine the **thermal efficiency** of the entire cycle.

(c) [12 pts] Determine the **adiabatic (isentropic) efficiency of the low pressure turbine** (LPT).

(d) [10 pts] Determine the **exergetic (2nd Law) efficiency of the pump**.

HINT: <u>Only find the property data necessary to complete the computations.</u> Much of the table can be left blank.

State	T [°C]	P [kPa]	h [kJ/kg]	s [kJ/(kg K)]		other
0	17	101.3	71.4	0.253		environment (dead state)
1	500	8000				
2	245.5	1000	2932.0	6.904		
3	450	1000	3370.7	7.618		
4		8	2521.0	8.052		
5	41.5	8	173.9	0.593		
6		8000	186.3	0.606		
7	15	200	63.1	0.224		
8	30	101.3	125.8	0.436		

(d) [4 pts] Most of the data required to calculate the **exergetic (2nd Law) efficiency of the condenser** are given in the table above.

(1) What parameter(s) are missing?

(2) How would you calculate it (them)?

(e) [4 pts] What is (are) the advantage(s) of adding a reheat to a modified-Rankine cycle.

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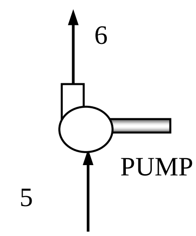
Problem 2 (25 pts)

Refer back to Problem 1 of this exam but focus on the pump of the steam cycle. Further measurements show that heat is being transferred out of the pump at a rate of 5 kJ/kg from a surface at 45°C. You may neglect the changes in kinetic and potential energies.



(a) [5 pts] Determine the exergy transfer by heat from the pump, in kJ/kg.

(b) [7 pts] Determine the **NEW** energy transfer by work to the pump, in kJ/kg.

(c) [8 pts] Determine the rate of exergy destruction in the pump, in kJ/kg.

(d) [5 pts] Circle the correct answer. Qualitatively, how does the heat transfer affect

i. the thermal efficiency of the cycle? [increase / decrease / stay the same]

ii. the exergetic efficiency of the pump? [increase / decrease / stay the same]

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Problem 3 (25 pts)

A mixture of ideal gases contains 75% N_2 (M = 28 kg/kmol) and 25% CO_2 (M = 44 kg/kmol) **by mass**. The mixture is initially at T_1=27°C and P_1 = 100 kPa.

(a) What are the partial pressures (in kPa) of the N_2 and the CO_2 at state 1?

(b) If 1 kmol of the mixture is heated to a temperature of T_2 = 37°C and P_2 = 200 kPa, what is the total change in entropy, $S_2 - S_1$, in kJ/K?

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