ME 200 Exam 3  
November 16, 2011  
8:00 p.m. to 9:00 p.m.  

INSTRUCTIONS  

1. This is a closed book examination. You are provided with an equation sheet and all needed 
property tables are provided.  
2. Do not hesitate to ask the instructor if you do not understand a problem statement.  
3. Start each problem on the same page as the problem statement. Write on only one side of the 
page. Materials on the back side of the page will not be graded. There are blank pages 
following problems 2 and 3 for your work.  
4. Put only one problem on a page. Another problem on the same page will not be graded.  
5. Label your system and list relevant assumptions for problems 2 and 3.  
6. If you give multiple solutions, you will receive only a partial credit although one of the solutions 
might be correct. Delete the solution you do not want graded.  
7. For your own benefit, please write clearly and legibly. Maximum credit for each problem is 
indicated below.  
8. After you have completed the exam, at your seat put your papers in order. This may mean 
that you have to remove the staple and re-staple. Do not turn in loose pages.  
9. Once time is called you will have three minutes to turn in your exam. Points will be subtracted 
for exams turned in after these three minutes.  

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Problem 1 (30 points) Show all work to receive credit.

(a) A refrigerator with two compartments removes heat at the rate of 1000 kW from one compartment at -23°C and at the rate of 1400 kW from another compartment at 7°C; 300 kW of power input is required to operate the refrigerator. The refrigerator rejects heat to the ambient reservoir at 27°C.

Draw a sketch of the refrigerator showing all heat and work interactions. Determine whether the refrigerator is reversible, irreversible, or impossible. (20 points)
Problem 1 (continued)

(b) Consider two equilibrium states of a thermodynamic system. A reversible process (along path A) and an irreversible process (along path B) occur between these two states. Answer the following questions; provide justification for each answer.

Entropy change along path A is less than entropy change along path B. (5 points)

True     False     Insufficient Information

Entropy generation along path A is less than entropy generation along path B. (5 points)

True     False     Insufficient Information
Problem 2 (35 points) R-134a enters a counter-flow heat exchanger at 8 bar and 90°C (state 1) and is cooled to saturated liquid at 8 bar (state 2). Liquid water enters at 1 bar and 15°C (state 3) and leaves at 1 bar and 23°C (state 4). The mass flow rate of R-134a is 2.5 kg/s.

(a) Calculate the mass flow rate (kg/s) of liquid water.
(b) Determine the rate of entropy generation (kW/K) within the heat exchanger.

Identify your system, list assumptions, and start with basic equations.
First Name ___________________ Last Name ___________________

Problem 2 (continued)
Problem 3 (35 points)  Air expands from 14 bar and 330 K (state 1) to 2.8 bar (state 2) via a reversible, isothermal process inside a piston-cylinder device.

(a) Calculate the specific heat transfer (kJ/kg) during the expansion process.
(b) Determine the specific work (kJ/kg) during the expansion process.
(c) Show the expansion process on P-v and T-s diagrams. Label the states clearly, indicate appropriate lines of constant pressure and temperature, and associate the work and heat transfer with areas on these diagrams. Do not show values of specific volume and specific entropy.

Identify your system, list assumptions, and start with basic equations.
Problem 3 (continued)