ME 200
Summer 2013
Exam 1
Tuesday 2 July

READ THESE INSTRUCTIONS BEFORE DOING ANYTHING ELSE

1. This is a closed book examination. All needed property tables, equation sheets and units conversions are provided as attachments to this exam.
2. Do not hesitate to ask questions 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 (the front) of each page. Material on the back side of any page will not be graded. Additional paper will be provided upon request.
4. Put only one problem on each page. A second problem on the same page will not be graded.
5. Follow the Problem Solution Format given in class in order to be eligible for full credit.
6. If you provide multiple solutions, you will receive only partial credit even if one of the solutions is correct. Delete the solution(s) you do not want.
7. For your own benefit, please write clearly and legibly.
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 then re-staple at the front of the room. Regardless, do not turn in loose pages.
9. Once time is called you must stop writing immediately. Points will be subtracted from those writing after this time (not kidding on this one—it’s a pet peeve of mine).

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<th>Problem</th>
<th>Possible score</th>
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1. **[20 points]** A piston-cylinder device is filled with 2 lbm of air at a pressure of 1 atm and a temperature of 75°F. The air is compressed according to the relationship $p_v^{4/3} = \text{constant}$; the final temperature is 725°F.

**Compute the work associated with this process.** Report your answer in ft-lb°F.

2. [30 points] 2.5 kg/s of 5 bar, saturated vapor steam enter a heat exchanger from above (state A). 2.0 kg/s of saturated liquid steam, also at 5 bar, enter from below (state B). The two streams mix with the result that steam exits to the right (state C). In addition, the heat exchanger is not completely insulated so there is a heat loss of 525 kW from the steam to the surroundings.

What is the quality of the exiting steam?
3. [50 points] A piston-cylinder assembly is connected to a valve as shown below. The assembly initially contains 1.2 kg of air at 27°C and 101 kPa. The valve is opened and an extra 2.2 kg of air at 101 kPa and 47°C enters the assembly. The valve is then closed and heat transfer between the air in the assembly and the surroundings occurs. The final state of the air in the assembly is 32°C and 101 kPa. Clearly the process is one of constant pressure. In addition you should neglect the effect of kinetic and potential energy changes when answering the following questions.

\[
\begin{align*}
\text{Surrounding pressure:} & \\
& 101 \text{kPa}
\end{align*}
\]

\[
\begin{align*}
\text{Valve} & \\
\text{Air at 47°C}
\end{align*}
\]

a) [2 points] Draw the system boundary in the figure above using a dashed line.

b) [3 points] Identify the mass transfer to/from the system, the heat transfer to/from the surroundings and work done by/on the system in the diagram by arrows. The direction of the arrows should represent the positive direction of the variables.

c) [15 points] Find the initial and final volume of the air inside the assembly. Report your answer in m³.

d) [20 points] Calculate the heat transfer between the air in the assembly and the surroundings. Report your answer in kJ.

e) [10 points] Determine the work done by the piston-cylinder assembly on the surrounding air. Report your answer in kJ.