Midterm #1

MEMS 0051 - Introduction to Thermodynamics
Spring 2021

Assigned: March 1st, 2021
Due: March 8th, 2021, 11:59 pm via Gradescope

Rules

The following listed rules, in addition, but not limited to, those listed on the syllabus, those listed on page 11, and those outlined by Pitt's Academic Integrity Policy, apply to this examination:

1. This test is open notes, open book, open lecture videos, open homework and homework solutions, open quiz and quiz solutions, and you are able to reference previous assessment materials posted on GitHub;
2. You are to complete all **3** problems.
3. You can direct general questions to Dr. Barry via email. A general question constitutes a point of clarification with a question, for example "Why is thermodynamics the coolest subject ever?" Specific questions about how to solve a problem, pertinent equations, related to general guidance, etc., are *not* permitted;
4. You are *not* to communicate with *any* other student about this exam. Period;
5. You are *not* to use any online resources, such as Chegg, Quora, etc.. Seeking external assistance in the form of posting this exam, posting pictures/screenshots/images of this exam, posting questions from this exam, asking questions pertaining to the problems within the exam, etc., are in direction violation of the Academic Integrity policy and will result in immediate failure of this exam;
6. Unsubstantiated results will be marked incorrect. A result where the mathematics do not substantiated the final result will be marked wrong;
7. The work for your exam must be submitted on the exam sheets. Failure to do so will result in your exam not being graded. Your work must be neat, legible, and follow a clear and logical progression. Your final answer must be boxed with proper units, and significant digits. As outlined in the course syllabus, an answer without units will be marked incorrect;
8. You must complete the Academic Integrity Statement and include it with your exam submission for your exam to be graded.

Problem #1

(20 pts.) A rigid, non-deformable tank contains R-410a, which is existing as a saturated vapor at -3 °C. The tank is then cooled to a temperature of -43.7 °C. Determine the amount of specific heat transferred (units taken as [kJ/kg]).

Problem #2

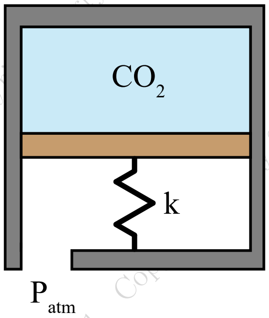
(30 pts.) A tank contains 0.488 [kg] of water initially at 247.3 [kPa] with a quality of 9.5%. This tank is connected to a piston-cylinder by a valve, that is initially closed. The piston-cylinder contains 0.502 [kg] of water initially at 198 [kPa] and a temperature of 406 °C. The valve connecting the tank and piston-cylinder is then opened, allowing thermodynamic equilibrium to be achieved. Additionally, heat transfer is allowed to take place between the system and surroundings, until a final temperature of 148.5 °C is reached. Determine the following:

a) The final pressure of the system;
b) The volume of the system;
c) The work associated with this process;
d) The heat transfer associated with this process.

Problem #3

(50 pts.) A piston-cylinder device is connected to a spring, which has linear behavior (i.e. the pressure within the piston cylinder linearly changes with volume - we literally constructed this expression in Lecture 8, Example #1 part b)). Within the piston-cylinder device, there exists 2,000 [g] of CO_2 existing at a pressure of 502 [kPa] and a temperature of 1,173 [K]. Then, the system is then cooled to a temperature of 609 [K], and in doing such, the pressure is 302 [kPa]. Determine the following:

a) The work associated with this process;
b) The heat transfer associated with this process assuming a constant specific heat taken from Table A.5;
c) The heat transfer associated with this process assuming a specific heat, based upon the average of the initial and final temperatures, from Table A.6;
d) The heat transfer associated with this process assuming a specific heat, based upon the integral-averaged value using the initial and final temperatures, from Table A.6;
e) The heat transfer associated with this process assuming a specific heat taken from Table A.8;
f) The applicability of the Ideal Gas Law.



Note: figure is not drawn to scale

Academic Integrity Statement:

I hereby attest that I have received no assistance (from a friend, from another student, from an on-line resource, such as Chegg, etc.), and that I have provided no assistance to another student, during this exam. All the work presented within is solely my own work.

Signature: ______________________________________

Date: ________________________