ME 322 – Mechanical Engineering Thermodynamics (Exam 1 Do-Over)

Spring 2018

You get to take Exam 1 again as a take-home. You are still not allowed to work with anyone (just don't do it). Your in-class exam 1 grade will be averaged with your take-home exam 1 grade. However, as a take-home there will be minimal partial credit on the problems.

Please read the following statement:

Article II, Section 1 of the University of Idaho Student Code of Conduct states,

> *Cheating on classroom or outside assignments, examinations, or tests is a violation of this code. Plagiarism, falsification of academic records, and the acquisition or use of test materials without faculty authorization are considered forms of academic dishonesty and, as such, are violations of this code. Because academic honesty and integrity are core values at a university, the faculty finds that even one incident of academic dishonesty seriously and critically endangers the essential operation of the university and may merit expulsion.*

I have read and understand the above statement.

_____ _____

Signature Date

_____

Printed Name (40 points)

EXAM INSTRUCTIONS – PLEASE READ THIS CAREFULLY

Show all of your work in the space provided on the exam. If more space is needed you should use the back of the exam.

You may use your computer (and EES software). If you use EES, you need to attach your EES output (code, solution, etc.). You may use Google, and the Internet as a source of information. However, you may not use the Internet to get people to calculate your answers for you.

Part 1: Engineering Calculations – 45 Points

Problem 1: (15 points) You have R-134a at a temperature of 70 °F and a pressure of 250 psia. Use your supplemental tables to calculate/determine the following: (Note: You can/should check your answer using EES, but you still need to do the calculations using data from the tables)

a) What phase is the R-134a in (solid, liquid, saturated, or superheated)? (2 points)

b) What is the density [lbm/ft^3] of the R-134a? (5 points)

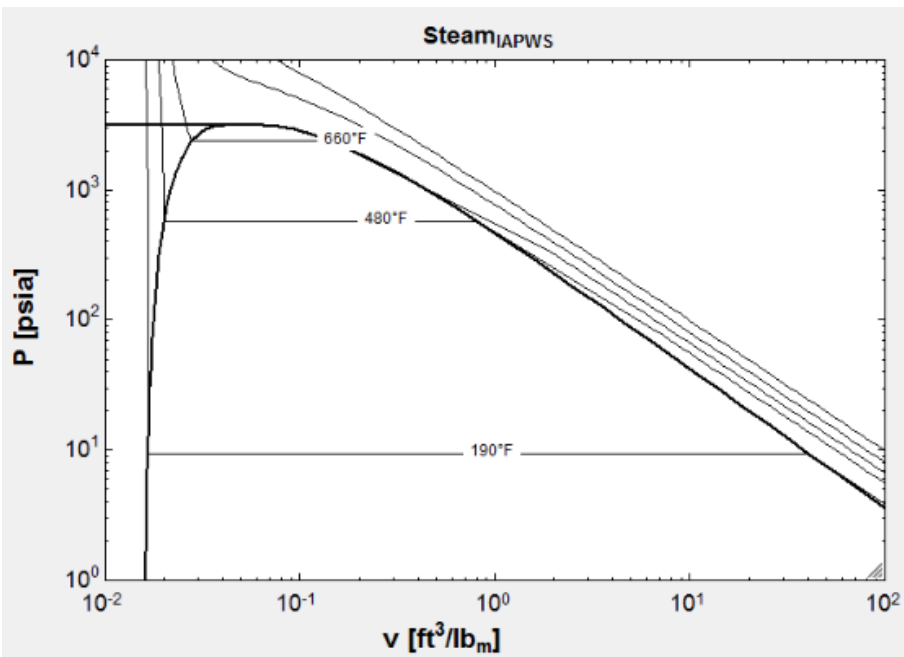
c) What assumption(s) did you have to make to get to this answer? (3 points)

d) What is the value of specific enthalpy [Btu/lbm] of the R-134a? (5 points)
Tip: You can't ignore the pressure effects when calculating enthalpy.

Problem 2: (15 points) Saturated water vapor (H_2O) is at a temperature of 320 °F. It is in a cylindrical sealed container with an initial volume of 1.50 ft^3, and pressure in the container is kept constant by a sealed, movable piston with a mass on top of it. You remove heat from the water until it reaches saturated liquid. Use your supplemental tables to calculate/determine the following:

a) Calculate the mass [lbm] of water in the cylinder. (2 points)

b) Draw this process on the P-v diagram below and label the initial and the final states. (3 points)



c) Calculate the work [ft*lbf] done on the water during this process. (5 points)

d) Use First Law of Thermodynamics to calculate the amount of heat [Btu] that was removed for this process to occur. (5 points)
Tip: The unit conversion sheet shows 1 Btu = 778.16 ft*lbf

Problem 3: (15 points) An Atkinson cycle engine can be modeled by an <u>ideal gas</u> undergoing the following <u>closed cycle</u>.

1-2: Isobaric compression at P_1 from V_1 to V_2
2-3: Adiabatic, polytropic compression from P_2 to P_3
3-4: Isochoric combustion from P_3 to P_4
4-1:Adaibatic, polytropic expansion back to state 1

a) Complete the following table, <u>giving the correct sign (+, -, or zero)</u> (1 point each)
Tip: It may be helpful to draw the cycle on a Pv diagram.

	Work	Heat	Change in Internal Energy
Process 1-2			
Process 2-3		Q=0 (process is adiabatic)	
Process 3-4	W = 0 (process is isochoric, so no dV)		
Process 4-1			
Net for Entire Cycle			

Part 2: Multiple Choice Conceptual Questions –15 Points

5 points each. Some problems have multiple answers. To earn all 5 points you must mark all the correct answers.

Problem 4: What is true about this EES code

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T_1 = 350 [C]
x_1 = 0.9
v=Volume(steam_IAPWS, T=T_1, x=x_1)
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a) this will compute volume of water in the container

b) this will compute the specific volume of steam as a compressed liquid

c) the current state is a saturated mixture

d) This will compute the specific volume of the two-phase water mixture

Problem 5: Which of the following statements are true about the 1st law equation?

$$E_T + E_p = E_g$$

a) E_p can be zero, positive, or negative

b) E_g is the net energy gain of the system over a finite interval

c) E_g is the change in internal energy if kinetic and potential energy are negligible

d) E_T is thermal energy inside the system

Problem 6: In a two phase mixture, the correct definition of <u>quality</u> is:

a) The volume of vapor divided by the total volume

b) The volume of liquid divided by the total volume

c) The mass fraction that is saturated vapor

d) The volume fraction of saturated vapor