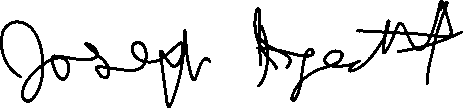
ME 200 – Thermodynamics, L. Liebenberg

**Name:** Joseph Specht

**Quiz 8** (Total: 30 points)

**Due back on Wed. 5 April in the Quiz 8 folder on Canvas**

* *Follow the problem-solving strategy that you learnt in class. You will be penalized if you do not.*
* *Save your entire assignment as one PDF document and upload it in the appropriate assignment folder on Canvas.*
* *Assignments will only be graded if the honor code statement, below, is completed and signed.*



**Honor Code Statement**

***ME 200, Quiz 8***

Being a student of high standards, I pledge to embody the principles of *academic integrity*.

This ME 200 quiz is my own work. I did not seek (or get) outside help or collaboration with any of the questions and their solutions. I also did not offer my solutions to any other student.

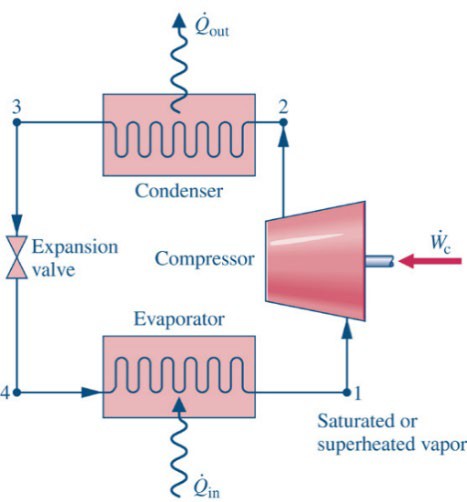
I understand that this quiz is “open book” and “open notes” which means that I was permitted to use my prescribed textbook and lecture notes when addressing any of the questions. I have properly cited any other resources, with full cognizance of the regulations pertaining to plagiarism, copyright infringement, academic cheating, etc., as stipulated in the Student Code.

I acknowledge that academic violations will be dealt with according to the UIUC Student Code, Article 1, Part 4.

ME 200 Student’s signature: Student’s Name: Joseph Specht

Net-ID: jspecht3

Date: 4/2/23

Consider an air-conditioning system that operates on an ideal vapor- compression cycle. The system uses R-134a as refrigerant. The refrigerant enters the compressor as a saturated vapor at 5ºC and leaves the condenser as a saturated liquid at 55ºC. The mass flowrate of the refrigerant is 0.7 kg/s.

1. Draw the cycle on a *p*-*h* diagram and indicate all state points. Clearly show the processes where heat and work transfer take place. Also indicate all known temperatures and pressures. *(2)*



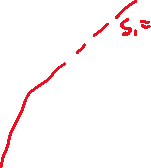
T\_1 = 5 \*C (sat vapor)

T\_3 = 55 \*C (sat liquid)

…………………………………………………………………………………………………………



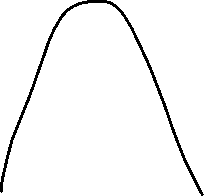
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1. Complete this table *after* you have performed all calculations in Questions 3 – 5. (No credit will be given for completing the table. Non-completion of the table will however result in 5 points being deducted from your quiz total.)

|  |  |  |  |
| --- | --- | --- | --- |
| **Process** | **Specific heat, *q***  **(kJ/kg)** | **Specific work, *w***  **(kJ/kg)** | **Change in specific enthalpy,**  ***h*exit – *h*inlet**  **(kJ/kg)** |
| **1 – 2** | 0 | -30.7455 | 29.8675 |
| **2 - 3** | -151.548 | 0 | -151.548 |
| **3 - 4** | 0 | 0 | 0 |
| **4 - 1** | 120.8025 | 0 | 120.8025 |
| **Σ:** | -30.7455 | -30.7455 | 0 |

# Calculate the specific enthalpies and specific entropies at state points 1, 2, 3 and 4. Show ALL interpolations! *(16)*

We know that @ state point 1, we have a saturated refrigerant 134a that is a saturated vapor, so go to table A-10 and interpolate to find the enthalpy and entropy

Now we must repeat the same process to find the entropy!

Before we calculate the values at state point 2, we need to know the pressure at this state, but we are in luck as the pressure at state point 3 and 2 are the same and we know information about state point 3.

@ State point 3, we have a saturated liquid at T=55\*C, so using table A-10, we can find all these values

After solving state point 3, we can find the enthalpy and entropy at state point 2. We know that state points 1 and 2 have the same entropy and we know state point 2 will be superheated as you do work on a saturated vapor that experiences adiabatic compression. We also know the pressure is equal to p\_3.

If we do the same interpolation process for the entropy, we get…

Now that we have solved for state point 3, we can realize s\_1 = s\_2 and use table A-12 to solve for h\_2.

Since we know h\_3 = h\_4, the only information we need to find is s\_4, so we go to table A-10 as state point 4 lies in the saturated mixture region. We know p\_1 = p\_4, so we must find p\_1 first.

Now that have these two properties, we can find the value of s\_4 from table A-10. But first, we must find the vapor quality.

56.70

Since we know h\_4, h\_f@p4, and h\_fg@p4, we can find x

If we have this value, we can then interpolate from A-10 to find s\_4

First, we need to find the values of s\_f and s\_fg, so

Now, we have to find s\_g to find s\_fg

This means s\_fg is…

With all the entropies we need, we can find the final value of s\_4

|  |  |  |
| --- | --- | --- |
| State point | H [kJ/kg] | S [kJ/(kg\*K)] |
| 1 | 250.0975 | .916425 |
| 2 | 280.843 | .916425 |
| 3 | 129.295 | .4573 |
| 4 | 129.295 | .482 |

Now that we have all these values, we just need to calculate the work and heat transfer with the first law

For 1-2, we know this is adiabatic and gives no work, so

For 2-3, we know this is an isobaric process, so work is zero and this process ejects heat, so q\_out = 0

For process 3-4, we know it is a valve that does no work or add any heat, so everything is 0.

For process 4-1, we know this is an isobaric process, so work is 0 and this raises the enthalpy, so q\_out=0

# Calculate the specific work required at the compressor. *(3)*

For 1-2, we know this is adiabatic and gives no work, so

1. Calculate heat transfer rate (in kW) in the condenser. *(3)*

For 2-3, we know this is an isobaric process, so work is zero and this process ejects heat, so q\_out = 0

# Calculate heat transfer rate (in kW) in the evaporator. *(3)*

For process 4-1, we know this is an isobaric process, so work is 0 and this raises the enthalpy, so q\_out=0

# Calculate the coefficient of performance of the cycle. *(3)*

, which seems high