HW2 – EES and Vapor Compression Cycles 1

INSTRUCTIONS:

For any problems labeled with 'E' in the problem, use EES to solve the problem. You are welcome to use EES for problems without an 'E' as well.

Submit all assignments as **PDF** to **Canvas**. You can submit your EES files Additionally, but you MUST submit a PDF as well! **EES files alone will NOT BE GRADED.**

Follow the EES Formatting Guide (located as a page on Canvas) to generate solutions to the below problems.

DO NOT FORGET TO SOLVE PRIOR TO PRINTING TO PDF!

PROBLEMS:

1E. Find the solution of X, Y and Z of the following equations:

x + y^3 = 5
y = z^2-6
z = x^3-5+y

2E. Write down the following function:

$$Nu = 1.29 + \frac{(0.1259 + \frac{0.0826}{Pr\ ^{0.4}})Gz}{1.2 + 0.1522 Gz^{0.5}}$$

From this function find Nu given that Gz = 1.4, Pr = 0.8

3E. Water enters a nozzle steadily at 3.2 kg/m3 and 40 m/s and leaves at 1.4 kg/m3 and 160 m/s. If the inlet area of the nozzle is 200cm^2, Determine:

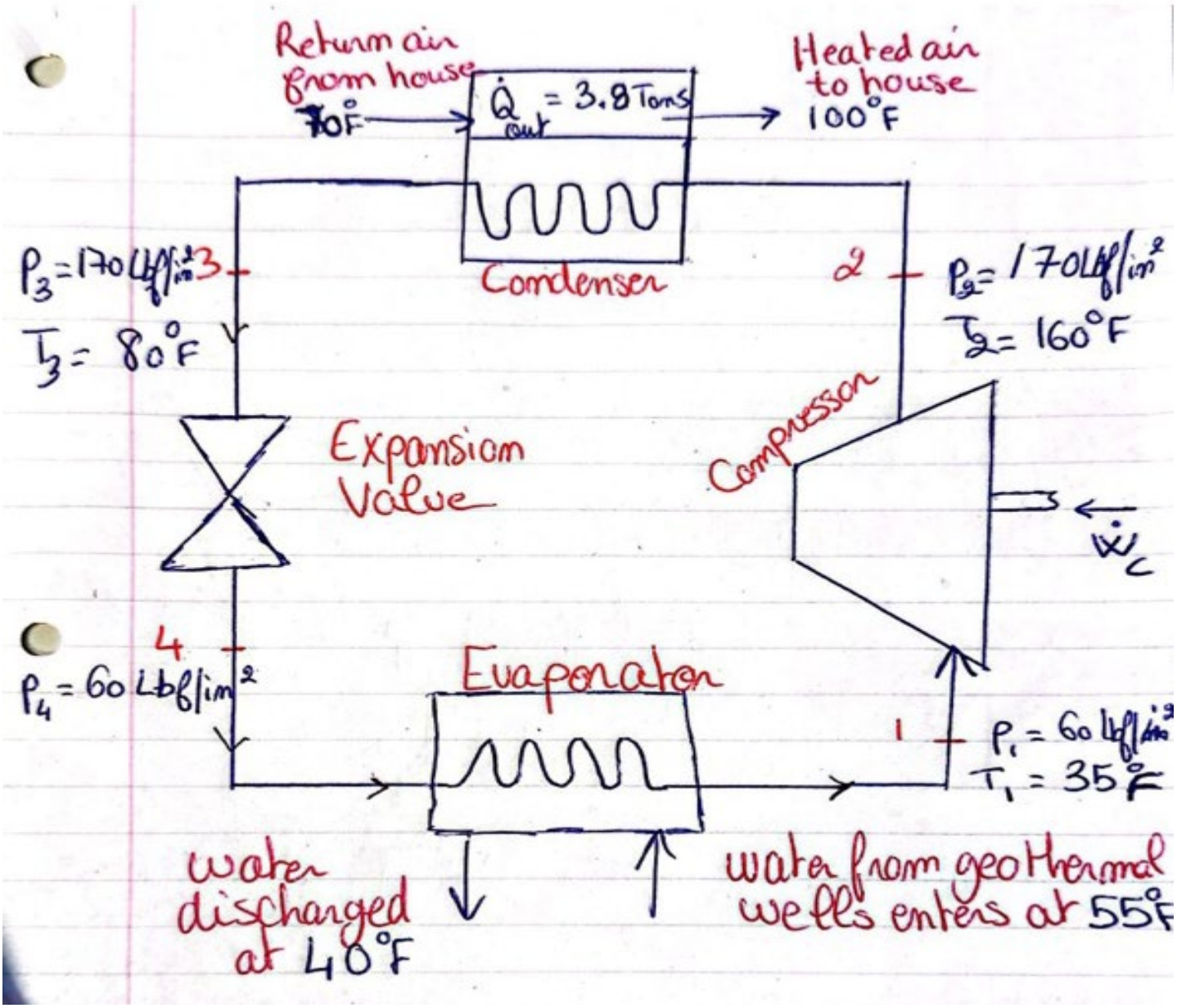
a. Mass flow rate through the nozzle,
b. Exit area of the nozzle.

4E. A vapor-compression refrigeration cycle operates at steady state with Refrigerant 134a as the working fluid. Saturated vapor enters the compressor at 4 bar, and saturated liquid exits the condenser at 9 bar. The isentropic compressor efficiency is 70%. The mass flow rate of refrigerant is 3 kg/min. Determine,

a. the compressor power, in kW.
b. the refrigerating capacity, in tons.
c. the coefficient of performance.
d. Create T-s and P-h plots. Add an additional point to "close" the cycle on the plot.

5. A ground-source heat pump (GSHP) operating at steady state with Refrigerant, R-22 as the working fluid is shown below. The heat pump uses 55F water from wells as thermal source. Operating data is shown in the figure for a day in which the outside air temperature is 20F. Assume adiabatic operating of the compressor. For the heat pump, determine:

a. The volumetric flow rate of the heated air to the house, in ft^3/min.
b. The isentropic compressor efficiency.
c. The compressor power, in horsepower.
d. The coefficient of performance
e. The volumetric flow rate of water from the ground heat exchangers (geothermal wells), in gal/min
f. The Carnot heat pump efficiency assuming the warm temperature is the return air from the house and cool temperature is the water temperature from the ground heat exchanger (geothermal wells).



One more problem on next page →

6E. An ideal vapor-compression refrigeration cycle, with Ammonia as the working fluid, is modified to include a counterflow heat exchanger (sometimes called a suction line heat exchanger). The working fluid leaves the evaporator as a saturated vapor at 2 bar and is heated at a constant pressure to 5C before entering the compressor. The compressor is isentropic and compresses to 18 bar then the fluid enters the condenser where it is cooled at a constant pressure to 45C, 18bar. The liquid then passes through the heat exchanger, entering the expansion valve at 18 bar. If the mass flow rate of refrigerant is 8 kg/min, find:

a. The refrigeration capacity, in tons of refrigeration
b. The compressor power, in kW
c. The coefficient of performance
d. Create T-s and P-h plots