Exam III
Administered: Wednesday, November 9, 2018
20 points

For each problem part: 0 points if not attempted or no work shown,
1 point for partial credit, if work is shown,
2 points for correct numerical value of solution, if work is shown

Problem 1. (8 points)

For an ideal mixture, the enthalpy of the mixture, H_{mix}, is given by the sum of the pure component enthalpies, H_i, weighted by the mole fraction. The entropy of the mixture, S_{mix}, is given by the formula below, where $R = 0.008314\ kJ/mol/K$. As a reminder, the sum of the mole fractions is unity.

$$H_{mix} = \sum_{i=1}^{n_c} x_i H_i \qquad S_{mix} = -R \sum_{i=1}^{n_c} x_i ln(x_i) \qquad 1 = \sum_{i=1}^{n_c} x_i$$

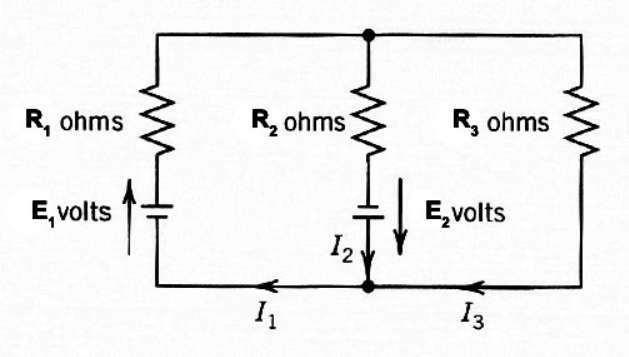
where n_c is the number of components. Now consider a three component ideal mixture ($n_c = 3$) with the following pure component properties and mixture properties.

component	A	B	C	mixture
enthalpy (kJ/mol)	49	74	45	66.1
entropy (kJ/mol/K)				0.0067

(a) Is this system of algebraic equations linear or nonlinear? (2 pts)
(b) Determine the composition of this mixture. Show reasoning and method. (6 pts)

(problem two on other side)

Problem 2. (12 points)
Consider the following circuit.



Circuit analysis is performed by using Kirchoff's Current & Voltage laws. Kirchoff's current law states that the sum of the currents entering and leaving any node must sum to zero. So for the bottom node, Kirchoff's current law provides the following equation.

$$-i_1 + i_2 + i_3 = 0$$

where *i* denotes current. Kirchoff's voltage law states that in a loop the sum of the voltages is zero. The application of Kirchoff's voltage law to the right and left loops respectively yields

$$R_1 i_1 + R_2 i_2 = E_1 + E_2$$

$$-R_2 i_2 + R_3 i_3 = -E_2$$

where *R* denotes a resistance and *E* denotes an applied voltage. Consider an example where the following values are assigned: $R_1 = 15, R_2 = 15, R_3 = 25, E_1 = 50, E_2 = 80$

(a) Write this set of equations in matrix notation, $\underline{A}\underline{x} = \underline{b}$. Identify all three quantities, $\underline{A}$, $\underline{x}$ and $\underline{b}$.
(b) Calculate the determinant of $\underline{A}$.
(c) Calculate the rank of $\underline{A}$.
(d) Calculate the rank of $\underline{A}|\underline{b}$
(e) How many solutions are there to this problem?
(f) Calculate the currents.