Enter all your work and your answers directly in the spaces provided on the printed pages. Make sure that your name is on all sheets. Use the backs of the printed pages as scratch paper, but we will only grade the work that you neatly transfer to the spaces on the printed pages. Answers must be derived or explained, not just simply written down. The quiz is closed book, but calculators are allowed.

This quiz contains 9 pages including the cover sheet. Make sure that your quiz contains all 9 pages and that you hand in all 9 pages.
Problem 1: (30 points) For parts (A)-(C), use the associated branch variables as defined in Figure 1.

(A) Write element laws for the resistor $R_1$, the current source $I_A$, and the voltage source $V_B$.

(B) Write a complete set of independent KVL equations expressed only in terms of the branch voltages $v_1$, $v_2$, ..., and $v_8$.

(C) Write a complete set of independent KCL equations expressed only in terms of the branch currents $i_1$, $i_2$, ..., and $i_8$. 

Figure 1: Circuit for Problem 1(A), 1(B) and 1(C)
(D) The same circuit is shown in Figure 2, labeled for node analysis. Write out the node equations necessary to solve for the three unknown node voltages $e_1$, $e_2$ and $e_3$. **DO NOT SOLVE** these equations.

Figure 2: Circuit for Problem 1(D)
(E) The current $i_1$ in Figure 3 can be written in the form:

$$i_1 = aV_A + bV_B + cI_A + dI_B$$

Determine the coefficients $a$, $b$, $c$ and $d$ in terms of the resistor variables in the circuit.

![Circuit for Problem 1(E)](image)

Figure 3: Circuit for Problem 1(E)

\[ a = \]  
\[ b = \]  
\[ c = \]  
\[ d = \]
Problem 2: (40 points) Network 1, shown in Figure 4, is described by its $v$-$i$ relationship measured at the terminals. Network 2, shown in Figure 5, is described by a schematic diagram of its components.

(A) Find the Thévenin and Norton equivalent circuits that have the same $v$-$i$ relationship as Network 1.

![Figure 4: Network for Problem 2(A)](image-url)
(B) Find the Thévenin and Norton equivalent circuits that have the same $v$-$i$ relationship as Network 2.

Figure 5: Network for Problem 2(B)
(C) Suppose that the two networks are connected together through a resistor as shown in Figure 6. Find the current $i_1$ and the voltage $v_1$.

Figure 6: Network for Problem 2(C)

\[ i_1 = \underline{\hphantom{1234567890}} \]

\[ v_1 = \underline{\hphantom{1234567890}} \]
(D) Suppose that the two networks are connected together through a resistor as shown in Figure 7. Find the current $i_2$ and the voltage $v_2$.

$$i_2 = \text{___________}$$

$$v_2 = \text{___________}$$
Problem 3: (30 points) Determine all node potentials in the network shown in Figure 8 in terms of the conductances of the resistors \((G_A, G_B, G_C, G_D, G_E, \text{ and } G_F)\), the current sources \((I_C \text{ and } I_F)\), and the voltage sources \((V_A, V_B, V_D \text{ and } V_E)\).

![Figure 8: Circuit for Problem 3](image)

\[
e_1 =
\]

\[
e_2 =
\]

\[
e_3 =
\]

\[
e_4 =
\]

\[
e_5 =
\]