15 pts

**PROBLEM 1:** Given the circuit below:

(a) Simplify the circuit and find $R_{eq}$.

(b) Find the magnitude and sign of $I_0$.

(c) Find the magnitude and sign of the power of the voltage source.

\[ I_5 = \frac{25}{3.33} = 7.5 \text{ A} \]

\[ I_0 = \frac{3.95 \times \frac{3.33}{10}}{6.33} = 1.32 \text{ A} \]

\[ P_{25V} = -98.75 \text{ W} \]
**Problem 2:** Use Node Voltage Analysis!

30 pts.

\[ (V_b - 40) \]

(a) Find \( N_e \).

\[ N_e = 4 \]

(b) Find the theoretical number of Kirchhoff equations, \( \# KL \).

\[ \# KL = 3 \]

(c) Write the auxiliary eqn.

\[ V_B = V_b - 0 = V_b \]

(d) Write the Kirchhoff equations, do not simplify.

- KCL @ \( V_b \):
  \[ -2 + \frac{V_b}{5} + \frac{(V_b - 40) - V_d}{6} = 0 \]

- KCL @ \( V_d \):
  \[ \frac{V_d - (V_b - 40)}{6} + \frac{V_d - V_f}{7} + \frac{V_d - (V_f + 2V_B)}{4} = 0 \]

- KCL @ \( V_f \):
  \[ \frac{V_f - 0}{3} + \frac{V_f - V_d}{7} + \frac{(V_f + 2V_B) - V_d}{4} = 0 \]

Can be simplified to:

- KCL @ \( V_b \):
  \[ -2 + \frac{V_b}{5} + \frac{(V_b - 40) - V_d}{6} = 0 \]

- KCL @ \( V_d \):
  \[ \frac{V_d - (V_b - 40)}{6} + \frac{V_d - V_f}{7} + \frac{V_d - (V_f + 2V_B)}{4} = 0 \]

- KCL @ \( V_f \):
  \[ \frac{V_f}{3} + \frac{V_f - V_d}{7} + \frac{(V_f + 2V_B) - V_d}{4} = 0 \]
**Problem 3:** Use mesh current analysis!

35 pts.

(a) Find \( \eta_e \).
\[ \eta_e = 3 \]

(b) Find \( \eta_e \).
\[ \eta_e = 4 \]

(c) Find theoretical # of Kirchhoff equations, #KL.
\[ \#KL = 2 \]

(d) Write auxiliary eqn for \( V_\lambda \).
\[ 4 - 2 = 2 \]

(e) Write auxiliary eqn for \( i_\beta \).

(f) Write Kirchhoff equations, simplify and put in matrix form.

\[ \begin{align*}
KVL @ I_1 & \quad 50 - 2I_1 - 4(I_1 - I_2) - 3i_\beta = 0 \\
& \quad 50 - 2I_1 - 4I_1 + 4I_2 - 3I_2 = 0 \\
& \quad -6I_1 + I_2 = -50
\end{align*} \]

\[ \begin{align*}
KVL @ I_2 & \quad 3I_2 - 4I_1 + 4I_2 - 6I_2 - 4(4)(I_1 - I_2) = 0 \\
& \quad 3I_2 - 4I_1 + 4I_2 - 6I_2 - 16I_1 + 16I_2 = 0 \\
& \quad (4 - 16)I_1 + (3 - 4 - 6 - 8 + 16)I_2 = 0 \\
& \quad -12I_1 + I_2 = 0
\end{align*} \]

\[
\begin{bmatrix}
-6 & 1 \\
-12 & 1
\end{bmatrix}
\begin{bmatrix}
I_1 \\
I_2
\end{bmatrix} =
\begin{bmatrix}
-50 \\
0
\end{bmatrix}
\]
20pts.

Problem 4

Spots:
(a) If the power in a dependent voltage source is negative, it indicates that the source is generating power. (Generating, dissipating, absorbing, conducting)

Spots:
(b) An independent voltage source with a series resistor is placed in a black box so that only the two terminals stick out. A voltmeter is used to measure 10V across the terminals. An ammeter is used to measure 5A of current. Find $V_s$ and $R_s$.

\[
V_s = 10 \text{ V} \\
R_s = 2 \text{ } \Omega
\]

Spots:
(c) Which source below has positive power?:

\[
\begin{align*}
1: (V-I) = -P \\
2: (V-I) = +P \\
3: (V+I) = -P
\end{align*}
\]

Spots:
(d) Perform a source transform.

\[
I_s = -1.67 \text{ A} \\
R_s = 6 \text{ } \Omega
\]