Name: __________________________

Instructor: Kassakian Kassakian Afridi Afridi
Time: 11 12 1 2

• There are 18 pages in this quiz, including this cover page.
• Please put your name in the space provided above, and circle the name of your recitation instructor together with the time of your recitation.
• Do your work for each question within the boundaries of that question, or on the back of the preceding page.
• This is a closed-book quiz, but calculators and a single two-sided page of notes are allowed.
• Good luck!

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Problem 1 – 25%

This problem has three independent pairs of parts.

For parts (1A) and (1B), consider the circuit shown below comprising a constant voltage source, three identical light bulbs, and a switch. Initially the switch is open, and then it closes so that Bulb C turns on. Assume that the light bulbs are resistive in nature, and that their brightness increases with their power dissipation.

![Circuit Diagram]

(1A) After the switch closes, does Bulb A burn brighter or darker, or is its light output unchanged? Does Bulb B burn brighter or darker, or is its light output unchanged?

Circle One for Bulb A: Brighter Darker Unchanged

Circle One for Bulb B: Brighter Darker Unchanged

Compare the A/B voltage divider to the AC/B voltage divider. The voltage across Bulb A decreases while the voltage across Bulb B increases.

(1B) Now assume that the source in the light bulb circuit is a constant current source. After the switch closes, does Bulb A burn brighter or darker, or is its light output unchanged? Does Bulb B burn brighter or darker, or is its light output unchanged?

Circle One for Bulb A: Brighter Darker Unchanged

Circle One for Bulb B: Brighter Darker Unchanged

Bulb C diverts current from Bulb A while the current through Bulb B remains unchanged.
For Parts (1C) and (1D), consider the general network shown below that comprises only independent sources, linear resistors and a single port. When the two terminals of the port are connected together, the current $i$ is measured to be 200 mA. When a linear resistor having a 150-Ω resistor is connected across the port, the current $i$ is measured to be 50 mA.

(1C) When there is no device of any kind connected across the port, what is the voltage $v$? A numerical answer with proper units is expected.

From the numerical data, construct the following Norton equivalent

![Norton Equivalent](image)

From this equivalent, the open-circuit voltage is seen to be 10 V.
(1D) A resistor is connected across the port. What should its resistance be so that the voltage $v$ is one half of the value found in Part (1C)? A numerical answer with proper units is expected.

The resistance should be 50 ohms, the Thevenin/Norton resistance.
For Parts (1E) and (1F) consider the network shown below. It contains two nodes at which the voltages are unknown. Those voltages are labeled as $e_1$ and $e_2$.

(1E) By carrying out a node analysis, write two algebraic equations that can be solved for the two unknown node voltages $e_1$ and $e_2$ in terms of the source values $V$ and $I$, and the resistances of the four resistors. Do not solve the equations for $e_1$ and $e_2$.

\[
\begin{align*}
\frac{e_1 - V}{R_2} + \frac{e_1}{R_3} + \frac{e_1 - e_2}{R_4} &= 0 \\
\frac{e_2 - e_1}{R_3} + \frac{e_2}{R_4} + I &= 0 \\
e_1 \left[ \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right] + e_2 \left[ \frac{-1}{R_3} \right] &= V \left[ \frac{1}{R_1} \right] \\
e_1 \left[ \frac{-1}{R_3} \right] + e_2 \left[ \frac{1}{R_2} + \frac{1}{R_4} \right] &= -I
\end{align*}
\]
(1F) Assume that $R_1 = R_2 = 2R$ and that $R_3 = R_4 = R$. Determine the node voltage $e_1$ in terms of $V$, $I$ and $R$.

Use superposition

\[ e_1 = \frac{V}{3} \]

\[ e_1 = -\frac{I}{8} R \]

\[ e_1 = \frac{1}{3} (V - RI) \]