Faculty of Engineering

ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT

EENG223 – Circuit Theory I

Midterm Exam
Spring 2016-17

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Duration: 100 minutes

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Problem 1

The current through and voltage across an element is shown in Figure P1. Sketch the power delivered to the element for $t > 0$.

\[ i(t) = \begin{cases} 
2t & 0 < t < 15s \\
-3t + 75 & 15s < t < 25s \\
30 & 0 < t < 10s 
\end{cases} \]

\[ v(t) = \begin{cases} 
-5t + 80 & 10s < t < 15s \\
5V & 15s < t < 25s 
\end{cases} \]

\[ p(t) = i(t)v(t) = \begin{cases} 
60t & 0 < t < 10s \\
-10t^2 + 160t & 10s < t < 15s \\
-15t + 375 & 15s < t < 25s 
\end{cases} \]
Problem 2

Find $V_0$ and the power supplied by 8 V voltage source in the circuit of Fig. P2.

a) Using Nodal Analysis.
b) Using Mesh Analysis.

![Figure P2](image)

**a) Nodal Analysis**

KCL at $V_0$:

\[
\frac{V_0 + V_0 - 12}{3} - \frac{V_0 - 12}{6} = 2
\]

Multiply both sides by 6 yields:

\[2V_0 + 4V_0 = 12 + 12 = 24\]

\[V_0 = 8\text{V}\]
Power supplied by 8V Voltage source:
\[ p = 8i = 8\left(\frac{4}{5} + 2\right) = \frac{32}{5} + 16 = \frac{112}{5} = 22.4 \text{ W absorbs} \]

b) Mesh Analysis

There is a current source between mesh I and mesh III. These two meshes constitutes a SUPERMESH.

\[ i_3 - i_1 = 2 \Rightarrow i_3 = 2 + i_1 \]

KVL around the SUPERMESH:
\[ 6i_1 + 3(2 + i_1) + 5(2 + i_1 - i_2) = 8 \]
\[ 14i_1 - 5i_2 = -8 \ldots \ldots (1) \]

KVL around mesh II:
\[-12 + 8 + 5(i_2 - 2 - i_1) = 0 \]
\[-5i_1 + 5i_2 = 14 \ldots \ldots (2) \]

Addition of Eqns.(1) and (2) gives:
\[ 9i_1 = 6 \]
\[ i_1 = \frac{2}{3} A \]
\[ 5i_2 = 14 + 5 \times \frac{2}{3} = \frac{52}{3} \Rightarrow i_2 = \frac{52}{15} A \]

\[ i_3 = 2 + \frac{2}{3} = \frac{8}{3} A \]

\[ V_0 = \frac{8}{3} \times 3 = 8 \text{ V} \]

Power supplied by 8V Voltage source:
\[ p = 8i = 8(i_2 - i_1) = 8\left(\frac{52}{15} - \frac{2}{3}\right) = 8\left(\frac{42}{15}\right) = 8\left(\frac{14}{5}\right) = \frac{112}{5} = 22.4 \text{ W absorbs} \]
Problem 3

Find $i_b$ for the circuit shown in Fig. P3 using the superposition principle.

0.5 A Current source is active, 10 V voltage source is diactive.

Since $i = 0$, then $i'_b = 0.5A$

10 V voltage source is active and 0.5 A Current source is .

$$i''_b = \frac{10}{(25 + 75)} = 0.1A$$

$$i_b = i'_b + i''_b = 0.5 + 0.1 = 0.6 \ A$$
Problem 4

Use Thevenin’s theorem to find $i$ in the circuit shown in Fig. P4.

\[ V_{oc} = 432 \text{ V} = V_{TH} \]

In order to determine $R_{TH}$, set all independent source values to zero and connect a 1 A current source as a test source.
KVL around the loop:
\[-28 - 12 + V = 0\]
\[V = 40 \text{ V}\]
\[R_{TH} = \frac{V}{1} = 40 \Omega\]

\[i = \frac{V_{TH}}{R_{TH} + 8} = \frac{432}{40 + 8} = 9 \text{ A}\]