Faculty of Engineering

ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT

EENG223 Circuit Theory I

Spring 2006-07

Instructor:

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Midterm EXAMINATION

April 13, 2007

Duration: 100 minutes

Number of Problems: 4

Good Luck

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1. (a) Is the interconnection in Fig.P1 valid? Explain. (10 pts.)
   (b) Can you find the total energy developed in the circuit? Explain. (15 pts.)

(a) Yes, no violation of Kirchhoff’s Laws.

(b) No, because the voltage across the independent and dependent current sources are indeterminate.
2. Use nodal analysis to find \( v_0 \) and \( i_0 \) in the circuit in Fig. P2. (25 pts.)

![Circuit Diagram](image)

**Figure P2**

KCL at \( v_1 \):

\[
\left(\frac{1}{6} + \frac{1}{12} + \frac{1}{15}\right)v_1 - \frac{1}{15}v_2 - \frac{1}{6}(-75) - \frac{1}{12}\left(-\frac{7}{15}(v_2 - v_1)\right) = 0
\]

Multiply both sides by 180 yields:

\[
(30 + 15 + 12)v_1 - 12v_2 + (30)(75) + 7(v_2 - v_1) = 0
\]

\[
50v_1 - 5v_2 = -2250 \quad \ldots \ldots \ldots (1)
\]

KCL at \( v_2 \):

\[
-\frac{1}{15}v_1 + \left(\frac{1}{15} + \frac{1}{60}\right)v_2 + 1.6(-75 - v_1) = 0
\]

Multiply both sides by 60 yields:

\[
-4v_1 + 5v_2 + 96(-75 - v_1) = 0
\]

\[
-100v_1 + 5v_2 = 7200 \quad \ldots \ldots \ldots (2)
\]

One can obtain \( v_1 \) and \( v_2 \) by solving Eqns. (1) and (2) as:

\[
v_1 = -99 \text{ V}
\]

\[
v_2 = -540 \text{ V}
\]

Therefore

\[
v_0 = -75 - v_1 = 24 \text{ V}
\]

And

\[
i_0 = \frac{1}{15}(v_2 - v_1) = -29.4 \text{ A}
\]
3. Use superposition theorem to find $i_0$ and $v_0$ in the circuit in Fig.P3. (25 pts.)

By using voltage division principle:

$$v_0' = -135 \frac{60}{60 + 30} = -90V$$

20Ω and 80Ω resistors are in series.

$$20 + 80 = 100\ \Omega$$

100Ω and 25Ω resistor are in parallel.

$$\frac{100 \times 25}{100 + 25} = 20\ \Omega$$

$$i_0' = -\frac{135}{60} = -2.25\ A$$

30Ω and 60Ω resistors are in parallel

$$30/60 = 20\ \Omega$$

Therefore

$$v_0'' = 20 \times 18 = 360V$$

40/25 = 15.384Ω

By using current division principle:

$$i = 18 \frac{80}{80 + 20 + 15.384} = 12.48\ A$$

By using current division principle one more:

$$i''_0 = i - \frac{25}{25 + 45} = 4.8A$$

Therefore

$$v_0 = v_0' + v_0'' = -90 + 360 = 270V$$

$$i_0 = i''_0 + i''_0 = -2.25 + 4.8 = 2.55\ A$$
4. (a) Use a series of source transformation to find $i_0$ in the circuit in Fig. P4. (10 pts.)
(b) Verify your solution by using the mesh analysis method to find $i_0$. (15 pts.)

![Figure P4](image)

By using voltage division principle

$$i_0 = 1.25 \times \frac{8}{10} = 1 A$$
KVL around $i_i$:

$$(5 + 4 + 1 + 40)i_i - 40i_0 - 5(4) - 1(-10) = -10$$

$$50i_i - 40i_0 = 0 \ldots \ldots \ldots (1)$$

KVL around $i_0$:

$$-40i_i + 42i_0 = 10 \ldots \ldots \ldots (2)$$

Using Eqns.(1) and (2) we can obtain $i_0$ as:

$$i_0 = 1A$$