EE40 Discussion Section
9/20/04

their hw this week: 2.6, 2.16, 2.25, 2.43, 2.68, 2.74, 2.77, 2.85

good problems for discussion: 2.26, 2.41, 2.65, 2.68, 2.72

2.26

\[ \begin{align*}
4A &+ &i_1 &+ &i_2 &+ &2A \\
5\Omega & & & & & &15\Omega
\end{align*} \]

find the power in each element and state whether it is delivering or receiving power

KCL: \[ 4 = i_1 + i_2 + 2 \]

\[ i_1 = \frac{V_x}{5} \]

\[ i_2 = \frac{V_x}{15} \]

\[ \Rightarrow \]

\[ i_1 = \frac{3}{2} = 1.5A \]

\[ i_2 = 0.5A \]

\[ V_x = 7.5V \]

\[ i_1 \text{ and } i_2 \text{ come out right} \Rightarrow \text{our reference directions are correct} \]

power
resistors always absorb power
dependent sources always supply power

\[ \text{side note: voltage sources could} \]

Not
for current / voltage sources:

**supplying power:**

\[ I > 0 \quad V > 0 \quad I > 0 \quad V > 0 \]

**absorbing power**

\[ I > 0 \quad V < 0 \quad I < 0 \quad V > 0 \]

so 4A source supplies while 2A source absorbs power.

2.41

\[ \begin{align*}
2 \Omega & \quad V_4 \\
10 \Omega & \quad V_1 \quad 2A \\
5 \Omega & \quad V_3 \\
3 \Omega & \quad V_3
\end{align*} \]

solve for the node voltages

step 1: current references

\[ \begin{align*}
2 \Omega & \quad V_4 \\
10 \Omega & \quad V_1 \quad 2A \\
5 \Omega & \quad V_3 \\
3 \Omega & \quad V_3
\end{align*} \]
Step 2: KCL (Σ\text{in} = Σ\text{out})

\[i_1 = i_2\]
\[i_3 = i_4 + i_5\]
\[i_2 + 2i_6 = 0\]
\[i_4 \pm i_5 = i_5 + i_6\]

Step 3: ohm (V = IR)

\[i_1 = \frac{0 - V_4}{2}\]
\[i_2 = \frac{V_4 - V_3}{3}\]
\[i_3 = \frac{0 - V_1}{10}\]
\[i_4 = \frac{V_1 - V_5}{2}\]
\[i_5 = \frac{V_6 - 0}{5}\]
\[i_6 = \frac{V_5 - V_3}{2}\]

we have 1 unknowns and 10 equations \(\Rightarrow\) we can solve this system

\[2.65\]

\[10\]

\[10\]

Find thevenin and norton equivalents

\[\text{if we have no dependent}\]
step 1: open circuit voltage

\[ i_1 + i_2 = i_2 \]
\[ i_1 = \frac{10 - V_{oc}}{10} \]
\[ i_2 = \frac{V_{oc}}{5} \]

\[ \Rightarrow V_{oc} = 6.7 \text{V} \]
\[ i_1 = 0.5 \text{A} \]
\[ i_2 = 1.3 \text{A} \]

\[ V_{oc} \] will be our thinned voltage

step 2: if you have no dependent sources, you may shut off all independent sources and read off the equivalent thinned resistance

Current source — off means it has OA going through it.

Voltage source — off means it has OA across it. This is the same as a short circuit

\[ R_{th} = 5 \parallel 10 = \frac{5}{5 + \frac{1}{10}} = 3.3 \text{Q} \]
Thevenin equivalent:

\[ R_{th} = 3.3 \ \Omega \]

V

\[ V_{th} \]

\[ I_{th} \]

\[ R_{th} \]

\[ I_{th} = \frac{V_{th}}{R_{th}} \] (Ohm's law)

Norton equivalent:

can easily be obtained from thevenin equivalent

\[ I_n = \frac{V_{th}}{R_{th}} \]

\[ R_n = R_{th} \]

\[ 2 \ \text{A} \]

\[ 3.3 \ \Omega \]

2,72
step 1: open circuit voltage

\[
\begin{align*}
&i_x = 0.5i_x + i_2 \\
&i_y = 20 - Voc \\
&i_2 = \frac{Voc}{10} \\
\end{align*}
\]

\[\Rightarrow \quad Voc = 10\,V \quad i_2 = 1\,A \quad i_x = 2\,A\]

So our Thevenin voltage is 10\,V.

step 2: this circuit has a dependent source, so we must find the Thevenin resistance differently.

Find short circuit current

\[
\begin{align*}
&i_x = 0.5i_x + i_2 + i_{sc} \\
&i_x = \frac{20-0}{5} \\
&i_2 = \frac{0-0}{10} = 0
\end{align*}
\]

\[\Rightarrow \quad i_{sc} = 2\,A\]
\[ R_{th} = \frac{V_{oc}}{I_{sc}} = 5 \Omega \]

**Thevenin equivalent:**

![Thevenin equivalent circuit diagram]

**Norton equivalent:**

\[ R_n = R_{th} = 5 \Omega \]

\[ I_n = \frac{V_{th}}{R_{th}} = 2A \]

![Norton equivalent circuit diagram]