Overview

• Mesh and Nodal review
• Three new analysis techniques, for reducing complexity of circuits
  • Linearity
  • Superposition
  • Source transformation

Practice Circuit Analysis

• Find all currents and voltages

Reducing Circuit Complexity...

New theorems:
Linearity
Superposition & Source Transformation
Use linearity to solve for $i_0$

- How do we find $i_0$?
- What is $i_0$ if $V_s$ is 10V?
- What is the power consumed by the load in each situation?

Superposition Warmup

- Could use nodal or mesh analysis
- New technique – superposition

Superposition

- Voltage divider
  - $V_{123} = V_1 \left[ (|R_2| + |R_3|)/(|R_1 + R_2 + R_3|) \right]$

Superposition

- Voltage divider
  - $V_{234} = V_2 \left[ (|R_1| + |R_3|)/(|R_2 + R_1 + R_3|) \right]$
Superposition

- Voltage divider
  - $V_{1RS} = V_1 \left( \frac{R_2}{R_1+R_2+R_3} \right)$
  - $V_{2RS} = V_2 \left( \frac{R_1}{R_1+R_2+R_3} \right)$
- Add the result contributed by each source for final value
  - For $v_1$ and $v_2$ as the combined input, the total voltage across $R_3$ from these sources is $(v_{1RS} + v_{2RS})$

* How do we find $i$ & $P_{4Ω}$?
  - First set $V_{src} = 0$
  - Next set $I_{src} = 0$
* Since power is not linear, how do we find it?

Review: Matrices with Matlab

\[ 3l_1 + 4l_3 = 5 \]
\[ 2l_1 + 6l_2 = 0 \]
\[ l_1 - 2l_2 - l_3 = 5 \]

\[
\begin{bmatrix}
3 & 0 & 4 \\
2 & 6 & 0 \\
1 & -2 & -1
\end{bmatrix}
\]
\[
\begin{bmatrix}
5 \\
0 \\
5
\end{bmatrix}
\]

\[
I = \text{inv}(A) \times B
\]
\[
\begin{bmatrix}
2.5862 \\
-0.8621 \\
-0.6897
\end{bmatrix}
\]
Source Transformation & Equivalents

- Voltage $V_{ab}$ and equivalent $R$, $R_{eq}$, can be measured at the ‘output’ terminals of any device or circuit (that is powered on).
  - Equivalent $V-I-R$ behavior at terminals
- What is actually inside each device?
- Do we care about all the details or only the device’s behavior?

Source Transformation

- Voltage $V_s$ and equivalent $R$, $R_{eq}$, can be measured at the ‘output’ terminals of any device or circuit (that is powered on).
  - Equivalent $V-I-R$ behavior at terminals
- What is actually inside each device?
- Do we care about all the details or only the device’s behavior?

Source Transformation

- For circuit elements connected across nodes $a$ and $b$, the sources above are identical
  - This means _____________________________
- Caution: maintain polarity of sources

Source Transformation

- Find $i$ in the circuit below

Source Transformation

- Find $V_s +$ series-$R$ equivalent circuit:
Example in Homework

• Find $V_o$ using superposition and source transformation

Summary

• Circuit analysis tools
  o Nodal and mesh analysis, that use...
  o KVL and KCL to get simultaneous equations
  o Ohm’s law to put equations into needed form
  o $R_{eq}$ and voltage/current dividers if they help

• Today
  o Linearity
  o Superposition

• Next class – Source transformation & Thevenin equivalent – READ sections