Please pick up exams after lecture today.

Previous class

Special case of nodal analysis
- Voltage source with none of its nodes connected to ground (reference)

\[ V_a - V_b = V_s \; ; \; \; V_a = V_b + V_s \]  
\[ V_b = V_a - V_s \]

KCL at supernode: \[ i_1 + i_2 + i_3 + i_4 + i_5 = 0 \]

Mesh analysis

- Label all mesh currents
- Write KVL in each mesh \[ \sum V_{\text{ mesh}} = 0 \]
- Solve system of equations for the unknown mesh currents

What happens with independent/dependent current sources?

Cannot write KVL in a mesh that includes a current source because the voltage drop across the current source cannot be related to the mesh current

Current source is in a single mesh

\[ \text{mesh current} = \pm \text{"current source" current} \]

Current source shared between 2 meshes

1. Write KVL in a supermesh
2. Constraint equation due to current source
\[ I_5 = i_2 - i_1 \]

**Linearity Property**

\[
\begin{align*}
V_1 &= I_1 \cdot 1 \\
V_2 &= 10I_1 \cdot 1 = 10V_1 \\
V_3 &= (I_1+I_2) \cdot 1 \\
V_4 &= (10I_1+3I_2) \cdot 1
\end{align*}
\]

A function is linear if it satisfies the following property

\[ f(Ax_1 + Bx_2) = Af(x_1) + Bf(x_2) \]

A circuit is linear if it satisfies the linearity property

\[ V = I R \]

Circuits consisting of independent sources, linear resistors \( (V = IR) \)

and linear dependent sources are linear

How do we use the linearity property in circuit analysis?

**Case 1:** Single independent source

Suppose we are given that

\[ i = 2A \] for \( V_3 = 1V \)

What is \( i \) when \( V_3 = 10V \) \( \Rightarrow i = 2 \times 10 = 20A \)

\( V_3 = 5V \) then \( i = 2 \times 5 = 10A \)

**Case 2:** Several independent sources

The voltage across or the current through an element can be determined by algebraically summing the voltages or currents due to each source acting alone.

This is the superposition principle \( \Rightarrow \) source superposition.
Procedure

For each independent source in the circuit (until done)

1. Turn off (zero out) all other independent sources
   - i.e. \( V_s = 0 \) \( \Rightarrow \) Short circuit
   - \( I_s = 0 \) \( \Rightarrow \) open circuit

2. Find the voltage or current due to the single independent source using an analysis method (nodal, mesh, ...)

Sum up the contributions due to each source to get the voltage or current with ALL independent sources

Ex: Find \( V_o \) using superposition

\[
V_o = V_{o1} + V_{o2} = 8 + 4 = 12 \text{V}
\]

With only the 8A current source

\[
V_{o1} = 2 \times 4 = 8 \text{V}
\]

With only the 20V voltage source

\[
V_{o2} = 20 \times \frac{2}{2+3+5} = 4 \text{V}
\]

Note: Dependent (or controlled) sources are left intact when applying the superposition principle

Ex: \( V_x = V_{x1} + V_{x2} = 2.5 + 10 = 12.5 \text{V} \)

Use nodal analysis

\[
\frac{V_{x1} - 10}{20} + \frac{V_{x1} - 0.1V_{x1}}{4} = 0
\]

\( \Rightarrow V_{x1} = 2.5 \text{V} \)

\[
V_1 = V_{x1}
\]
\[
\frac{v_{x2}}{2D} - 2A + \frac{v_{x2}}{4} - 0.1v_{x2} = 0
\]

\[\Rightarrow v_{x2} = 10V\]