Assignment #5  Due Tomorrow afternoon (1 pm)

No assignment this week

Midterm 2:  - Thu 10-10:50AM
- Chapter 4
- Closed book/notes
  Reference equation notesheet will be provided
- No Calculators
- Sample Exam Posted
  (more details later today)

Help Session  Wed evening 5-6pm WNGR 153

Special Office Hours:  Thu 8:45-9:15AM
(KEC 4095)
& by appointment

Thevenin Equivalent Circuit

\[ V_{Th} = V_{oc} \quad ; \quad R_{Th} = R_{ab} \]

If there are no independent sources \( V_{Th} = 0 \)

Three methods for calculating \( R_{Th} \)

1) Short-circuit method
   \[ I_{sc} = \text{short-circuit current} \]
   \[ R_{Th} = \frac{V_{Th}}{I_{sc}} \]

Need at least one independent source
Works with dependent sources
2) Equivalent resistance method
   - Zero out all independent sources
     \[ \text{Indep voltage source} : V_S = 0 \Rightarrow \text{Short circuit} \]
     \[ \text{Current} : I_S = 0 \Rightarrow \text{Open circuit} \]
   - Calculate \( R_{ab} \) (series/parallel...)
     Cannot be used with dependent sources

3) External-source method (general method)
   - Zero out all independent sources
   - Apply an external voltage source \( V_{ex} \) and then measure the current \( I_{ex} \)

\[
R_m = \frac{V_{ex}}{I_{ex}}
\]

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**Example**

Find \( V_{Th} = V_{oc} \)

\[ V_x = V_{oc} \]

\[ I_1 = 10A \]

**KVL:**

\[ 2V_x + 2I_2 + 6(I_2 - I_1) = 0 \]

\[ V_x = 2I_2 \]

\[ 4I_2 + 2I_2 + 6I_2 - 60 = 0 \Rightarrow I_2 = 5A \]

\[ V_x = 10V = V_{oc} = V_{Th} \]

**Short-circuit method**

\[ V_x = 0V \]

\[ I_{sc} = 10A \]
Current division:
\[ i_{SC} = \frac{6 \Omega \parallel 2\Omega}{6\Omega \parallel 2\Omega + 0\Omega} \times 10A \]
\[ = 10A \]
\[ R_{Th} = \frac{10V}{10A} = 1\Omega \]

Thevenin equivalent circuit

External source method
\[ R_{Th} = \frac{V_{ex}}{i_{ex}} \quad v_x = v_{ex} \]
\[ \frac{V_{ex}}{2} + \frac{3V_{ex}}{6} - 1 = 0 \]
\[ V_{ex} = 1V \]
\[ R_{Th} = 1\Omega \]

Review:
- Node voltage (nodal) analysis
  - Identify all nodes
  - Define a reference (ground) node (specified for the exam)
- KCL in terms of node voltages
- Solve equations for unknown node voltages

Voltage sources
1) One terminal is grounded
\[ v_s \]

2) Connected between two non-reference nodes
\[ v_A - v_B = v_s \]

Supernode
Mesh current (mesh) analysis

- Identify mesh currents
- Convention clockwise direction
- Write KVL for each mesh in terms of mesh currents
- Solve for unknown mesh currents

Current Sources

1) part of a single mesh
defines mesh current for the mesh
2) common to 2 meshes
KVL for a supermesh

Superposition method

Source transformation

\[ V_s = I_s R \]

\[ I_s = \frac{V_s}{R} \]

Thevenin & Norton Equivalent Circuits

\[ R_N = R_{Th} \]
\[ I_N = I_{Sc} = \frac{V_{Th}}{R_{Th}} \]

Maximum power transfer occurs for \( R_L = R_s \)

\[ P_{max} = \frac{V_s^2}{4 R_s} \]