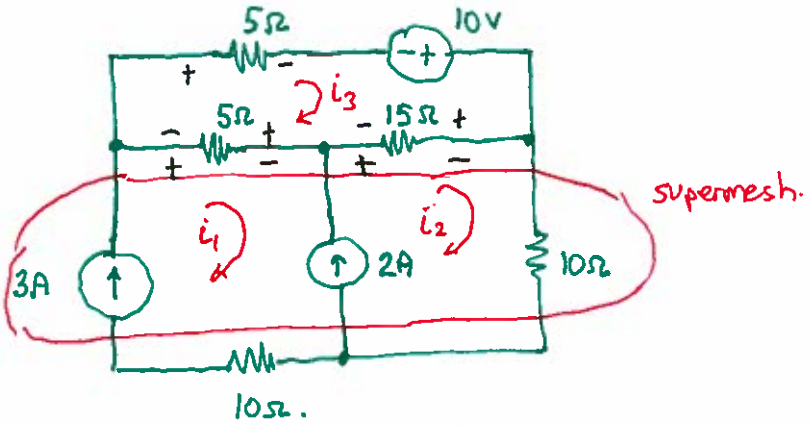
Wednesday, February 10, 2016.

Example 2 – From the 2012 midterm exam

(a) Find the mesh currents; (b) Find power in current sources.



(a) We have a supermesh in which i_1 is already known. $i_1 = 3A$

From the supermesh dependence equation

$$i_2 - i_1 = 2A, \quad \text{so} \quad i_2 = i_1 + 2A = 5A$$

Mesh 3: $5i_3 - 10 + 15(i_3 - i_2) + 5(i_3 - i_1) = 0$

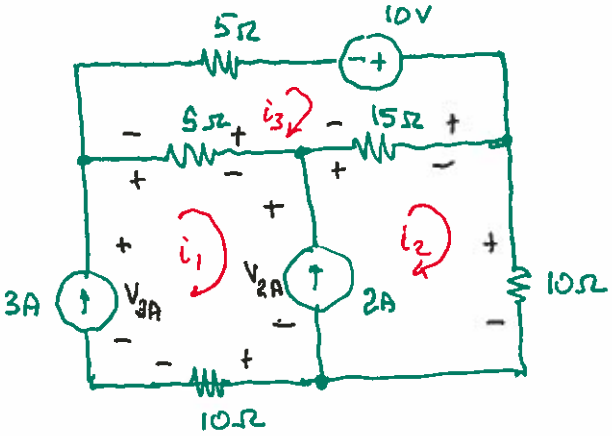
$$5i_3 + 15i_3 - 75 + 5i_3 - 15 = 10$$

$$25i_3 = 100$$

$$\text{so} \quad i_3 = 4$$

$i_1 = 3A$
$i_2 = 5A$
$i_3 = 4A$

(b)



Need unknown voltages V_{2A}, V_{3A}

Mesh 2: $-V_{2A} + 15(i_2 - i_3) + 10i_2 = 0$

$$-V_{2A} + 15 \times 1 + 10 \times 5 = 0$$

$$V_{2A} = 65V.$$

Power in 2-amp source: $P_{2A} = -V_{2A} \times 2\,A$

$= -65 \times 2$

$= -130\,W$ (130 W supplied)

Mesh 1: $-V_{3A} + 5(i_1 - i_3) + V_{2A} + 10i_1 = 0$

$-V_{3A} + 5 \times -1 + 65 + 10 \times 3 = 0$

$V_{3A} = 90v.$

Power in 3-amp source: $P_{3A} = -V_{3A}\, i_1$

$= -90 \times 3$

$= -270\,W$ (270 supplied)

Choosing between node-voltage and mesh-current methods

Pick the method with fewer equations:

Node-voltage: Look for nodes with voltage sources attached – may eliminate equations by good choice of reference node.

Mesh-current: Look for meshes where mesh currents are fixed in value by current sources.

Summary of circuit analysis methods:

So far:
1. Circuit simplification, KVL, KCL, Ohm's Law.
2. Node-voltage
3. Mesh-current.

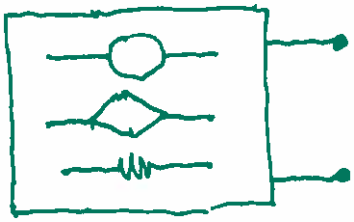
Coming:
4. Thevenin theorem.
5. Principle of superposition.

Thevenin and Norton equivalent circuits

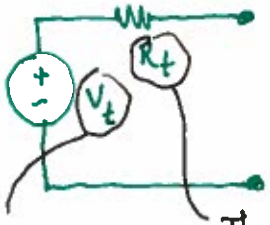
Thevenin's theorem states that:

A DC electrical network containing voltage sources, current sources, resistors, and with two terminals is electrically equivalent to a network with one voltage source and one resistor.

This gives us a way to arbitrarily complex "two-terminal" circuits.



⇒ modeled as



Thevenin voltage

Thevenin resistance.