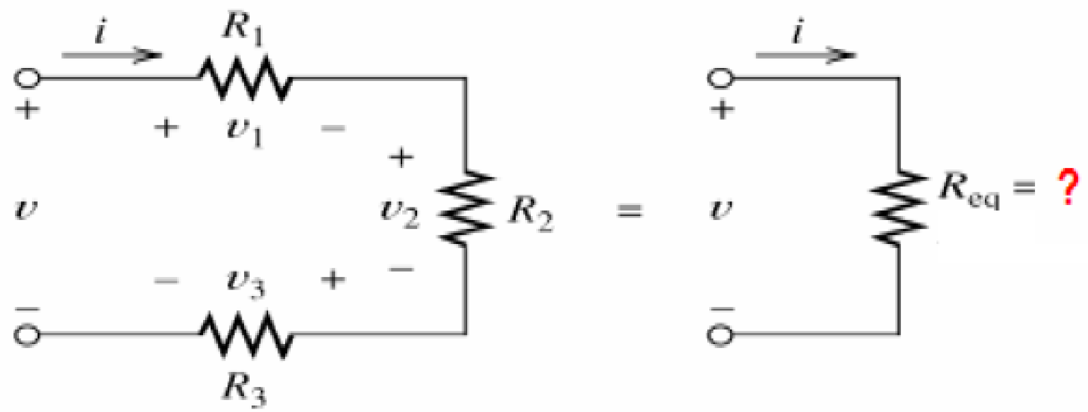
From Rajshekhar

ESc201, Lecture 4: Circuit Analysis

Series Resistances



(a) Three resistances in series

(b) Equivalent resistance

From (a)

$$v_1 = R_1 i$$

$$v_2 = R_2 i$$

$$v_3 = R_3 i$$

Using KVL :

$$v = v_1 + v_2 + v_3$$

$$= (R_1 + R_2 + R_3)i$$

From (b)

$$v = R_{eq} i$$

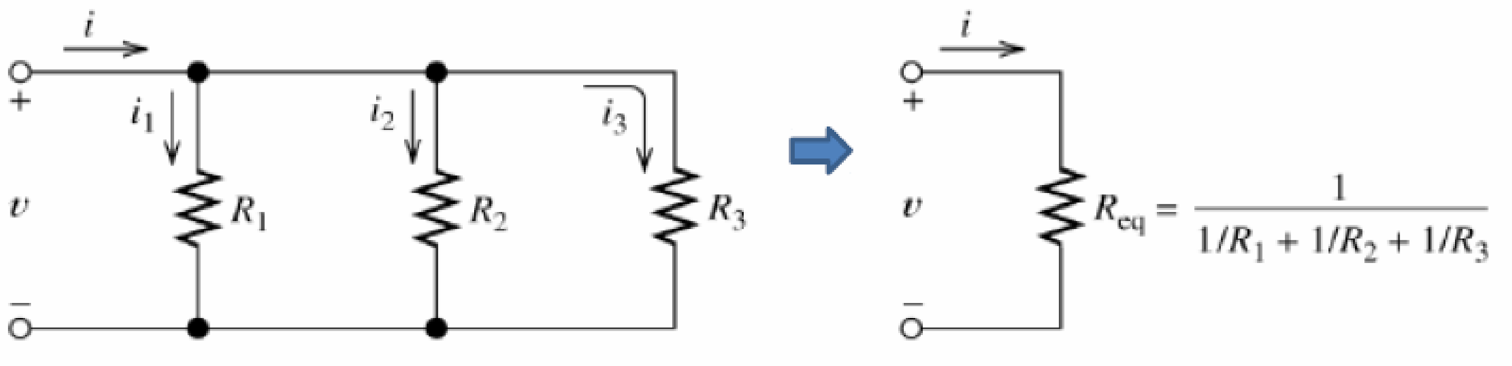
Thus,

$$R_{eq} = R_1 + R_2 + R_3$$

Both circuits are equivalent as far as ***v* vs. *i*** relation is concerned.

ESc201, Lecture 4: Circuit Analysis

Parallel Resistances



(a) Three resistances in parallel

(b) Equivalent resistance

From (a):

$i_1 = v / R_1$

$i_2 = v / R_2$

$i_3 = v / R_3$

By KCL

$i = i_1 + i_2 + i_3$

$= (\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3})v$

From (b)

$i = (\frac{1}{R_{eq}})v$

Thus,

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

ESc201, Lecture 4: Circuit Analysis – Super Node

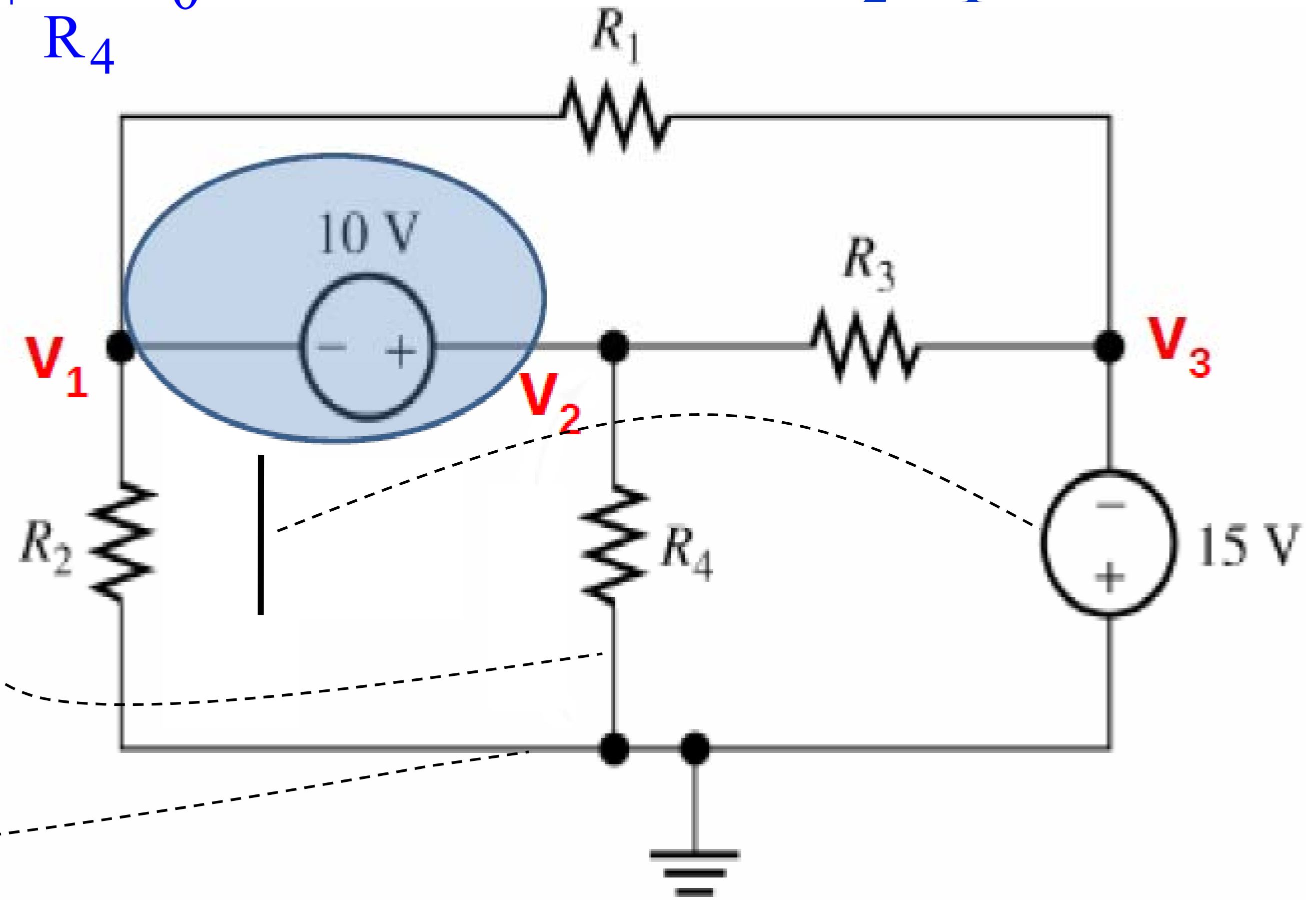
The concept of Supernode is used to reduce the number of nodal equations. i.e Node 1 and node 2 are merged together into a super node. KCL is applied to the super node.

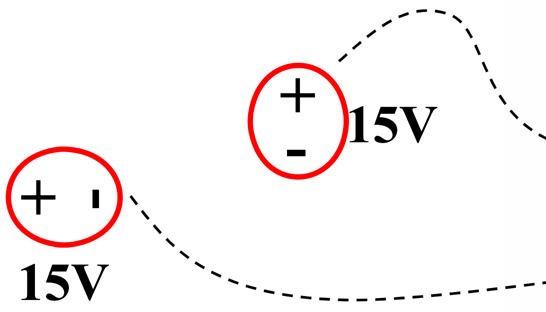
Sum of currents leaving a super node is zero. At the Supernode:

$$\frac{V_1}{R_2}+\frac{V_1-V_3}{R_1}+\frac{V_2-V_3}{R_3}+\frac{V_2}{R_4}=0$$

Obviously known V_2-V_1=10 V

Also to reduce the number of nodes a voltage supply may be pushed through a node.

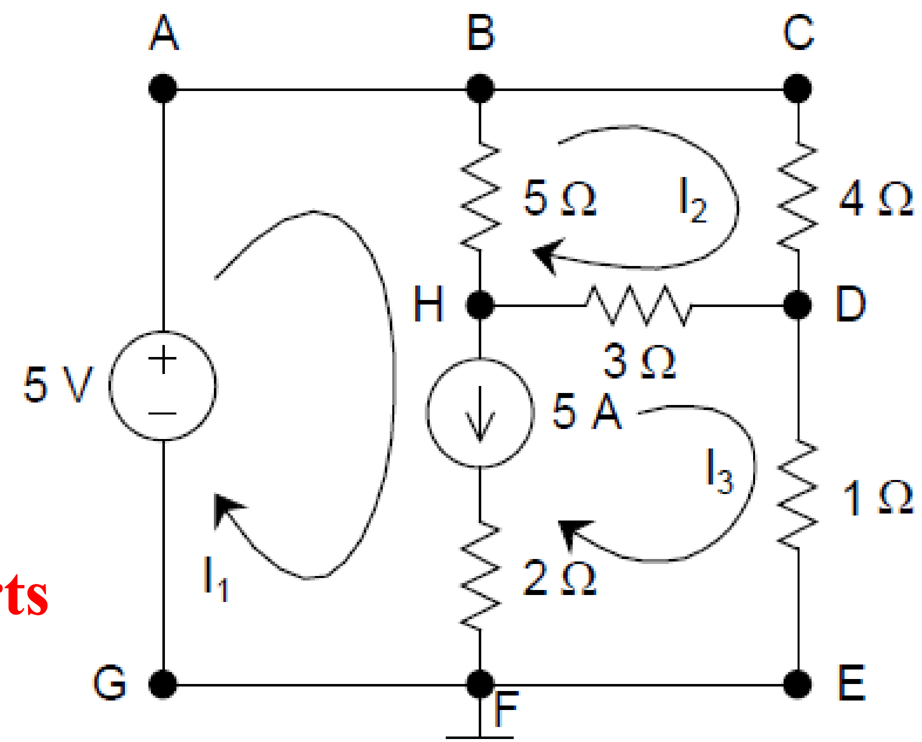




From ADutta

ESc201, Lecture 4: Circuit Analysis – Super Mesh-1

Loop containing an independent current source: Concept of *Supermesh*



Nodes A, B, and C are same node, similarly, nodes E, F, and G are same.

***KVL around the mesh ABHFGA and HDEFH cannot be written, since the potential dropped across the 5A current source is unknown*.**

Supermesh: A mesh containing parts of other meshes i.e. ABHDEFGA.

KVL around this loop:

$(I_1 - I_2) \times 5 + (I_3 - I_2) \times 3 + I_3 x1 - 5 = 0$, OR $5I_1 - 8I_2 + 4I_3 = 5$ with $I_1 - I_3 = 5A$

Gives : $9I_1 - 8I_2 = 25$

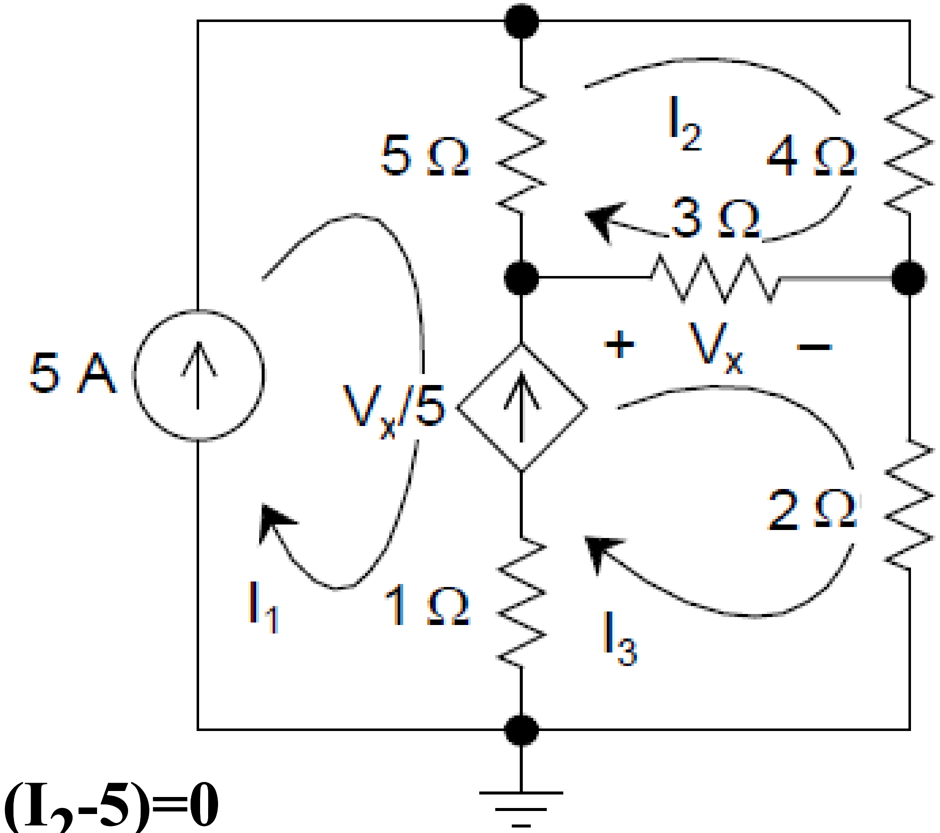
Similarly KVL around BCDHB:

$4I_2 + 3(I_2 - I_3) + 5(I_2 - I_1) = 0$ or $12I_2 - 5I_1 - 3I_3 = 0$ or $12I_2 - 8I_1 + 3(I_1 - I_3) = 0$

$15 = 8I_1 - 12I_2$ or $-15(2/3) = -8(2/3)I_1 + 8I_2$

Finally gives : $I_1 = (1/3.67)[25 - 15(2/3)] = 4.09$ A, $I_2 = 1.48$ A, $I_3 = -0.91$ A

ESc201, Lecture 4: Circuit Analysis – Super Mesh-2



I_1=5A, and mesh equations for I_1 and I_3 cannot be written.

But $3(I_3-I_2)=V_x$

Also because of the current source $V_x/5$, $(V_x/5)=I_3-I_1$.

Hence $I_3= 5 + (3/5)(I_3-I_2)$

or $(2/5)I_3 + (3/5)I_2 = 5$

$3I_2 + 2I_3 = 25$

And from mesh 2, $4I_2+3(I_2-I_3)+5(I_2-5)=0$

Or $12I_2-3I_3=25$ giving $8I_2-2I_3=25(2/3)$

$11I_2=25(5/3)$ or $I_2=3.79$ A

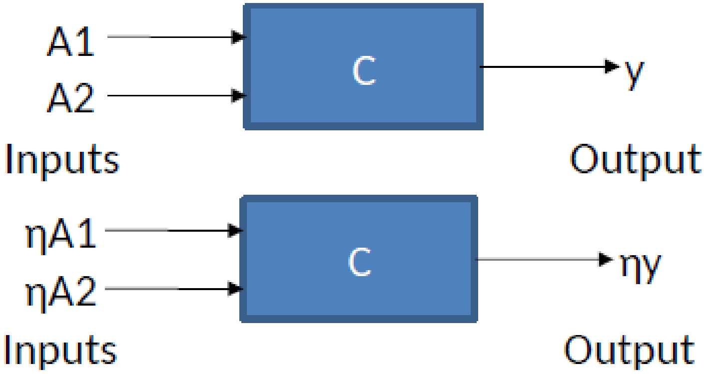
$I_3 =(1/2)(25-3x3.79)=6.82$ A

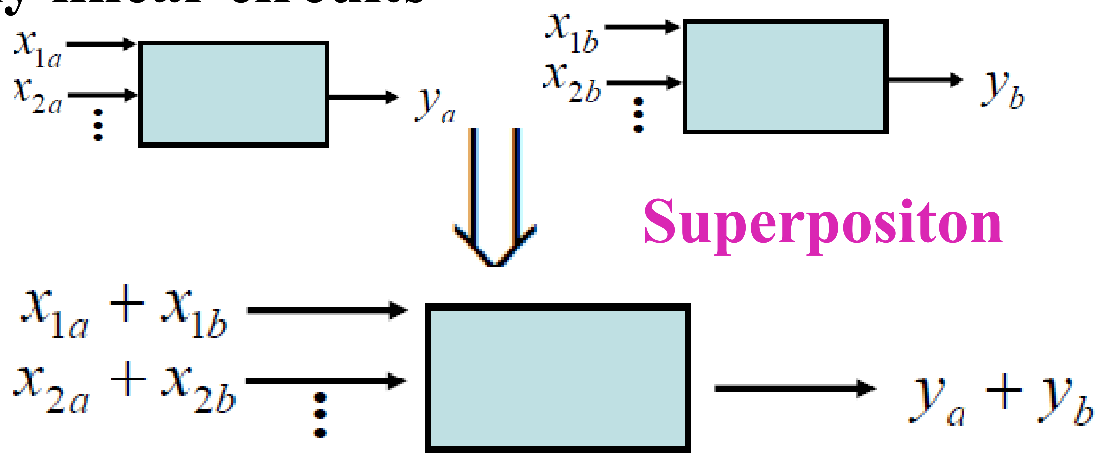
ESc201, Lecture 4: Circuit Analysis – Superposition

From GRajshekhar

Applicable to only linear circuits

Homogeneity

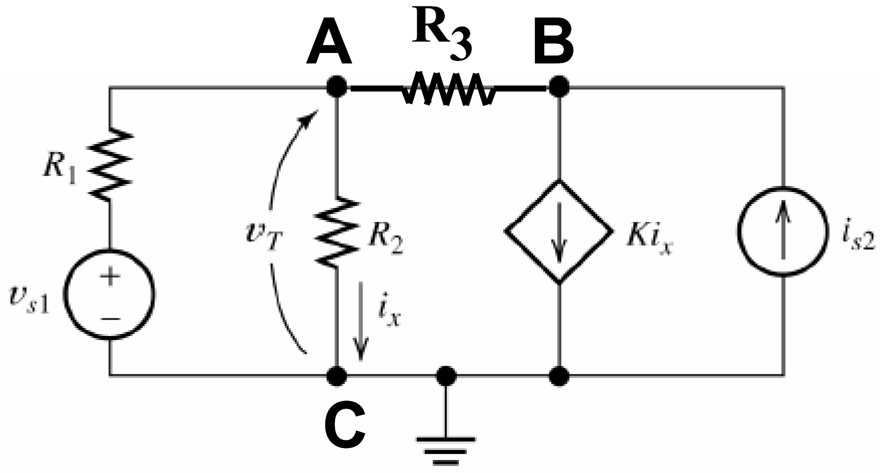




Steps:

1. **Take one source at a time and null all other independent sources:**
   i.e. Short all other independent voltage sources, and open all other independent current sources.
   Remember not top touch any of the dependent sources.
2. **By adopting KCL, KVL, node voltage, or mesh current method, evaluate the currents through all branches, as well as the node voltages.**
3. **Repeat steps 1 and 2 till all the sources are exhausted.**
4. **Finally, the current through any branch or the voltage at any node is found as a linear superposition of all the currents flowing through that branch or the voltages appearing at that node, contributed by the different sources.**

ESc201, Lecture 4: Circuit Analysis – Superposition



Step 1(a) : Short V_{s1}

Then R_1 and R_2 are in p/arallel and current through R_3 (B to A) is:

$I_{R_3} = I_{s2} - KI'_x = I'_{R1} + I'_x$

$= I'_{R_1} + V'_A / R_2$

$I_{s2} - K(V'_A / R_2) = V'_A (R_1 + R_2)/ R_1R_2$

Find V'_A

and $I'_x = V'_A / R_2$, $I'_{R1} = V'_A / R_1$

Step 1(b) : Open I_{s2}

Then $(V''_A – V_{s1})/ R_1 = I''_{R1}$ and $I''_X = V''_A / R_2$

$(I''_X R_2 – V_{s1})/ R_1 = I''_{R1}$

Current through R_3 (A to B) $= K I''_X = –I''_{R1} – I''_X$

Two equations for I''_X and I''_{R1} and solve for each.

Step 2 :

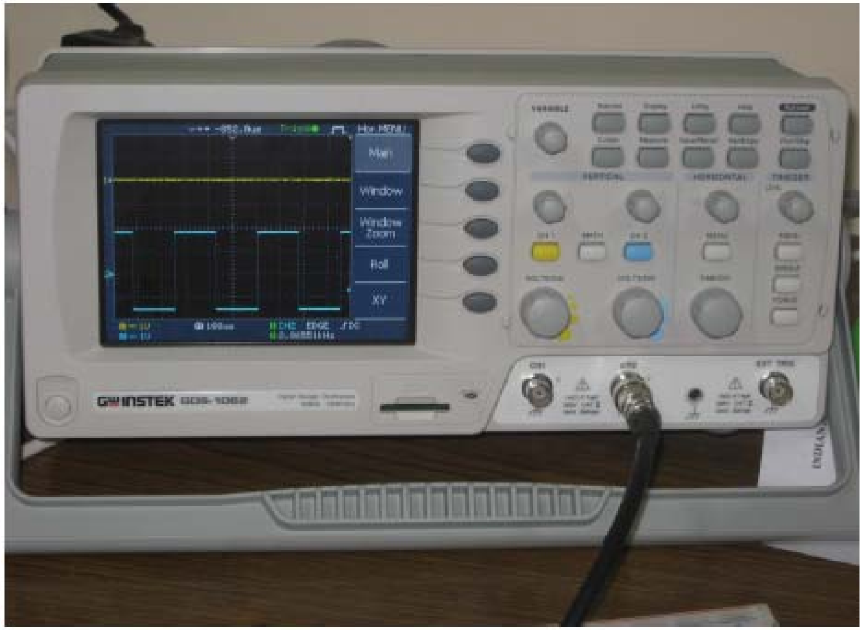
Then $I_X = I'_X + I''_X$

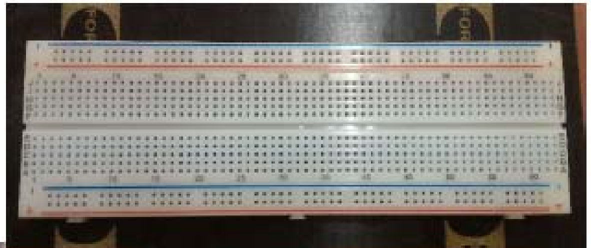
and $I_{R_1} = I'_{R_1} + I''_{R1}$

and $V_A = V'_A + V''_A$

ESc201, Lecture 4: Circuit Analysis – Laboratory

Esc 201A
Expt. 1





From GRajshekhar

From KRajawat

ESc201, Lecture 4: Circuit Analysis – Laboratory