The Superposition Theorem

In a Linear network, the voltage across or the current through any element may be calculated by adding algebraically all the individual voltages or currents caused by the seperate independent sources acting alone, i.e. with

1) all other independent voltage sources replaced by short circuits and
2) all other independent current sources replaced by open circuits.

* Dependent sources are left intact because they are controlled by circuit variables.

Linear Elements and Circuits

- a Linear circuit element has a Linear voltage - current relationship

$$v(t) = R\,i(t)$$

$$v(t) = \frac{1}{C}\int_{-\infty}^{t} i(t)\,dt$$

$$v(t) = L\frac{di(t)}{dt}$$

- Independent sources are Linear elements

- Dependent sources need Linear control equation to be Linear elements

- Linear Circuit is a Circuit composed entirely of independent sources, Linear dependent sources, and Linear elements

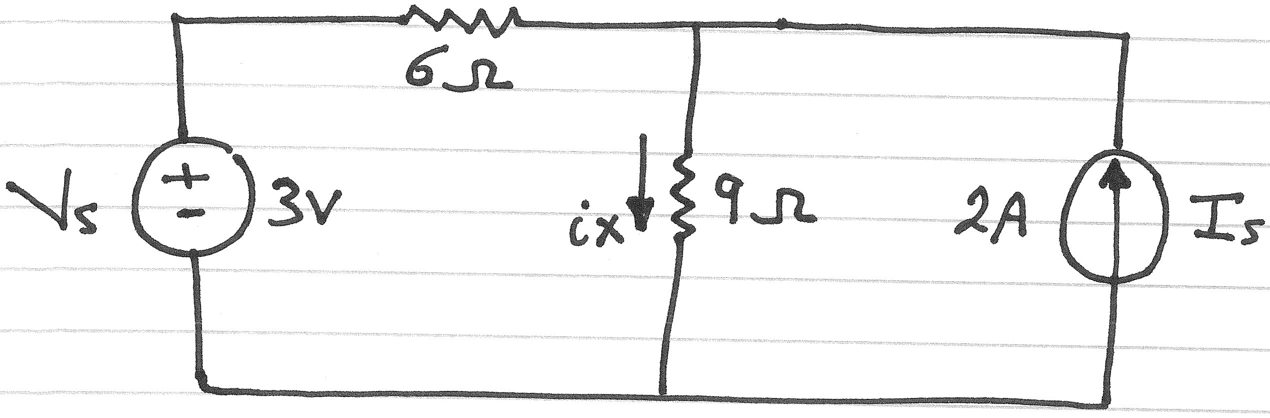
Steps to apply superposition principle

1. Turn off all indepedent sources except one source. Find the output (voltage or current) due to that source using nodal, mesh, ------ .

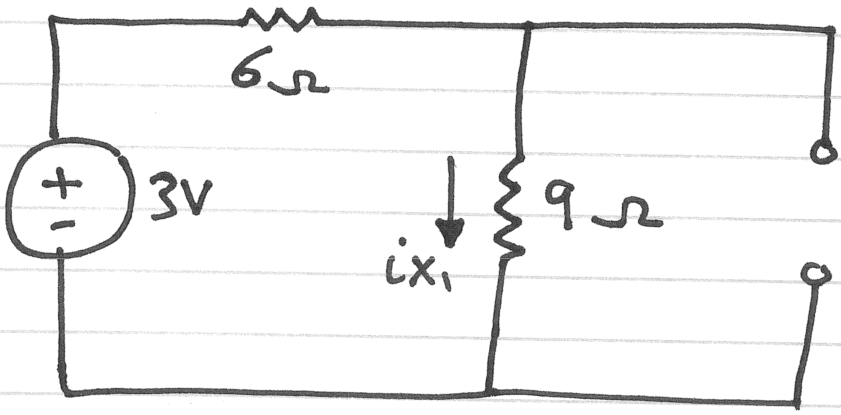
2. Repeat step 1 for each of the other independent sources.

3. Find the total Contribution by adding algebraically all the Contributions due to each independent sources.

Use superposition to solve for i_x

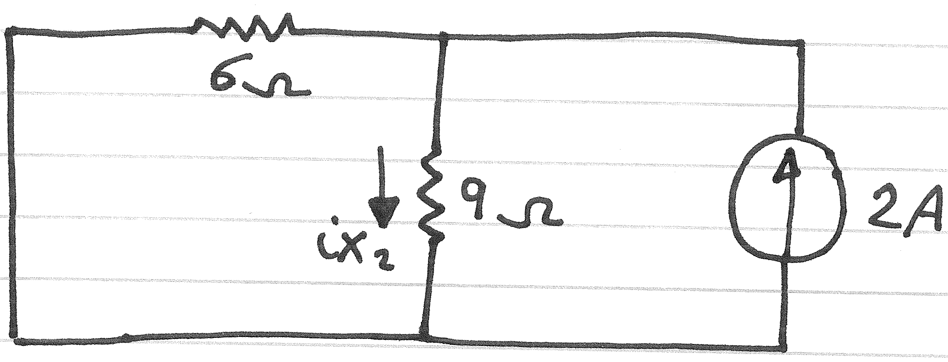


1) Let V_s on, and turn off I_s



$$i_{x_1} = \frac{3}{15} = 0.2\,A$$

2) let I_s on, and turn off V_s



$$i_{x_2} = \frac{6}{6+9}(2) = 0.8\,A$$

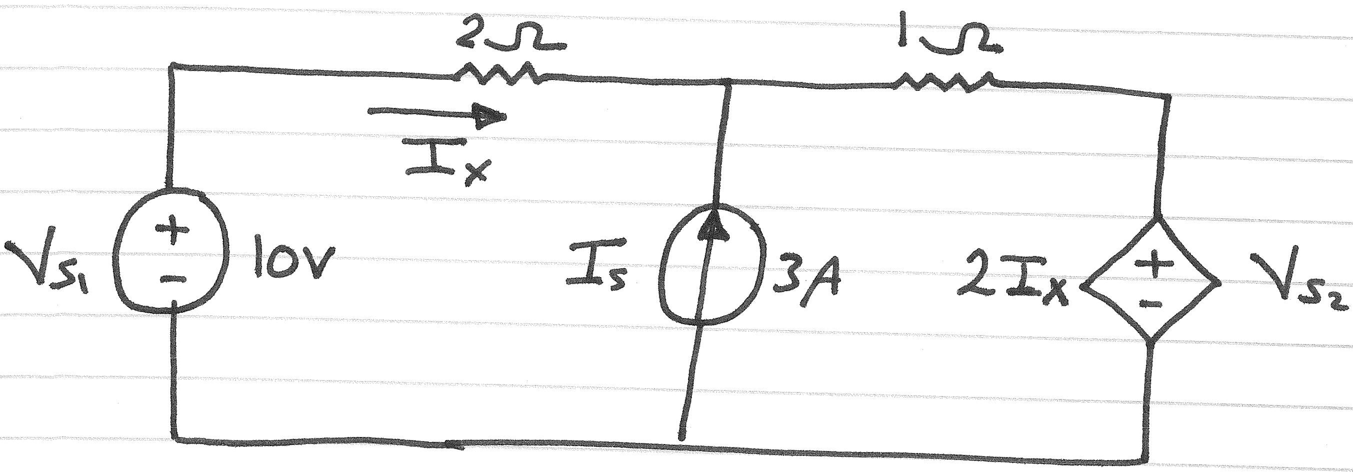
Finally, Combine the results :

$$i_x = i_{x1} + i_{x2}$$

$$= 0.2A + 0.8A$$

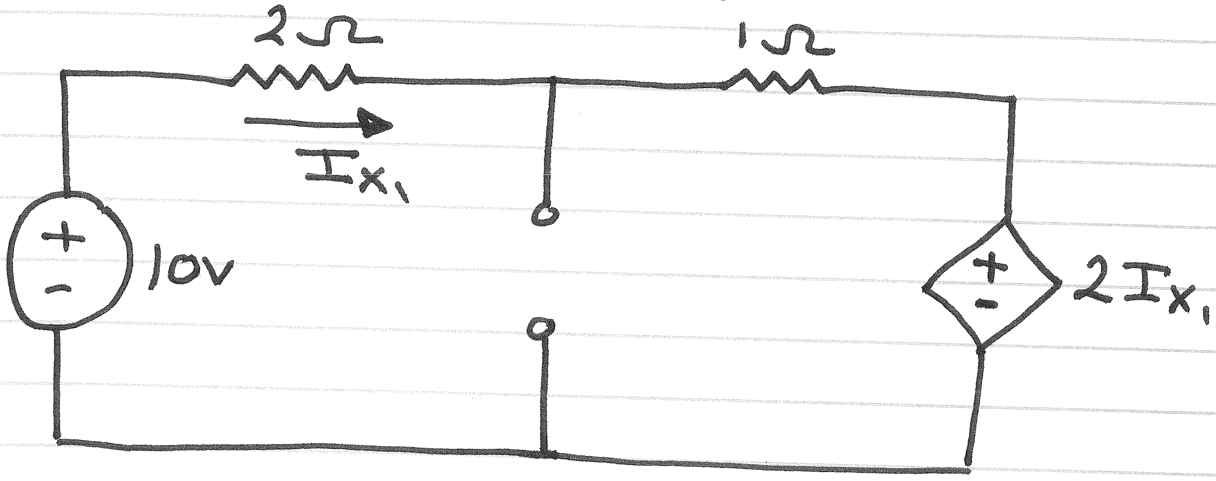
$$i_x = 1A$$

Superposition with a Dependent Source



Find I_x using superposition

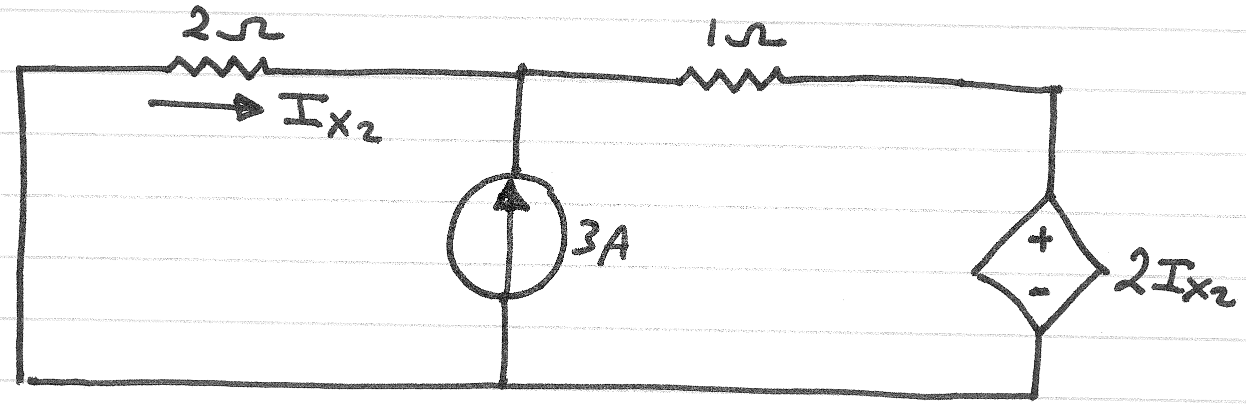
1) Let V_{s_1} on, and turn off I_s

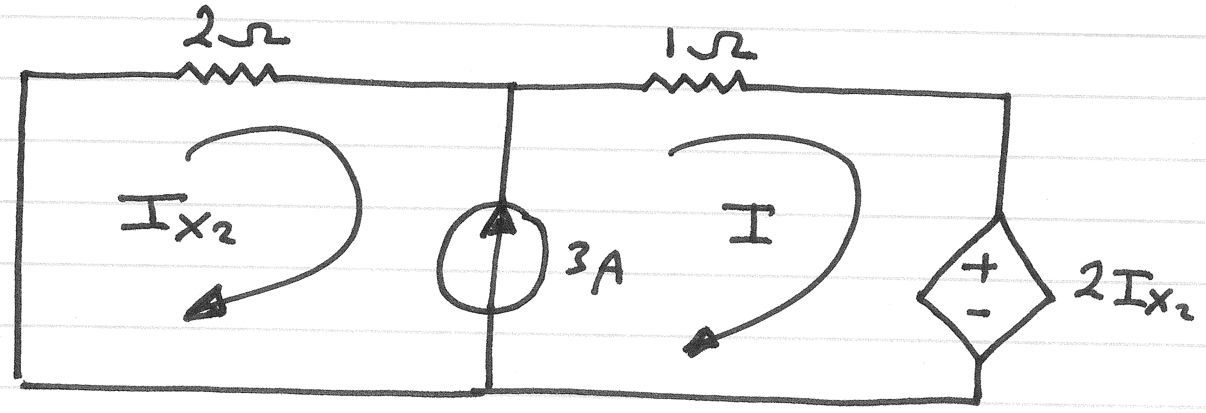


$$2I_{x_1} + I_{x_1} + 2I_{x_1} - 10 = 0$$

$$\therefore \quad I_{x_1} = 2A$$

2) let I_s on, and turn off V_{s1}





$3 = I - I_{x_2}$ Constrain equation

$-2I_{x_2} = 2I_{x_2} + I$ supermesh equation

$\therefore I_{x_2} = -0.6\,A$

$I_x = I_{x_1} + I_{x_2} = 2 - 0.6 = 1.4\,A$

* When applying superposition to circuits with dependent sources, these dependent Sources are never turned off.