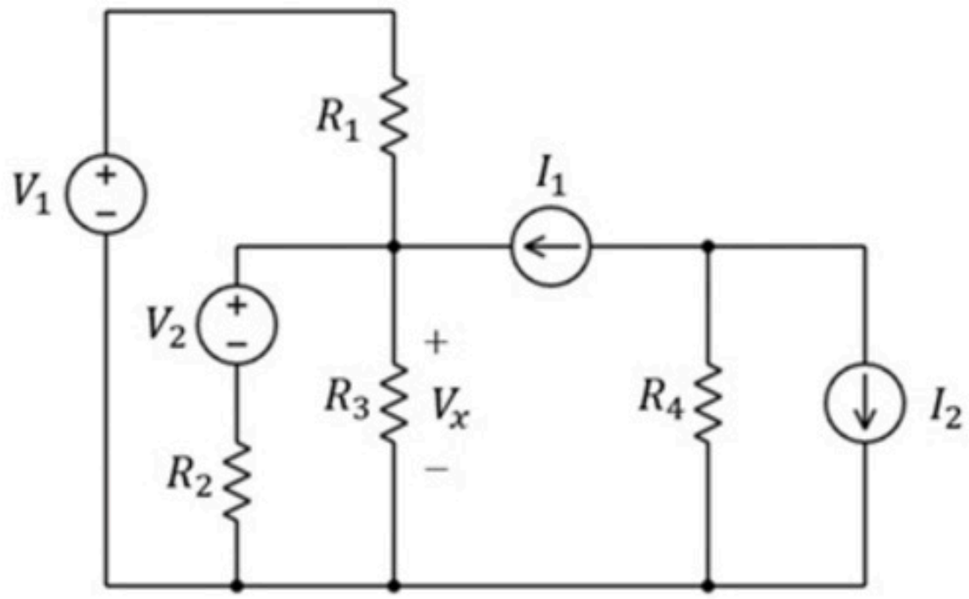
# Circuit theorems 015

Problem has been graded.

Consider the circuit below. You are not given the values of $V_1$, $V_2$ and $I_2$. However, you are told the values of the other components and that of $V_x$.

(a) What is the new value of $V_x$ when all the source values (i.e., $V_1$, $V_2$, $I_1$ and $I_2$) are doubled? We will call this new value $V_{x1}$.

(b) What is the new value of $V_x$ when only $I_1$ is doubled and the other sources are what they were originally? We will call this new value $V_{x2}$.




Given Variables:

R1 : 10 ohm

R2 : 10 ohm

R3 : 5 ohm

R4 : 7 ohm

I1 : 2 A

Vx : 16 V

Calculate the following:

Vx1 (V) :

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Vx2 (V) :

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> Hint: Use linearity and superposition to express Vx as a linear combination of all sources

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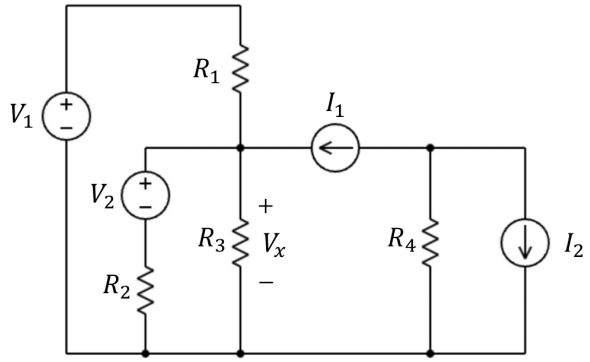
$R_1 = 15\Omega$
$R_2 = 5\Omega$
$R_3 = 15\Omega$
$R_4 = 7\Omega$
$I_1 = 2A$
$V_x = 15$




a. Generally,

$V_x = aV_1 + bV_2 + cI_1 + dI_2$ from linearity and superposition

If all sources are doubled,

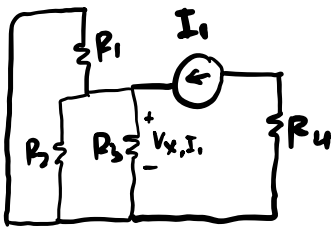
$$V_{x1} = a(2V_1) + b(2V_2) + c(2I_1) + d(2I_2) = 2(aV_1 + bV_2 + cI_1 + dI_2)$$
$$= 2V_x$$
$$= 2 \cdot 15$$
$$\boxed{V_{x1} = 30V}$$

b. If only $I_1$ is doubled

$$V_{x2} = aV_1 + bV_2 + c(2I_1) + dI_2 = (aV_1 + bV_2 + cI_1 + dI_2) + cI_1$$
$$= V_x + cI_1$$

Find the contribution of $I_1$ using superposition (c)

When only $I_1$ is on,




$$V_{x,I_1} = I_1\left(\frac{R_1 /\!/ R_2}{R_1 /\!/ R_2 + R_3}\right)R_3$$
$$V_{x,I_1} = 2\left(\frac{\frac{15}{4}}{\frac{15}{4} + 15}\right)15$$
$$= 2\left(\frac{15}{15 + 60}\right)15$$
$$= 2 \cdot \frac{1}{5} \cdot 15$$
$$= 6V \Rightarrow cI_1$$

$V_{x2} = V_x + cI_1$
$= 15 + 6$
$\boxed{V_{x2} = 21V}$