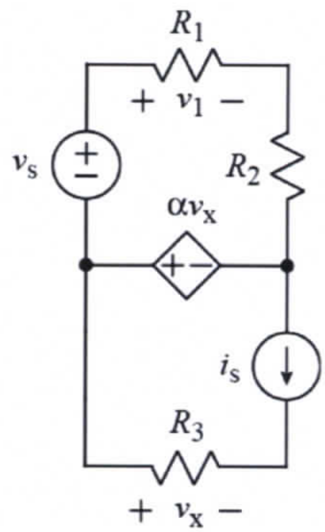
HOMEWORK #7 prob 2 solution

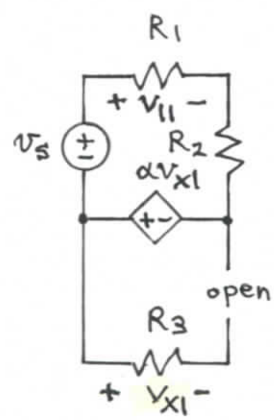
Ex:



Using superposition, derive an expression for v_1 that contains no circuit quantities other than i_s, v_s, R_1, R_2, R_3, and α, where $\alpha > 0$.

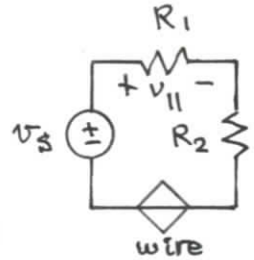
SOL'N: We turn on one independent source at a time. Note that we do not turn off the dependent source, since it acts like a resistor. We may find that the dependent source has a value of zero, however.

case I: v_s on, i_s off (open)



No current flows in R_3, so $v_{x1} = 0$ V.

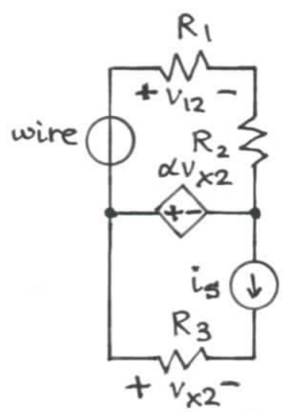
Since $v_x = 0V$, $\alpha v_x = 0V$ too, and the dependent source acts like a wire.



We have a v-divider.

$$v_{11} = v_s \frac{R_1}{R_1 + R_2}$$

case II: v_s off, i_s on
(wire)



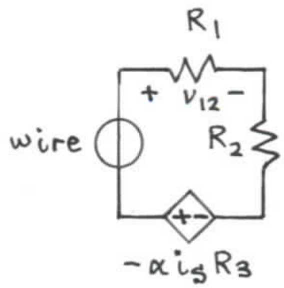
Because R_3 is in series with i_s, we use Ohm's law to calculate v_{x2}.

$$v_{x2} = -i_s R_3$$

So $\alpha v_{x2} = -\alpha i_s R_3$

The dependent source is a voltage source between two circuits. Consequently, we treat the top and bottom halves as separate circuits, each with an αv_{x2} source.

The top half of the circuit:



This is a voltage divider.

$$v_{12} = -\alpha i_s R_3 \frac{R_1}{R_1 + R_2}$$

Now we sum the results.

$$v_1 = v_{11} + v_{12} = (v_s - \alpha i_s R_3) \frac{R_1}{R_1 + R_2}$$