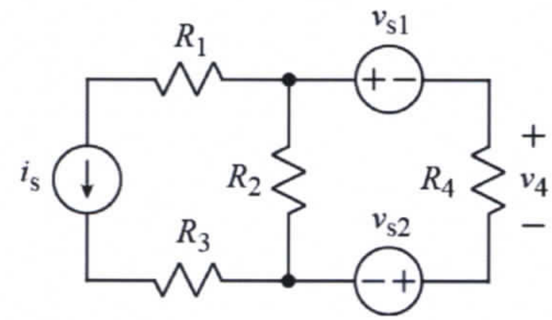
HOMEWORK #7 prob 1 solution

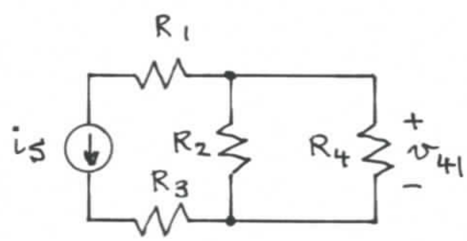
Ex:



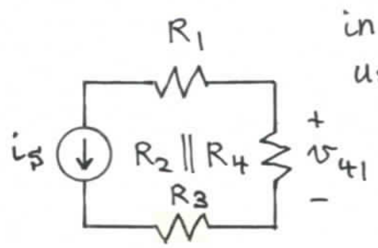
Using superposition, derive an expression for v_4 that contains no circuit quantities other than i_s, v_{s1}, v_{s2}, R_1, R_2, R_3, and R_4.

Sol'n: We turn on one independent source at a time. We find v_4 for each circuit and sum them.

case I: i_s on, v_{s1} off (wire), v_{s2} off (wire)

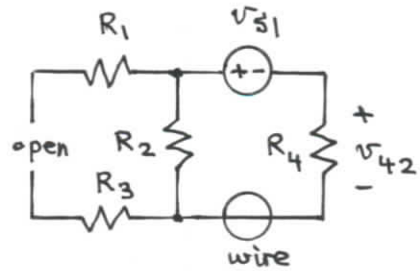


We may combine R_2 and R_4 into an equivalent resistance with v-drop v_{41} across it. Then we have a resistance in series with i_s. So we use Ohm's law.



$$v_{41} = -i_s \, R_2 \| R_4 = -i_s \frac{R_2 R_4}{R_2 + R_4}$$

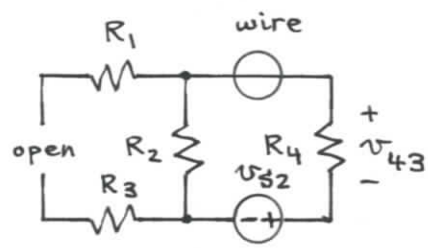
case II: i_s off (open), v_{s1} on, v_{s2} off (wire)



Here, R_1 and R_3 are dangling and may be ignored. That leaves a v-divider.

$$v_{42} = -v_{s1} \frac{R_4}{R_2 + R_4}$$

case III: i_s off (open), v_{s1} off (wire), v_{s2} on



As in case II, we may ignore R_1 and R_3, and we have a voltage divider.

$$v_{43} = -v_{s2} \frac{R_4}{R_2 + R_4}$$

We sum our results.

$$v_4 = v_{41} + v_{42} + v_{43} = \frac{-i_s R_2 R_4 - (v_{s1} + v_{s2}) R_4}{R_2 + R_4}$$