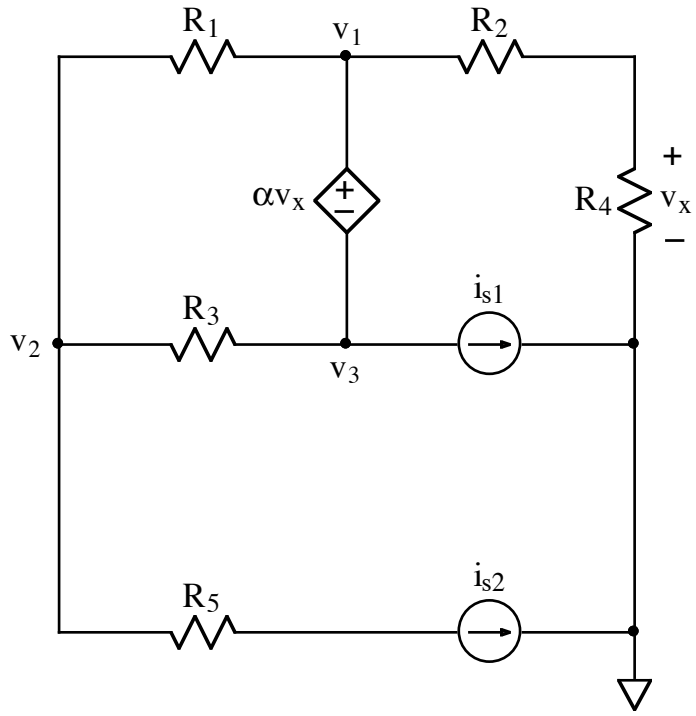
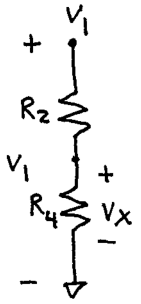
EX:



For the circuit shown, write three independent equations for the node-voltages, v_1, v_2, and v_3. The quantity v_x must not appear in the equations.

soln: We first write v_x in terms of node-v's.

We use a v-divider since we have v_1 across R_2 in series with R_4:



$$v_x = v_1 \cdot \frac{R_4}{R_2 + R_4}$$

We have a v-src connecting v_1 to v_3. So v_1, v_3 form a supernode.

We write a current summation eq'n for v_1, v_3. We find sum of i's flowing out of bubble containing v_1, v_3, and the dependent v-src.

(1) v_1, v_3 node: $\frac{v_1 - v_2}{R_1} + \frac{v_1 - 0V}{R_2 + R_4} + \frac{v_3 - v_2}{R_3} + i_{s1} = 0A$

We also write a voltage eq'n for v_1 and v_3. Note that we substitute for v_x to obtain an eq'n containing only node voltages.

(2) $v_1 = v_3 + \alpha \underbrace{\left(v_1 \frac{R_4}{R_2 + R_4} \right)}_{v_x}$

For v_2, we just sum currents out of node.

(3) v_2 node: $\frac{v_2 - v_1}{R_1} + \frac{v_2 - v_3}{R_3} + i_{s2} = 0A$

We now have our 3 eq'ns for v_1, v_2, and v_3.