Ex:

For the circuit shown, write three independent equations for the three mesh currents $i_1$, $i_2$, and $i_3$. The quantity $v_x$ must not appear in the equations.

Sol'n: We first define the variable for the dependent source in terms of mesh currents:

$$v_x = (i_1 - i_2)R_1$$

Since the dependent current source is on the outside edge of the circuit, $i_1$ is equal to $\alpha v_x$ (but in the opposite direction).

$$i_1 = -\alpha (i_1 - i_2)R_1$$

For $i_2$ and $i_3$, we have a super-mesh. Thus, we take a voltage loop around the outside of the $i_2$ and $i_3$ loops. We also write an equation for the $i_s$ source in terms of $i_2$ and $i_3$.

$$-i_3 R_3 - i_2 R_1 + i_1 R_1 - i_2 R_2 - i_3 R_4 = 0 \text{ V}$$

$$i_s = i_3 - i_2$$