Ex:

3 mA \[+\] $v_x$ \[-\] 10 k\(\Omega\) 0.5 mA \[-\] \[+\] $i_1$ \[-\] \[+\] $i_2$ 15 k\(\Omega\) 2$v_x$ 

a) Use the mesh-current method to find $i_1$ and $i_2$.
b) Find the power dissipated by the dependent source.

**Solution:**

a) We follow a step-by-step procedure:

1) We define mesh currents. If, however, we have any current sources on outside edges of the circuit, the mesh currents for those loops will be the same as the current source.

In this circuit, we have a current source on the left edge. Thus, the mesh current for the left loop is 3 mA.

Since $i_1$ and $i_2$, as defined, are on the outside edge of the circuit, we may use them as our mesh currents.
2) We define the voltage from the dependent src, $v_x$, in terms of mesh currents. Here, we observe that $v_x$ is across the 10kΩ resistor, too. For the 10kΩ resistor, we have

$$v_x = 3\, \text{mA} \cdot 10\, \text{kΩ} - i_1 \cdot 10\, \text{kΩ}$$

3) We look for loops with a current source in between, meaning we have a super mesh. This is the case for the $i_1, i_2$ loops. For the $i_1, i_2$ supermesh, we take a v-loop around the outside edge of the $i_1$ and $i_2$ loops, (bypassing the 0.5 mA src).

$$i_{1,2} \text{ v-loop: } -i_1 \cdot 10\, \text{kΩ} + 30V - 2(3\, \text{mA} - i_1)10\, \text{kΩ} + 3\, \text{mA} \cdot 10\, \text{kΩ} - i_2 \cdot 15\, \text{kΩ} = 0V$$

Add a current egh for the 0.5 mA src between the loops:

$$i_1 - i_2 = 0.5\, \text{mA} = \frac{1}{2}\, \text{mA}$$

Note: we have $-i_2$ for current measured opposite the arrow in the current src.

4) We solve our eghs for $i_1$ and $i_2$.

We group $i_1$ and $i_2$ terms on the left and move constant to the right side.
\[ i_1 \left( -10 \text{k}\Omega + 2 \cdot 10 \text{k}\Omega \right) + i_2 (-15 \text{k}\Omega) = -60V + 60V \]
\[ i_1 - i_2 = \frac{1}{2} \text{ mA} \]

Solving the 2nd eqn for \( i_1 \), we have
\[ i_1 = i_2 + \frac{1}{2} \text{ mA} \]

Substituting into 1st eqn, we have
\[ (i_2 + \frac{1}{2} \text{ mA}) 10 \text{k}\Omega + i_2 (-15 \text{k}\Omega) = 30V \]

or
\[ i_2 (10 \text{k}\Omega - 15 \text{k}\Omega) = 0V - \frac{1}{2} \text{ mA} \cdot 10 \text{k}\Omega \]

or
\[ -i_2 (5 \text{k}\Omega) = -5V \]

or
\[ i_2 = 1 \text{ mA} \]

Then
\[ i_1 = 1 \text{ mA} + \frac{1}{2} \text{ mA} = \frac{3}{2} \text{ mA} \]

Consistency check: calculate v-drops for \( i_1 \), \( i_2 \) and verify v-loops.

\[ \begin{align*}
\text{v}_x &= \frac{3}{2} \text{ mA} \cdot 10 \text{k}\Omega = 15V \\
\text{All v-loops sum to 0V, and all current sums at nodes = 0A.} \end{align*} \]
b) We know \( V_x = (3 \text{ mA} - i_1) \cdot 10 \text{k}\Omega \)

\[ i_1 = \frac{3}{2} \text{ mA} \cdot 10 \text{k}\Omega \]

\[ V_x = 15 \text{ V} \]

The current for the dependent src is \( i_2 \).

\[ i_2 = 1 \text{ mA} \]

Thus, power for the dependent src is

\[ P = V \cdot i = 2 \cdot V_x \cdot i_2 = 2(15 \text{ V}) \cdot 1 \text{ mA} \]

or \( P = 30 \text{ mW} \).