1.3 From Kirchhoff's current law, the sum of the currents entering node X must be zero. Hence \( I_1 + I_2 = 0 \). Thus \( I_2 = -I_1 = -2 \, \text{mA} \).

2.3 Note that, for example, the voltage across the ideal voltage source simply doesn't care what the current is; the voltage across it is always 2V. That is the distinctive property of this circuit element.
\[ R = \frac{R_1 R_3}{R_1 + R_3} + \frac{R_2 R_4}{R_2 + R_4} = 5.064 \text{ k}\Omega \]

**2.19**

Call the voltage at the top of \( R_1 = V_1 \), let bottom of circuit be ground. Then

\[ I_0 = \frac{V_1}{R_1} - \frac{V_1 - V_0}{R_3} = 0 \]

\[ I_1 = \frac{V_1 - V_0}{R_3} = \frac{I_0 R_1 - V_0}{R_1 + R_3} = 0 \]

**2.23**

Since we have a voltage source as a branch, we merge node A & B for the purpose of writing KCL equations.

\[ V_A = V_B + V_0 \]

- \((a)\)

KCL at A&B: \[ I_0 - \frac{V_A}{R_1} - \frac{V_B}{R_2} + \frac{V_C - V_B}{R_3} = 0 \]

- \((b)\)
KCL AT C: \[ \frac{V_B - V_C}{R_3} - \frac{V_C}{R_4} = 0 \] \hspace{1cm} (c)

Only three equations are necessary.

(2) Solving the equations gives

\[ V_B = \frac{R_2 (R_3 + R_4) (I_0 R_1 - V_0)}{(R_1 + R_2) (R_3 + R_4) + R_1 R_2} \]

\[ V_C = \frac{R_4}{R_3 + R_4} \cdot V_B \]

\[ = \frac{R_2 R_4 (I_0 R_1 - V_0)}{(R_1 + R_2) (R_3 + R_4) + R_1 R_2} \]

\[ V_A = V_B + V_0 \]

\[ = \frac{R_1 (R_3 + R_4) (V_0 + I_0 R_2) + R_1 R_2 V_0}{(R_1 + R_2) (R_3 + R_4) + R_1 R_2} \]

\[ V_{out} = V_C \]