1) Mesh/Nodal Analysis with Dependent Sources

In the above circuit:

a) Determine the current produced by $I_1$. \textit{(check $i_3$ is 0.154 mA)}
2) Thevenin/Norton Equivalent Circuits

![Circuit Diagram]

a) Find the voltage between A and B if R_load has a resistance of 4kΩ. *(Use PSpice to check!)*

b) Replace R_load with an open circuit and find the voltage between A and B \( (V_{\text{Thevenin}}) \).

c) Replace R_load with a short circuit and find current from A to B \( (I_{\text{Norton}}) \).

d) Short any voltage sources and open any current sources. Find the resistance between A and B when 'looking' to the left of the dashed line \( (R_{\text{Thevenin}}) \). \( (R_{\text{Load}} \) is not part of the circuit).

e) Draw the Thevenin circuit with \( V_T \), \( R_T \) and \( R_{\text{Load}} \).

f) In this two resistor circuit, verify that when \( R_{\text{Load}} \) is 4kΩ, the voltage between and B is the same as calculated in a).

\[ V_{\text{Thevenin}} = V_{\text{Norton}} \]

\[ I_{\text{Norton}} = \frac{V_{\text{Thevenin}}}{R_{\text{Thevenin}}} \]

\[ R_{\text{Thevenin}} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} \]

\[ R_{\text{Load}} = 4k\Omega \]

\[ R_{\text{Thevenin}} = \frac{1}{\frac{1}{1k\Omega} + \frac{1}{3k\Omega}} \]

\[ V_{\text{Thevenin}} = \frac{R_{\text{Load}}}{R_{\text{Thevenin}} + R_{\text{Load}}} \cdot V_1 \]

\[ I_{\text{Norton}} = \frac{V_{\text{Thevenin}}}{R_{\text{Thevenin}}} \]

\[ I_{\text{Norton}} \approx I_1 \]

\[ V_{\text{Norton}} = I_{\text{Norton}} \cdot R_{\text{Norton}} \]

\[ R_{\text{Norton}} \approx \frac{R_{\text{Load}}}{R_{\text{Thevenin}}} \]

\[ V_{\text{Norton}} = \frac{R_1}{R_1 + R_2} \cdot V_1 \]

\[ I_{\text{Norton}} \approx \frac{V_{\text{Norton}}}{R_{\text{Norton}}} \quad \text{and} \quad V_{\text{Norton}} \approx \frac{V_1}{1 + \frac{R_1}{R_2}} \]
3. Thevenin/Norton Equivalent Circuits - Dependent Sources

a) Find $V_{\text{Thevenin}}$ using the Open Circuit method

b) Find $I_{\text{Norton}}$ using the Short Circuit method

c) Find $R_{\text{Thevenin}}$ using the test/voltage current method
4. Amplifier Circuits

![Amplifier Circuit Diagram]

- **V1 = 5V**
- **V2 = 8V**

a) For the above circuit, determine the output voltage, Vout. The voltages supplied to the op-amps are 9V and -9V, as appropriate.

5. Amplifier Circuits: Design

a) Design a two stage amplifier such that the output of the first stage is \( V_1 = -4V_{in} \) and the output of the second stage is \( V_{out} = -2V_1 \)

b) Design an amplifier circuit with three inputs (V1, V2, and V3) such that

\[ V_{out} = V_1 - 2V_2 - 4V_3 \]