CHAPTER 3 NODAL AND LOOP ANALYSIS TECHNIQUES

N linearly independent equations must be written to solve for the loop currents.

- If current sources are present in the circuit, either of two techniques can be employed. In the first case, one loop current is selected to pass through one of the current sources. The remaining loop currents are determined by open-circuiting the current sources in the circuit and using this modified circuit to select them. In the second case, a current is assigned to each mesh in the circuit.

- Write a constraint equation for each current source—-independent or dependent—in the circuit in terms of the assigned loop currents using KCL. Each constraint equation represents one of the necessary linearly independent equations, and \( N_f \) current sources yield \( N_f \) linearly independent equations. For each dependent current source, express the controlling variable for that source in terms of the loop currents.

- Use KVL to formulate the remaining \( N - N_f \) linearly independent equations. Treat dependent voltage sources like independent voltage sources when formulating the KVL equations. For each dependent voltage source, express the controlling variable in terms of the loop currents.

PROBLEMS

3.1 Use nodal analysis to find \( V_1 \) in the circuit in Fig. P3.1.

![Figure P3.1](image)

3.2 Find both \( I_o \) and \( V_o \) in the network in Fig. P3.2 using nodal analysis.

![Figure P3.2](image)

3.3 Use nodal analysis to find \( V_1 \) in the circuit in Fig. P3.3.

![Figure P3.3](image)

3.4 Find \( V_1 \) and \( V_2 \) in the circuit in Fig. P3.4 using nodal analysis. Then solve the problem using MATLAB and compare your answers.

![Figure P3.4](image)
**3.5** Use nodal analysis to find both $V_1$ and $V_o$ in the circuit in Fig. P3.5.

![Figure P3.5](image)

**3.6** Write the node equations for the circuit in Fig. P3.6 in matrix form, and find all the node voltages using MATLAB.

![Figure P3.6](image)

**3.7** Find $V_o$ in the network in Fig. P3.7.

![Figure P3.7](image)

**3.8** Find $I_o$ in the circuit in Fig. P3.8 using nodal analysis.

![Figure P3.8](image)

**3.9** Use nodal analysis to find $I_o$ in the network in Fig. P3.9.

![Figure P3.9](image)
3.10 Use nodal analysis to find $V_o$ in the circuit in Fig. P3.10.

3.11 Find $V_o$ in the network in Fig. P3.11 using nodal analysis.

3.12 Use nodal analysis to find $V_o$ in the circuit in Fig. P3.12.

3.13 Use nodal analysis to find $V_o$ in the circuit in Fig. P3.13.

3.14 Use nodal analysis to find $V_o$ in the network in Fig. P3.14.

3.15 Use nodal analysis to find $V_o$ in the circuit in Fig. P3.15.

3.16 Find $I_o$ in the network in Fig. P3.16 using nodal analysis.

3.17 Use nodal analysis to solve for the node voltages in the circuit in Fig. P3.17. Also calculate the power supplied by the 1-A current source.
3.18 Find \( V_o \) in the network in Fig. P3.18 using nodal equations.

![Figure P3.18](image)

3.19 Find \( I_o \) in the network in Fig. P3.19 using nodal analysis.

![Figure P3.19](image)

3.20 Use nodal analysis to find \( I_o \) in the circuit in Fig. P3.20.

![Figure P3.20](image)

3.21 Find \( V_o \) in the circuit in Fig. P3.21 using nodal analysis.

![Figure P3.21](image)

3.22 Use nodal analysis to find \( V_o \) in the network in Fig. P3.22.

![Figure P3.22](image)

3.23 Find \( I_o \) in the circuit in Fig. P3.23 using nodal analysis.

![Figure P3.23](image)

3.24 Use nodal analysis to find \( I_o \) in the circuit in Fig. P3.24.

![Figure P3.24](image)

3.25 Using nodal analysis, find \( V_o \) in the network in Fig. P3.25.

![Figure P3.25](image)
3.26 Find $V_o$ in the network in Fig. P3.26 using nodal analysis.

![Figure P3.26](image)

3.27 Find $V_o$ in the circuit in Fig. P3.27 using nodal analysis.

![Figure P3.27](image)

3.28 Find $V_o$ in the circuit in Fig. P3.28 using nodal analysis.

![Figure P3.28](image)

3.29 Use nodal analysis to find $V_o$ in the circuit in Fig. P3.29.

![Figure P3.29](image)

3.30 Find $V_o$ in the circuit in Fig. P3.30.

![Figure P3.30](image)

3.31 Find $V_o$ in the circuit in Fig. P3.31 using nodal analysis.

![Figure P3.31](image)

3.32 Use nodal analysis to find $V_o$ in the circuit in Fig. P3.32.

![Figure P3.32](image)

3.33 Use nodal analysis to find $V_o$ in the circuit in Fig. P3.33.

![Figure P3.33](image)
3.34 Find $V_o$ in the network in Fig. P3.34.

![Figure P3.34](image)

3.35 Find $I_x$ in the circuit in Fig. P3.35 using nodal analysis.

![Figure P3.35](image)

3.36 Find $V_o$ in the circuit in Fig. P3.36 using nodal analysis.

![Figure P3.36](image)

3.37 Find $V_x$ in the circuit in Fig. P3.37.

![Figure P3.37](image)

3.38 Use nodal analysis to find $V_o$ in the circuit in Fig. P3.38.

![Figure P3.38](image)

3.39 Use nodal analysis to find $V_x$ in the circuit in Fig. P3.39. In addition, find all branch currents and check your answers using KCL at every node.

![Figure P3.39](image)

3.40 Determine $V_o$ in the network in Fig. P3.40 using nodal analysis.

![Figure P3.40](image)

3.41 Determine $V_o$ in the network in Fig. P3.41.

![Figure P3.41](image)
3.42 Find $I_x$ in the circuit in Fig. P3.42.

![Figure P3.42](image)

3.43 Use nodal analysis to solve for $I_x$ in the network in Fig. P3.43.

![Figure P3.43](image)

3.44 Use nodal analysis to find $V_1$, $V_2$, $V_3$, and $V_4$ in the circuit in Fig. P3.44.

![Figure P3.44](image)

3.45 Use nodal analysis to find $V_1$, $V_2$, $V_3$, and $V_4$ in the network in Fig. P3.45.

![Figure P3.45](image)

3.46 Find $I_x$ in the network in Fig. P3.46 using mesh analysis.

![Figure P3.46](image)

3.47 Use mesh analysis to find $V_o$ in the circuit in Fig. P3.47.

![Figure P3.47](image)
3.48 Find $I_o$ in the circuit in Fig. P3.48.

3.49 Find $V_o$ in the network in Fig. P3.49 using mesh equations.

3.50 Find $V_o$ in the network in Fig. P3.50 using mesh equations.

3.51 Find $I_o$ in the circuit in Fig. P3.51.

3.52 Find $V_o$ in the circuit in Fig. P3.52 using mesh analysis.

3.53 Solve Problem 3.27 using loop analysis.

3.54 Solve Problem 3.32 using loop analysis.

3.55 Use loop analysis to find $V_o$ in the network in Fig. P3.55.

3.56 Use mesh analysis to find $V_o$ in the network in Fig. P3.56.

3.57 Find $I_o$ in the circuit in Fig. P3.57 using mesh analysis.
3.58 Find $V_o$ in the circuit in Fig. P3.58 using mesh analysis.

![Figure P3.58](image)

3.59 Use mesh analysis to find $V_o$ in the circuit in Fig. P3.59.

![Figure P3.59](image)

3.60 Use mesh analysis to find $I_o$ in the circuit in Fig. P3.60.

![Figure P3.60](image)

3.61 Use loop analysis to find $V_o$ in the circuit in Fig. P3.61.

![Figure P3.61](image)

3.62 Use loop analysis to calculate the power supplied by the 20-V voltage source in the circuit in Fig. P3.62.

![Figure P3.62](image)

3.63 Find $I_o$ in the network in Fig. P3.63 using loop analysis.

![Figure P3.63](image)

3.64 Use loop analysis to find $I_o$ and $I_i$ in the network in Fig. P3.64.

![Figure P3.64](image)

3.65 Find $I_o$ in the network in Fig. P3.65 using loop analysis. Then solve the problem using MATLAB and compare your answers.

![Figure P3.65](image)
3.66 Use loop analysis to find $V_o$ in the circuit in Fig. P3.66.

**Figure P3.66**

3.67 Using loop analysis, find $V_o$ in the Network in Fig. P3.67.

**Figure P3.67**

3.68 Find $I_o$ in the circuit in Fig. P3.68.

**Figure P3.68**

3.69 Use loop analysis to find $I_o$ in the network in Fig. P3.69.

**Figure P3.69**

3.70 Use loop analysis to find $I_o$ in the network in Fig. P3.70.

**Figure P3.70**

3.71 Using loop analysis, find $V_o$ in the circuit in Fig. P3.71.

**Figure P3.71**

3.72 Using loop analysis, find $V_o$ in the network in Fig. P3.72.

**Figure P3.72**

3.73 Using loop analysis, find $I_o$ in the circuit in Fig. P3.73.

**Figure P3.73**
3.74 Use MATLAB to find the mesh currents in the network in Fig. P3.74.

![Figure P3.74](image1)

3.75 Use loop analysis to find $V_o$ in the network in Fig. P3.75.

![Figure P3.75](image2)

3.76 Find $V_o$ in the circuit in Fig. P3.76 using nodal analysis.

![Figure P3.76](image3)

3.77 Use nodal analysis to find $V_o$ in Fig. P3.77.

![Figure P3.77](image4)

3.78 Use nodal analysis to find $V_o$ in the network in Fig. P3.78.

![Figure P3.78](image5)

3.79 Find the power supplied by the 2-A current source in the network in Fig. P3.79 using loop analysis.

![Figure P3.79](image6)

3.80 Find $I_x$ in the network in Fig. P3.80.

![Figure P3.80](image7)

3.81 Find $V_o$ in the circuit in Fig. P3.81 using loop analysis. Then solve the problem using MATLAB and compare your answers.

![Figure P3.81](image8)

3.82 Find $V_o$ in the network in Fig. P3.82 using nodal analysis.

![Figure P3.82](image9)
3.83 Find $V_o$ in the circuit in Fig. P3.83 using nodal analysis.

![Figure P3.83](image)

3.84 Use mesh analysis to find $V_o$ in the circuit in Fig. P3.84.

![Figure P3.84](image)

3.85 Find $V_x$ in the circuit in Fig. P3.85.

![Figure P3.85](image)

3.86 Using mesh analysis, find $V_x$ in the circuit in Fig. P3.86.

![Figure P3.86](image)

3.87 Find $I_o$ in the circuit in Fig. P3.87.

![Figure P3.87](image)

3.88 Write mesh equations for the circuit in Fig. P3.88 using the assigned currents.

![Figure P3.88](image)

3.89 Find $V_o$ in the network in Fig. P3.89.

![Figure P3.89](image)
3.90 Using loop analysis, find $V_o$ in the circuit in Fig. P3.90.

3.91 Solve for the assigned mesh currents in the network in Fig. P3.91.

3.92 Using the assigned mesh currents shown in Fig. P3.92, solve for the power supplied by the dependent voltage source.

3.93 Using loop analysis, find $V_o$ in the circuit in Fig. P3.93.

3.94 Using loop analysis, find $V_o$ in the network in Fig. P3.94.

3.95 Using loop analysis, find $V_o$ in the circuit in Fig. P3.95.

3.96 Using loop analysis, find $I_o$ in the network in Fig. P3.96.
**3.97** Using loop analysis, find $I_o$ in the circuit in Fig. P3.97.

![Figure P3.97](image)

**3.98** Use mesh analysis to determine the power delivered by the independent 3-V source in the network in Fig. P3.98.

![Figure P3.98](image)

**3.99** Use mesh analysis to find the power delivered by the current-controlled voltage source in the circuit in Fig. P3.99.

![Figure P3.99](image)

**3.100** Use both nodal and loop analyses to determine $I_o$ in the circuit in Fig. P3.100.

![Figure P3.100](image)

**3.101** Use both nodal and loop analyses to find $V_o$ in the circuit in Fig. P3.101.

![Figure P3.101](image)

**3.102** Find $I_n$ in the network in Fig. P3.102 using nodal analysis.

![Figure P3.102](image)