• Nodal Analysis

Steps
Identify Nodes; Mark Node Voltages and Reference
Write KCL at each Node
Solve for Node Voltages

Figure 1: Example 1: Nodal Analysis

Solve for phasor $V_1$
\[
\frac{V_1 - 100\angle 0}{2} + \frac{V_1}{1 + j3} + \frac{V_1 - 50V_x}{-j4} = 0
\]

\[
V_x = \frac{V_1 \cdot 1}{1 + j3}
\]

\[
V_1 \left[ \frac{1}{2} + \frac{1}{1 + j3} - \frac{1}{j4} + \frac{50}{j4(1 + j3)} \right] = 50\angle 0
\]

\[
V_1 \left[ 0.5 + \frac{1 - j3}{10} + j0.25 - j\frac{50 \cdot (1 - j3)}{4 \cdot 10} \right] = 50\angle 0
\]

\[
V_1 [0.5 + 0.1 - j0.3 + j0.25 - j1.25 - 3.75] = 50\angle 0
\]

\[
V_1 = \frac{50\angle 0}{-3.15 - j1.3} = \frac{50}{3.407\angle 22.425} = 14.67\angle 22.425
\]
MESH Analysis

Steps: Identify Mesh Currents (Clockwise); Map known currents to Mesh Current Variables

\[ I_0 = -I_1 \quad I_3 = -2 \angle 0 \]

\[ I_1[8 - j2 + j4] - I_2[j4] = 0 \]
\[ I_1[8 + j2] - I_2[j4] = 0 \]
\[ I_1[-j4] + I_2[6 + j4] - I_36 = -10 \angle 30 \]
\[ I_1[-j4] + I_2[6 + j4] = -12 \angle 0 - 10 \angle 30 \]
\[ I_2 = I_1 \frac{8 + j2}{j4} \]

\[ I_1 \left[ -j4 + \frac{(8 + j2)(6 + j4)}{j4} \right] = -12 - 10\cos(30) - j10\sin(30) \]

\[ I_1[11 - j14] = -20.66 - j5 \]

\[ I_1 = 1.19 \angle 65.44^\circ \]
Superposition Principle

**Step 1**: Replace time-varying functions by phasors.

\[ 60\cos(500t) : 60\angle 0 \quad 20\cos(500t) : 20\angle 0 \]

\[ 0.1H : j \times 500 \times 0.1 = j50 \quad 20\mu F : 10^6/j \times 500 \times 20 = -j100 \]

**Step 2**: Replace Current Source by an Open Circuit
Combine parallel elements \( j50 \) and \(-j100 \): Impedance: \( j100 \)
Current due to voltage source:

\[ I_{x1} = \frac{60\angle 0}{30+j100} = 1.998\angle 33.38^\circ \]
Step 3: Replace Voltage Source by a Short Circuit
Current due to current source:

\[ I_{x_2} = \frac{-2 \times j100}{30 + j100} \]

\[ = \frac{200\angle(90 + 180)}{104.4\angle73.3} \]

\[ = 1.915\angle196.7 \]

Superposition: \[ I_x = I_{x_1} + I_{x_2} = 2\angle33.4^\circ \]

Time Domain: \[ i(t) = 2\cos(500t + 33.4) \]