10.14

\[
\frac{e - 12}{2-j} + \frac{e}{2+2j} + \frac{e-4}{1} = -2
\]

\[
e \left( \frac{1}{2-j} + \frac{1}{2+2j} + \frac{1}{1} \right) = -2 + \frac{12}{2-j} + 4
\]

\[
e \left( \frac{2+j}{5} + \frac{1}{4} + 1 \right) = 2 + \frac{12}{5} (2+j)
\]

\[
e = \frac{34 + 12j}{33 - j} = \frac{34 + 12j \times 33 + j}{(33)^2 + 1}
\]

\[
= 4.37 \sqrt{21.175^\circ}
\]

\[V_0 = \frac{2}{2+2j} \quad e = \frac{1-j}{2} \quad e = 3.08 \sqrt{23}\]

*10.14

VS1 1 0 AC 12
R12 1 2 AC 2
C23 2 3 AC 1
IS 3 0 AC 2
L1 3 5 AC 2
R50 5 0 AC 2
R34 3 4 AC 1
VS2 4 0 AC 4

.AC LIN 1 .159155 .159155
.PRINT AC VR(5), VI(5), VM(5), VP(5),
+ VR(3), VI(3), VM(3), VP(3),
+ VM(1), VP(1), VM(4), VP(4),
.END

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<th>VI(5)</th>
<th>VM(5)</th>
<th>VP(5)</th>
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10.28

Note that the current in the capacitor (in the direction of the loop arrow) is 1+2, and so \(-j(1+2) + \angle (2j + 2) = 6\). Solve for 
Y_0 = 2 = (6+2j)/(2+j) = 4(7-j)/5 = 5.657 \sqrt{8.13^\circ}

Circuits Chap 10 Sinusoid 1 M H Miller
As an illustration this problem is analysed by first determining the Thevenin equivalent circuit 'seen' looking into the circuit from the 1\(\Omega\) as shown.

First determine the open-circuit voltage (Thevenin source voltage. \(I_x = -4\), \(2I_x = -8\). Hence the current in the capacitor is 12, and so the current in the inductor is 8. (See diagram for polarities.) Hence \(V_{DC} = 4 - j8\).

To determine the Thevenin impedance, set the strength of all independent sources to zero (and so the current source is an open-circuit), and determine the input impedance. For example 'measure' the impedance by applying a current source of unit strength and calculating the input voltage. The ratio is the impedance. Thus \(I_x = -1\), \(2I_x = -2\), and the current in the inductor is 1 as shown. The voltage \(V = 1 - j\), and \(V/I =\) Thevenin impedance \(= 1 - j\)

Replace the circuit 'seen' by the 1\(\Omega\) resistor by its Thevenin equivalent and find

\[
V_o = (4-j8) \frac{1}{1-j} = \frac{16-12j}{5} = 4 \sqrt{36.87^\circ}
\]

\[
= 4 \sqrt{36.87^\circ}
\]

Turn off the current source. The circuit then consists of 1\(\Omega\) in parallel with the series combination of the inductor and capacitor, all this is in series with the 2\(\Omega\). The expression for \(V_o(12)\) will be recognized as obtained by applying the voltage-divider relation. Then turn off the voltage source; this puts the 1\(\Omega\) in parallel with the 2\(\Omega\), and the source current divides between the capacitor and the series combination of the

\[
V_o(12) = \frac{2}{2+\frac{1(-j+2j)}{1-j+2j}} = \frac{4}{5+j}
\]

\[
V_o(4) = \frac{-j}{-j+2j+2\sqrt{3}}(2/3)
\]

\[
= \frac{-8j}{2+3j}
\]

\[
V_o = V_o(12) + V_o(4) = \frac{8}{15}(12-5j)
\]

\[
= \frac{8}{15}22.62^\circ
\]
inductor and the two parallel resistors. The expression for \( V_0(4) \) is an application of the current divider relation.

**10.59**

The voltage across the capacitor is \( 12 - 6\angle 30^\circ \), determine the current through the capacitor by dividing by \(-j2\). For the short-circuit current condition the current through the \( 4\Omega \) is \( 6\angle 30^\circ /4 \). Subtract to get the short-circuit current

\[
\text{ISC} = \frac{12 - 6\angle 30^\circ - 6\angle 30^\circ}{-j2} = 0.201 + j2.6519
\]

The Norton (same as Thevenin) impedance consists of the capacitor in parallel with the resistor; \( 4/(1+2j) \). Use the current divider relation to determine \( I = 2.95\angle 142^\circ \)

**10.61**

\[
11.3\angle 45^\circ = 8+j8
\]

\[
11.3\angle 45^\circ = 8+j8
\]

\[
2N = j4 \quad \text{(turn off the sources)}
\]

\[
V_x = \frac{(10)(j4)}{10 + j4} - j3
\]

\[
= \frac{120(1+j)}{6+5j} = 21.73\angle 5.19^\circ
\]

**10.64**

The Thevenin voltage is zero; the circuit has no independent sources. Rather the write mesh of node equations the analysis used is a ladder development.

The voltage drop across the \( 3\Omega \) resistor is \( 3V_x \), and the current into node 1 from the \( 3\Omega + 1\Omega \) branch is \( V_x \). The voltage at node 1 is \(-4V_x \), and so the current into node 1 from the capacitor is \( 2V_x - j \). The current from node 2 to node 1 is \(-V_x(1+2j) \), and hence the voltage at node 2 is \(-V_x(5+2j) \). Then the inductor current out of node 2 is \( V_x(-2+5j) \), so that the input current at node 2 is \( 3(-1+j) \). The Thevenin impedance is provided by the ratio of the voltage at the input current and (noting that \( V_x \) cancels) this is \( (3+7j)/6 \).