School of Electrical Engineering & Telecommunications

ELEC1111 Tutorial

Topic 8: AC Circuits II

1. Write nodal equations for the following circuits:

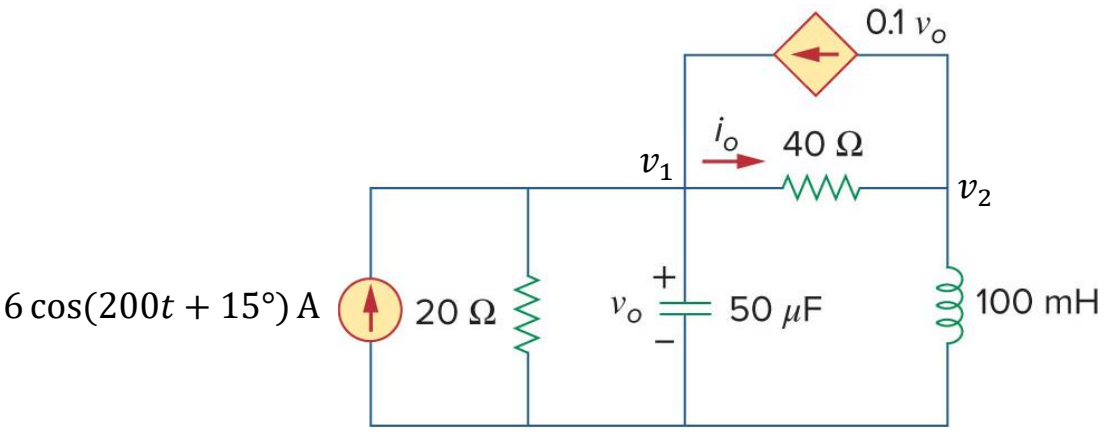


Fig. 1

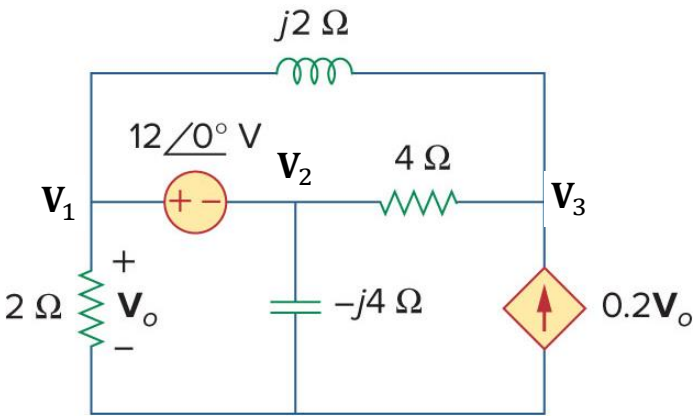


Fig. 2

Answer:

a) Fig. 1: $\begin{cases} (-2.5 + j1)\mathbf{V}_1 - 2.5\mathbf{V}_2 = 579.5 + j155.3 \\ 3\mathbf{V}_1 + (1 - j2)\mathbf{V}_2 = 0 \end{cases}$

b) Fig. 2: $\begin{cases} (2 - j2)\mathbf{V}_1 + (1 + j)\mathbf{V}_2 + (-1 + j2)\mathbf{V}_3 = 0 \text{ V} \\ (0.8 - j2)\mathbf{V}_1 + \mathbf{V}_2 + (-1 + j2)\mathbf{V}_3 = 0 \text{ V} \\ \mathbf{V}_1 - \mathbf{V}_2 = 12 \end{cases}$

2. Write mesh equations for the following circuits:

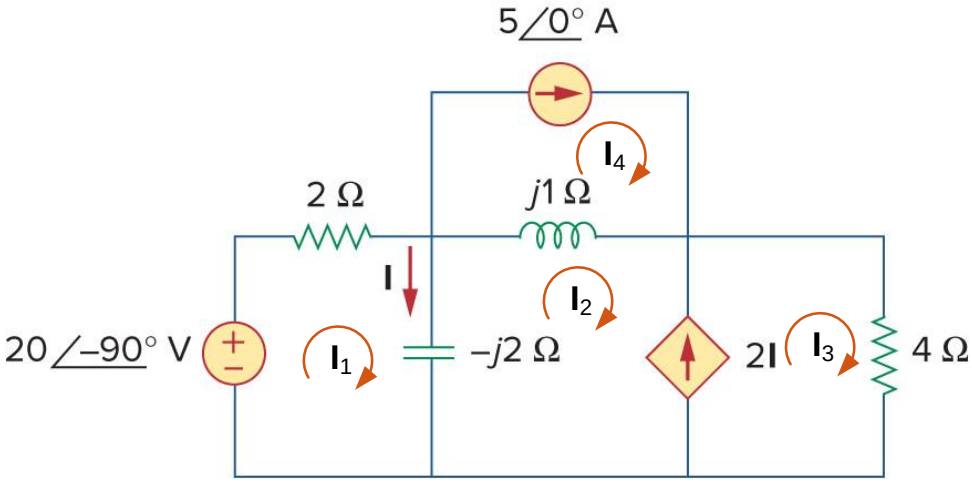


Fig. 1

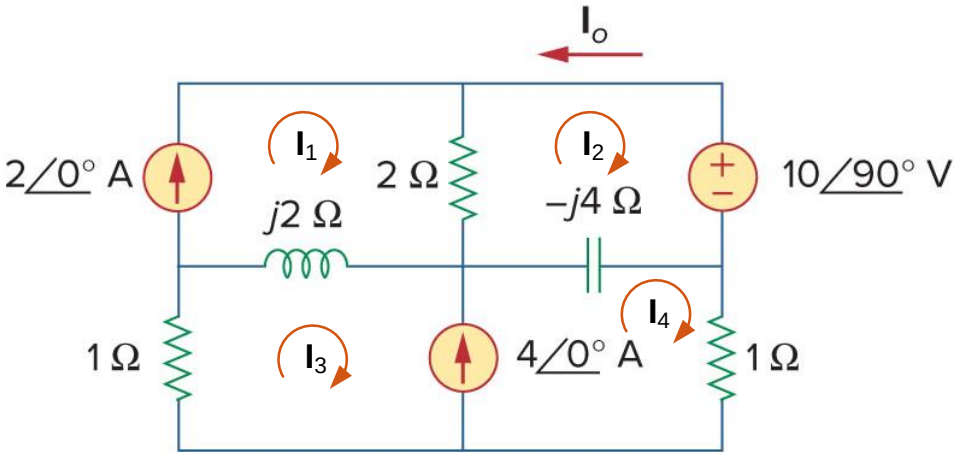


Fig. 2

Answer:

a) Fig. 1: $\begin{cases} (1-j)\mathbf{I}_1 + j\mathbf{I}_2 = -j10 \\ j2\mathbf{I}_1 - j\mathbf{I}_2 + 4\mathbf{I}_3 = j5 \\ 2\mathbf{I}_1 - \mathbf{I}_2 - \mathbf{I}_3 = 0 \\ \mathbf{I}_4 = 5 \end{cases}$

b) Fig. 2: $\begin{cases} \mathbf{I}_1 = 2 \\ (1-j2)\mathbf{I}_2 + j2\mathbf{I}_4 = 2 - j5 \\ j4\mathbf{I}_2 + (1+j2)\mathbf{I}_3 + (1-j4)\mathbf{I}_4 = j4 \\ \mathbf{I}_3 - \mathbf{I}_4 = -4 \end{cases}$

3. Use superposition principle to find i_x and v_x in the following circuits

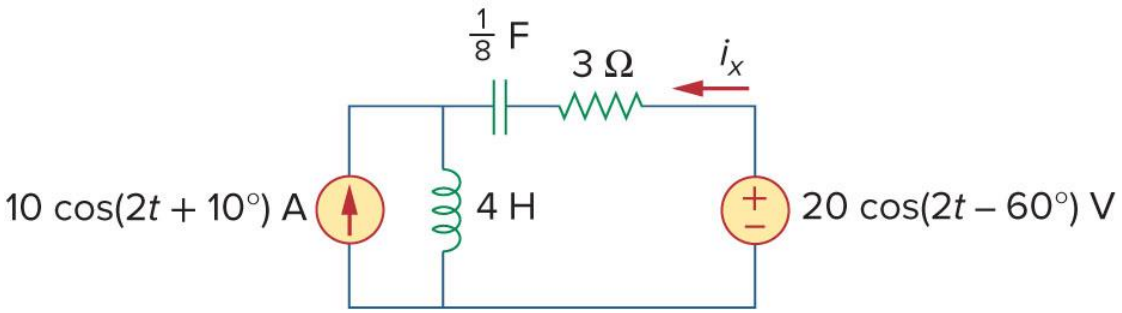


Fig. 1

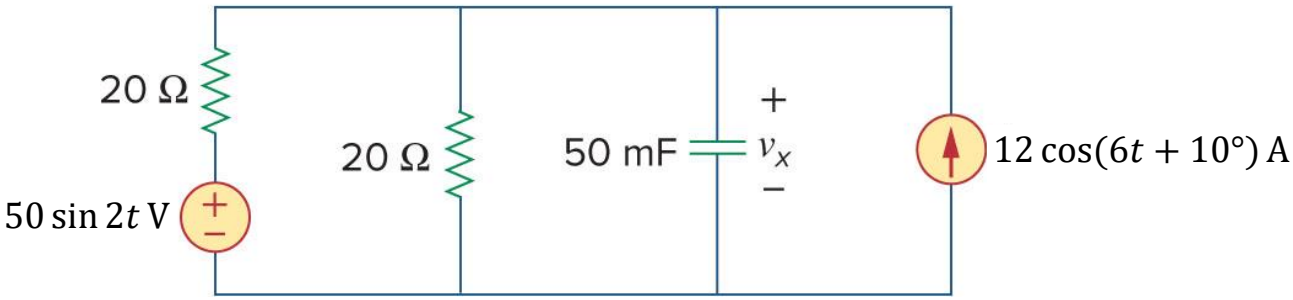


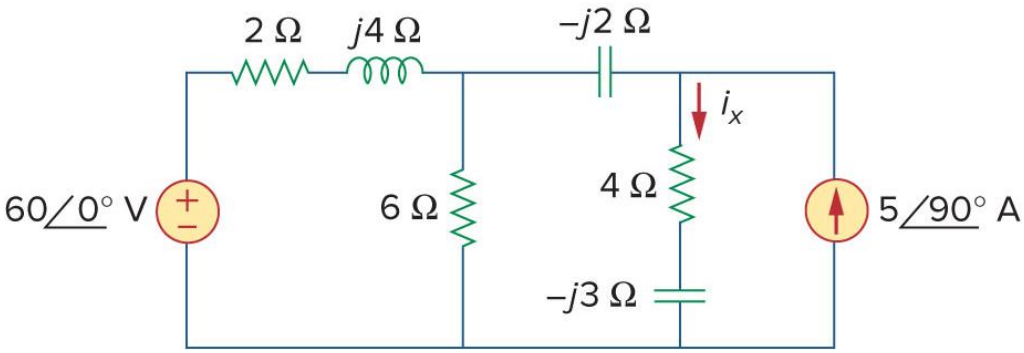
Fig. 2

Answer:

a) Fig.1: $i_x(t) = 19.8\cos(2t - 129.1°)$ A

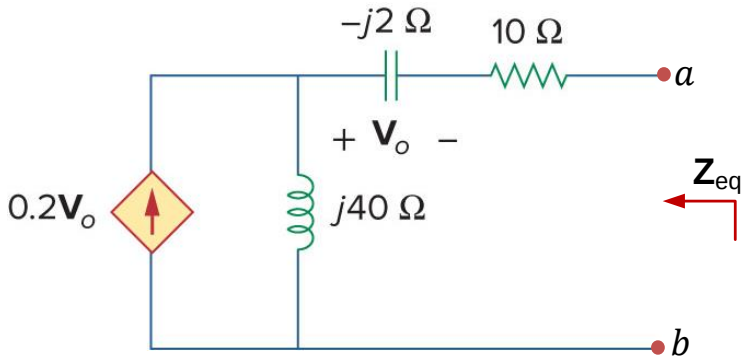
b) Fig. 2: $v_x(t) = [17.678\cos(2t - 135°) + 37.95\cos(6t - 61.5°)]$ V

4. Use source transformation to find $\mathbf{I}_x$ in the following circuit.



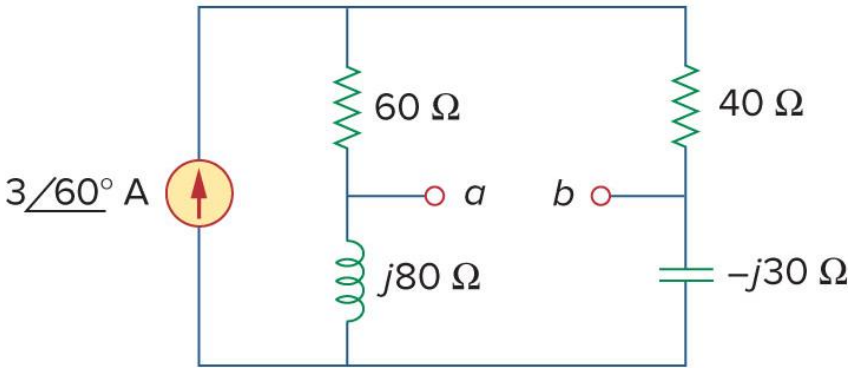
Answer: $\mathbf{I}_x = 5.238\angle 17.35°$ A

5. Calculate the equivalent impedance of the following circuit from the terminals *a*-*b*.



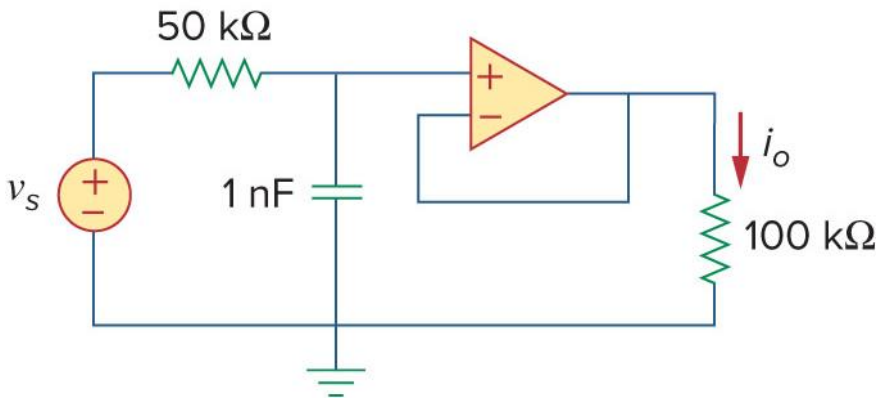
Answer: $\mathbf{Z}_{\text{eq}} = -6 + j38\ \Omega$.

6. For the following circuit, find the Thevenin and Norton equivalent circuits



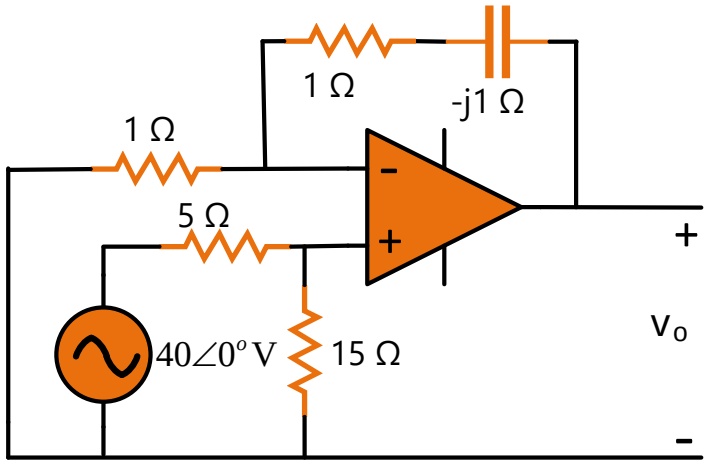
Answer: $\mathbf{Z}_{\text{eq}} = 20 + j40\ \Omega = 44.72\angle 63.43°\ \Omega$, $\mathbf{V}_{\text{Th}} = 134\angle 123.4°\ \text{V}$, $\mathbf{I}_N = 3\angle 60°\ \text{A}$

7. Find $i_o(t)$ in the Op Amp circuit shown below if $v_s = 4\cos(10^4 t)\ \text{V}$



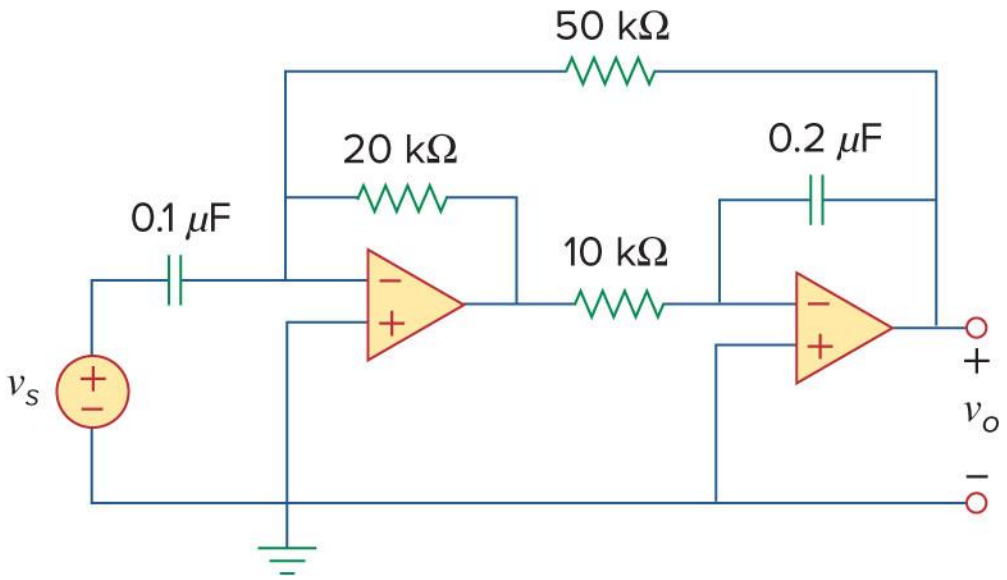
Answer: $i_o(t) = 35.78\cos(10^4 t - 26.56°)\ \mu\text{A}$

8. (**Final Exam – Summer, 2016-17**) For the circuit shown in below, calculate the output voltage $\mathbf{V}_o$.



Answer: $\mathbf{V}_o = 67.08\angle(-26.56°)\ \text{V} = 60 - j30\ \text{V}$

9. Calculate $v_o(t)$ for the Op Amp circuit below if $v_s = 12\cos(10^3 t - 60°)\ \text{V}$



Answer: $v_o(t) = 11.767\cos(10^3 t - 71.31°)\ \text{V}$