Chapter 10, Solution 4.

Compute $v_o(t)$ in the circuit of Fig. 10.53.

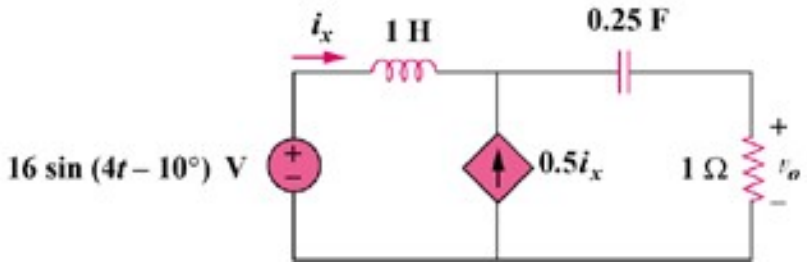
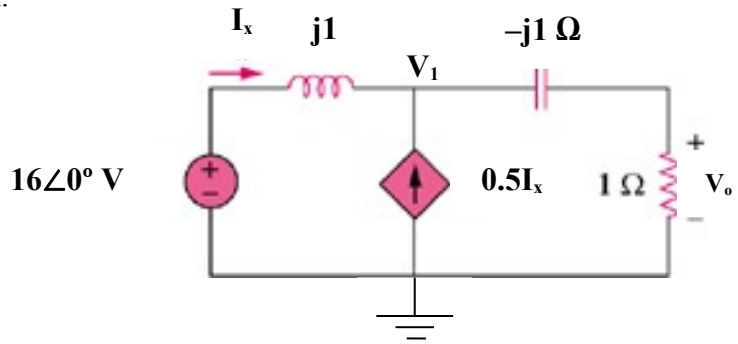


Figure 10.53
For Prob. 10.4.

Solution

Step 1. Convert the circuit into the frequency domain and solve for the node voltage, V_1, using analysis. The find the current $I_C = V_1/[1+(1/(j4x0.25)]$ which then produces $V_o = 1xI_C$. Finally, convert the capacitor voltage back into the time domain.



Note that we represented 16sin(4t–10°) volts by 16∠0° V. That will make our calculations easier and all we have to do is to offset our answer by a –10°.

Our node equation is $[(V_1–16)/j] – (0.5I_x) + [(V_1–0)/(1–j)] = 0$. We have two unknowns, therefore we need a constraint equation. $I_x = [(16–V_1)/j] = j(V_1–16)$. Once we have V_1, we can find $I_o = V_1/(1–j)$ and $V_o = 1xI_o$.

Step 2. Now all we need to do is to solve our equations.

$[(V_1–16)/j] – [0.5j(V_1–16] + [(V_1–0)/(1–j)] = [–j–j0.5+0.5+j0.5]V_1 +j16+j8 = 0$ or

$[0.5–j]V_1 = –j24$ or $V_1 = j24/(–0.5+j) = (24\angle 90º)/(1.118\angle 116.57º)$
$= 21.47\angle –26.57º$ V.

Finally, $I_x = V_1/(1–j) = (21.47\angle –26.57º)\ (0.7071\angle 45º) = 15.181\angle 18.43º$ A and V_o
$= 1xI_o = 15.181\angle 18.43º$ V or

$$v_o(t) = 15.181\sin(4t–10º+18.43º) = \textbf{15.181sin(4t–8.43º) volts}.$$