Homework 8

P6.3.3 Determine i_O in Figure P6.3.3, given that v_{SRC} = 200sin(1,000*t*) V. Simulate with PSpice.

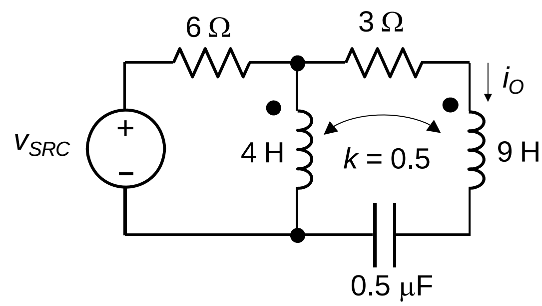


Figure P6.3.3

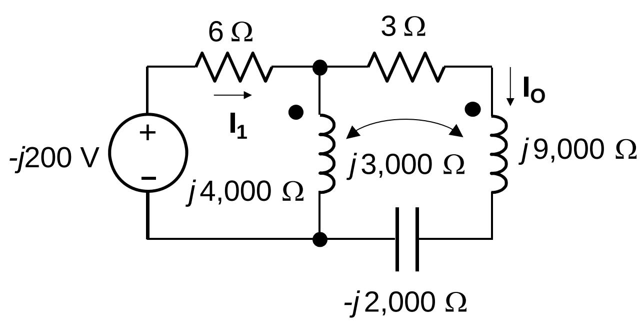
Solution P6.3.3

$1/j\omega C = 1/(j1000 \times 0.5 \times 10^{-6}) = -j2000\ \Omega$;

$j\omega L_1 = j1000 \times 4 = j4000\ \Omega$;

$j\omega L_2 = j1000 \times 9 = j9000\ \Omega$;

$j\omega M = j1000 \times 0.5\sqrt{4 \times 9} = j3000\ \Omega$;



Considering $\mathbf{I_1}$ to be a mesh current and $\mathbf{I_O}$ to be the current in the outer loop, KVL gives:

$(6 + j4000)\mathbf{I_1} + (j3000 + 6)\mathbf{I_o} = -j200$,

and, $(j3000 + 6)\mathbf{I_1} + (9 + j7000)\mathbf{I_o} = -j200$

Solving, gives $\mathbf{I_o} = -0.0105 \equiv -0.0105\cos(1{,}000t)$ A.

P6.3.4 Determine Z_x in Figure P6.3.4 so that $\mathbf{V_O} = 0$.

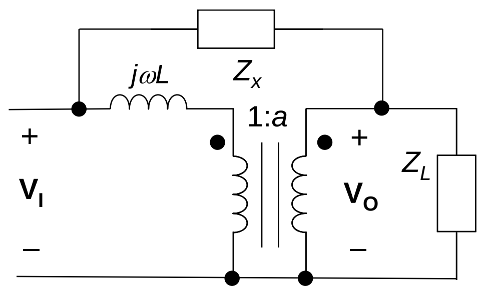
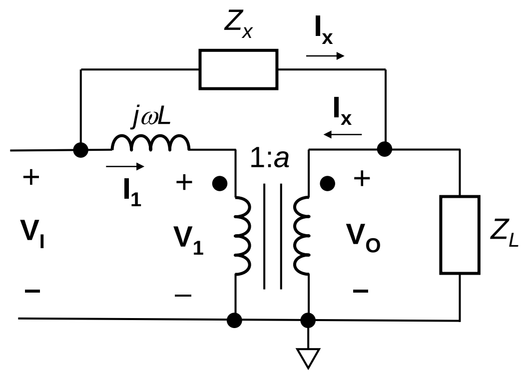


Figure P6.3.4

<u>Solution P6.3.4</u>



If $\mathbf{V_o} = 0$, then $\mathbf{V_1} = 0$, $\mathbf{I_1} = \dfrac{1}{j\omega L}\mathbf{V_1}$, and $\mathbf{I_x} = \dfrac{1}{Z_x}\mathbf{V_I}$.

But $\mathbf{I}_1 + a\mathbf{I_x} = 0$;

hence, $Z_x = -j\omega La$.

P6.3.7 Determine V_x and V_y in Figure P6.3.47, assuming f = 50 Hz.

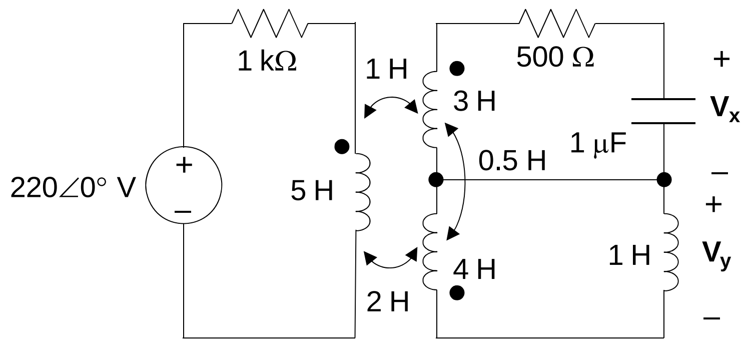


Figure P6.3.7

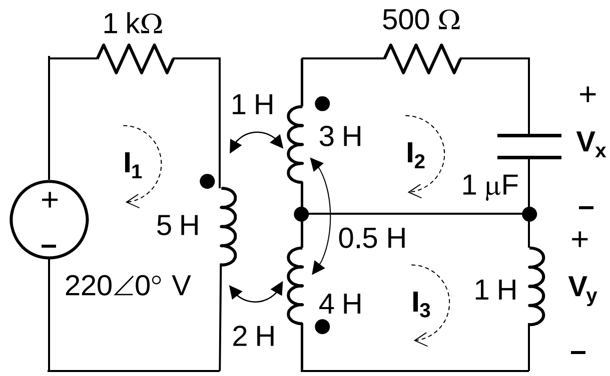
Solution P6.3.7

The mesh current equations are:

$(10^3 + j\omega 5)\mathbf{I_1} - j\omega 1\mathbf{I_2} + j\omega 2\mathbf{I_3} = 220$

$-j\omega 1\mathbf{I_1} + (500 + j\omega 3 - j/(\omega\times 10^{-6}))\mathbf{I_2} - j\omega 0.5\mathbf{I_3} = 0$

; $+j\omega 2\mathbf{I_1} - j\omega 0.5\mathbf{I_2} + j\omega 5\mathbf{I_3} = 0$



Substituting $\omega = 100\pi$ and solving gives:

$\mathbf{I_2} = -0.0059 + j0.013$ A, and $\mathbf{I_3} = -0.0319 + j0.0432$ A.

Hence, $\mathbf{V_x} = [-j/(\omega\times 10^{-6})]\mathbf{I_2} = 41.3 + j18.6 = 45.3\angle 25.3° \equiv 45.3\cos(100\pi t + 25.3°)$ V,

$\mathbf{V_y} = j\omega\mathbf{I_3} = -13.6 - j10.03 = 16.89\angle -143.6° \equiv 16.89\cos(100\pi t - 143.6°)$ V.

P6.3.10 Determine i_O in Figure P6.3.10, given that $v_{SRC} = 100\sin(100\pi t)$ V.

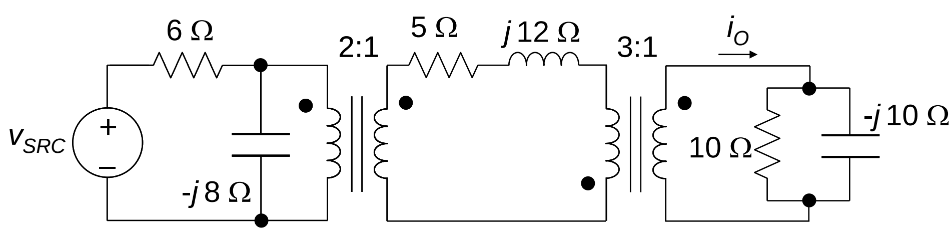
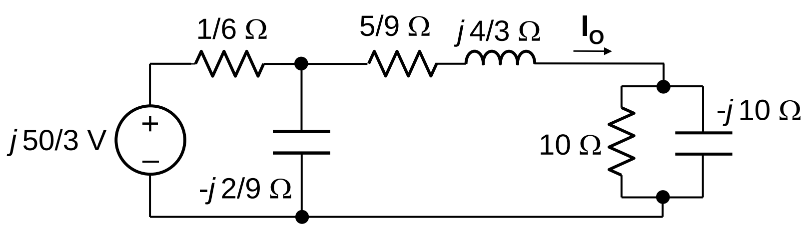


Figure P6.3.10

<u>Solution P6.3.10</u>

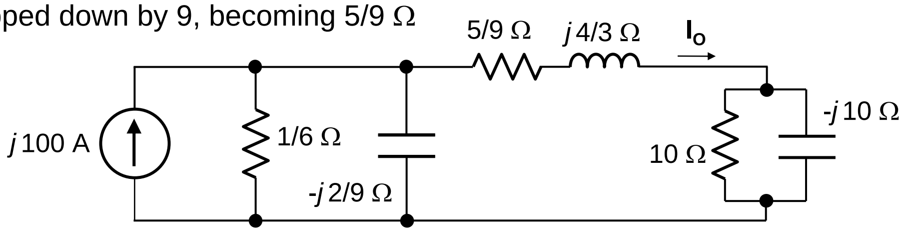
The -j100 V source is reflected through the two transformers by dividing it by 2 and then by -3, becoming j50/3 V, as shown.



The 6 Ω and -j8 Ω are stepped down by $(2)^2\times(3)^2 = 36$, becoming 1/6 Ω and -j2/9 Ω, as shown.

The 5 Ω and j12 Ω are stepped down by 9, becoming 5/9 Ω and j4/3 Ω, as shown.

The voltage source is transformed to a current source as shown.



Let $Z = \dfrac{5}{9} + j\dfrac{4}{3} + \dfrac{1}{0.1 + j0.1}$; then $Y = \dfrac{1}{Z} = 0.125 + j0.0828$ S.

Hence, $\mathbf{I_O} = \dfrac{Y}{Y + 6 + j4.5}(j100) = 0.116 + j1.96\text{ A} = 1.96\angle 86.6^\circ = 1.96\cos(100\pi t + 86.6^\circ)$ A.

P6.3.12 Determine $\mathbf{V_O}$ in Figure P6.3.12, given that $\mathbf{V_{SRC}} = 50\angle 45^\circ$ V.

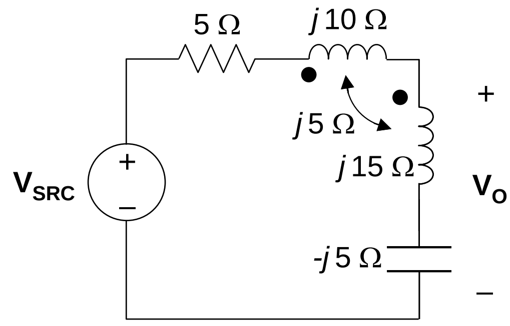
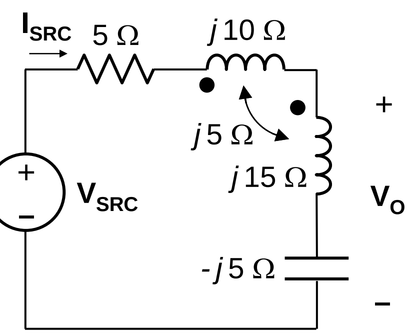


Figure P6.3.12

Solution P6.3.12



$\mathbf{I_{SRC}}\,[5 + j10 + j15 + 2\times j5 - j5] = 50(\cos 45^\circ + j\sin 45^\circ)$;

$\mathbf{I_{SRC}} = \dfrac{50(\cos 45^\circ + j\sin 45^\circ)}{5 + j30}$,

$\mathbf{V_O} = (j15 + j5 - j5)\mathbf{I_{SRC}} = \dfrac{j750(\cos 45^\circ + j\sin 45^\circ)}{5 + j30} =$

$14.33 + j20.07$ V.

P6.3.15 Derive TEC between terminals ab in Figure P6.3.15.

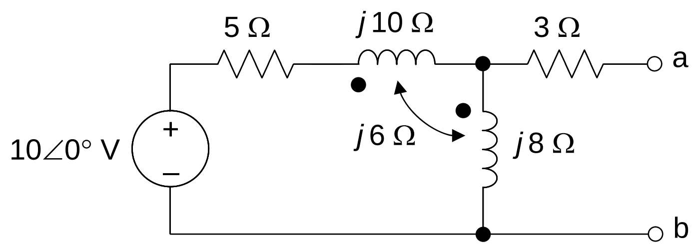
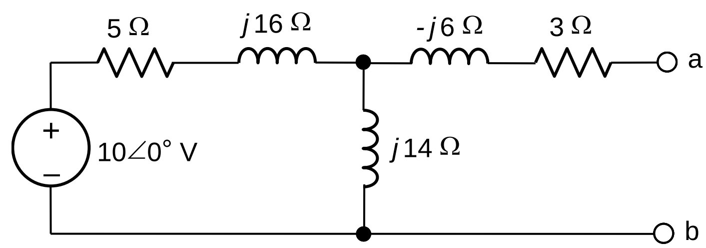


Figure P6.3.15

<u>Solution P6.3.15</u>

The linear transformer is replaced by its T-equivalent circuit. It follows that $\mathbf{V_{Th}}$ = $\frac{j14}{5+j30}\times 10 = \frac{28}{37}(6+j) = 4.6\angle 9.46\,\text{V}$.



When the voltage source is set to zero, the impedance looking into terminal ab is

$$Z_{Th} = 3 - j6 + \frac{j14(5+j16)}{5+j30} = \frac{751+j304}{185} = 4.060 + j1.643 = 4.38\angle 22.04°\ \Omega.$$

P6.3.21 Determine Z_{in} in Figure P6.3.21.

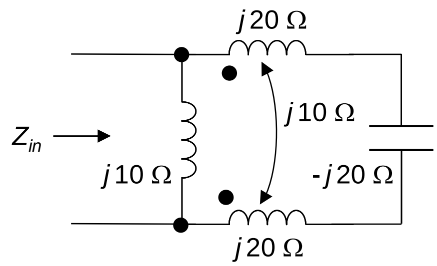


Figure P6.3.21

<u>Solution P6.3.21</u>

The impedance encountered by the current **I** is $j\omega L_1 + j\omega L_2 - j2\omega M - j/\omega C = j20 + j20 - j20 - j20 = 0$.

Hence, $Z_{in} = j10||0 = 0$.