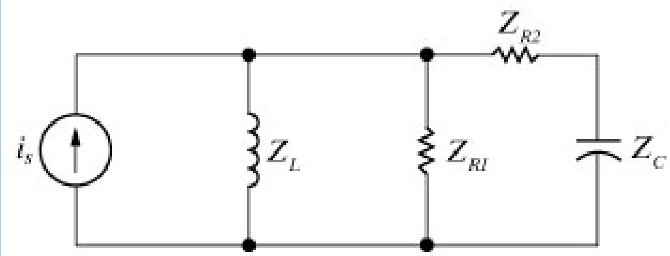
Problem 9.16 PSpice|Multisim

A 25 Ω resistor and a 10 mH inductor are connected in parallel. This parallel combination is also in parallel with the series combination of a 30 Ω resistor and a $10\ \mu\mathrm{F}$ capacitor. These three parallel branches are driven by a sinusoidal current source whose current is $225 \sin(2500t + 60^\circ)\ \mathrm{A}$.

Part A

Determine the impedances in .

Express your answers in complex form using three significant figures separated by commas.



ANSWER:

Z_L, Z_{R1}, Z_{R2}, Z_C = Ω, Ω, Ω, Ω

Part B

Reference the voltage across the current source as a rise in the direction of the source current, and find the phasor voltage.

Enter your answer using polar notation. Express argument in degrees.

ANSWER:

$\mathbf{V_o}$ = V

Part C

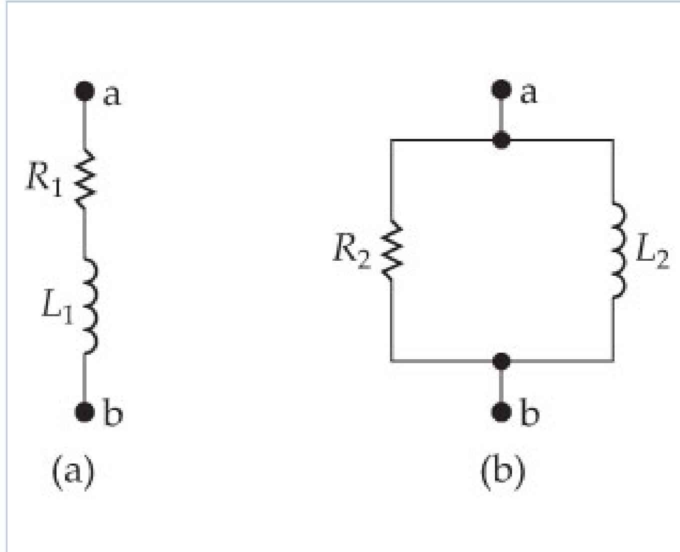
Choose the correct steady-state expression for $v(t)$.

ANSWER:

- $-5.22\sin(2500t + 3930^\circ)\,\mathrm{V}$
- $-5.22\cos(2500t + 3930^\circ)\,\mathrm{V}$
- $3930\cos(2500t - 5.22^\circ)\,\mathrm{V}$
- $3930\sin(2500t - 5.22^\circ)\,\mathrm{V}$

Problem 9.18

At a given frequency ω, the circuits in the figures (a) and (b) have the same impedance between the terminals a,b.



Part A

Find R_1.

Express your answer in terms of the variables ω, L_2 and R_2.

ANSWER:

R_1 =

Part B

Find L_1.

Express your answer in terms of the variables ω, L_2 and R_2.

ANSWER:

L_1 =

Part C

Find the value of resistance that when connected in series will have the same impedance at 4.8 $\mathrm{krad/s}$ as that of a 6 $\mathrm{k\Omega}$ resistor connected in parallel with a 1.4 H inductor.

Express your answer to four significant figures and include the appropriate units.

ANSWER:

R_1 =

Part D

Find the value of inductance that when connected in series will have the same impedance at 4.8 $\mathrm{krad/s}$ as that of a 6 $\mathrm{k\Omega}$ resistor connected in parallel with a 1.4 H inductor.

Express your answer with the appropriate units.

ANSWER:

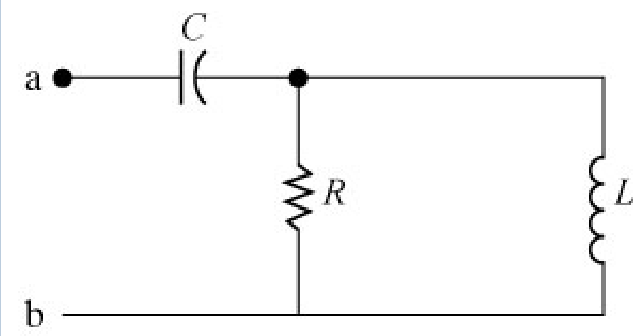
L_1 =

Problem 9.24 PSpice|Multisim

Part A

For the circuit shown in , find the frequency at which the impedance Z_{ab} is purely resistive. Suppose R = 400 Ω , L = 400 mH , and C = 50 $\mu\mathrm{F}$.

Express your answer using three significant figures.



ANSWER:

ω = ______ rad/s

Part B

Find the value of Z_{ab} at the frequency of Part A.

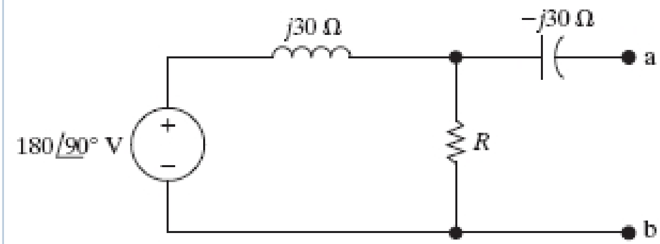
Express your answer to two significant figures and include the appropriate units.

ANSWER:

Z_{ab} = ______

Problem 9.44

Use source transformations to find the Norton equivalent circuit with respect to the terminals a,b for the circuit shown in . Suppose that R = 13 Ω .



Part A

Find the value of Z_{N} .

Express your answer in complex form using three significant figures.

ANSWER:

Z_{N} = Ω

Part B

Find the value of $\mathrm{I_N}$.

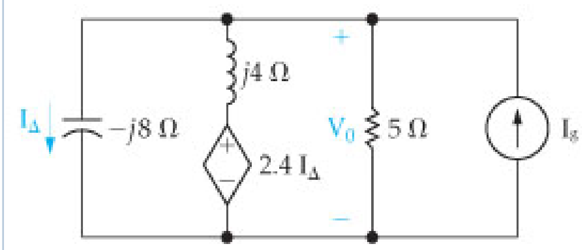
Express your answer in complex form using three significant figures.

ANSWER:

$\mathrm{I_N}$ = A

Problem 9.58

Use the node-voltage method to find the phasor voltage $\mathbf{V}_o$ in the circuit shown in the figure when I_g = 12 + 12 jA.



Part A

Express the voltage in polar form.

Enter your answer using polar notation. Express argument in degrees.

ANSWER:

$\mathbf{V}_o$ = V

Part B

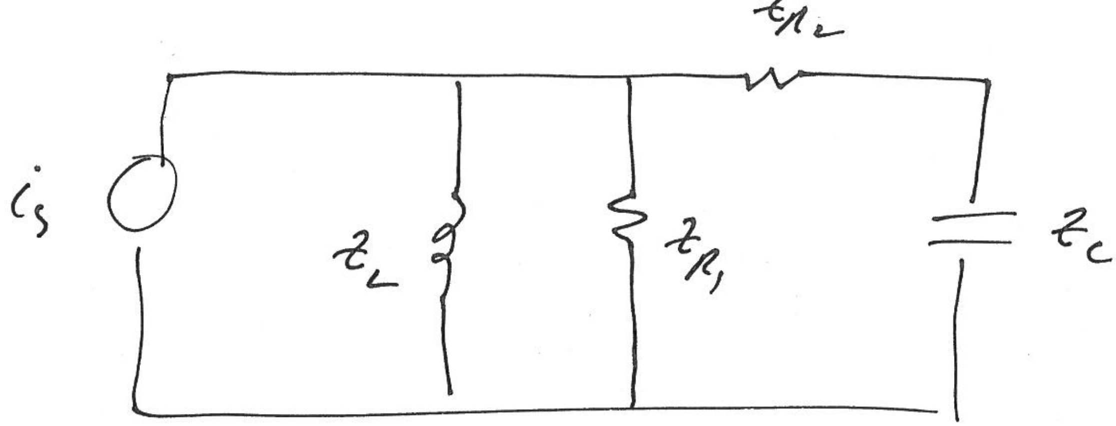
Express the voltage in rectangular form.

Express your answer in complex form.

ANSWER:

$\mathbf{V}_o$ = V

9.16



$L = 10\,mH; \quad R_1 = 25\,\Omega; \quad R_2 = 30\,\Omega; \quad C = 10\,\mu F$

$i_s = 225 \sin(\underbrace{2500}_{\omega} t + 60^\circ)\,A$

a) $z_L = j\omega L = j25.0\,\Omega$

$z_{R_1} = 25\,\Omega$

$z_{R_2} = 30\,\Omega$

$z_C = \dfrac{1}{j\omega C} = \dfrac{40}{j} = -j40\,\Omega$

b) $i_s = 225 \sin(2500t + 60^\circ)$
$= 225 \cos(2500t + 60^\circ - 90^\circ)$

$I_s = 225 \angle -30^\circ$

$z_{eq} = [25 \| (30 - j40)] \| j25$

$$25 \| (30 - j40) = \frac{25(30-j40)}{25+30-j40} = \frac{25(30-j40)}{55-j40}$$

$$z_{eq} = \frac{\left[\frac{25(30-j40)}{55-j40}\right] \times j25}{\left[\frac{25(30-j40)}{55-j40}\right] + j25}$$

$$= \frac{25(30-j40)(j25)}{25(30-j40) + j25(55-j40)}$$

$$= \frac{j25(30-j40)}{30+40 + j55 - j40} = \frac{j25(30-j40)}{70+j15}$$

$$= \frac{j5(30-j40)}{14+j3} \frac{(14-j3)}{(14-j3)}$$

$$= j5 \frac{(30-j40)(14-j3)}{196+9} = j5 \frac{(30-j40)(14-j3)}{205}$$

$$= j\left(\frac{30 \times 14 - j3 \times 30 - j14 \times 40 - 40 \times 3}{41}\right)$$

$$= \frac{650 + j300}{41} = 17.461 \angle 24.775^\circ$$

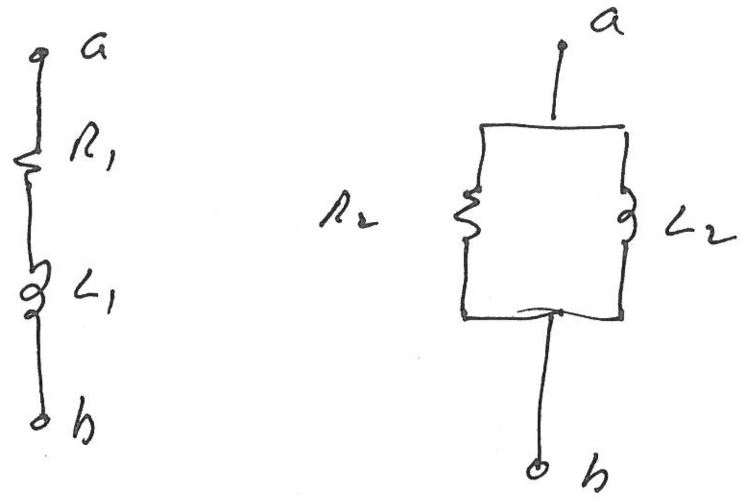
$$V_s = I_s Z_{eq}$$

$$= 225\angle -30° (17.461\angle 24.775°)$$

b) $V_s = 3{,}928.67\angle -5.2257°$

c) $v(t) = 3{,}930 \cos(2500t - 5.22°)$ V

9.18



$$Z_L = R_1 + j\omega L_1 \qquad Z_P = \frac{R_2(j\omega L_2)}{R_2 + j\omega L_2}$$

SET $Z_L = Z_P$ & SOLVE FOR R_1

STRATEGY: FIND $RE\{Z_P\} = R_1$

$$Z_P = \frac{j\omega L_2 R_2}{R_2 + j\omega L_2}\left(\frac{R_2 - j\omega L_2}{R_2 - j\omega L_2}\right)$$

$$= \frac{\omega^2 R_2 L_2^2}{R_2^2 + (\omega L_2)^2} + \frac{j\omega R_2^2 L_2}{R_2^2 + (\omega L_2)^2}$$

a) $$R_1 = \frac{\omega^2 R_2 L_2^2}{R_2^2 + (\omega L_2)^2}$$

b) SET $IM\{Z_2\} = IM\{Z_1\}$:

$$j\omega L_1 = \frac{j\omega R_2^2 L_2}{R_2^2 + (\omega L_2)^2}$$

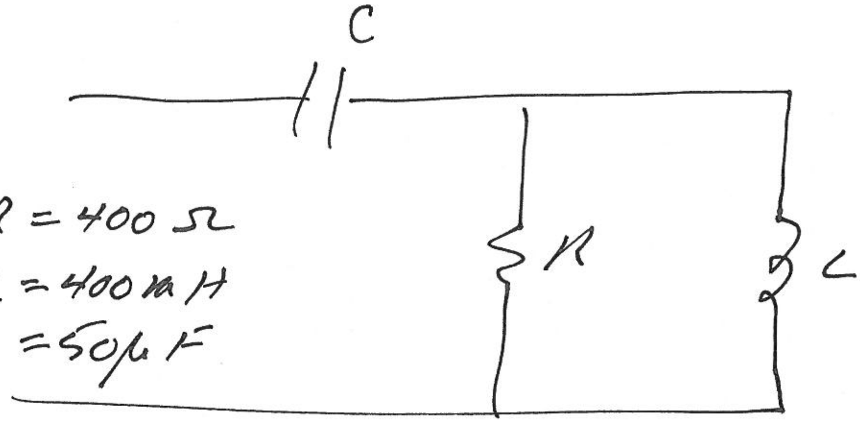
$$L_1 = \frac{R_2^2 L_2}{R_2^2 + (\omega L_2)^2}$$

NOW FOR $\omega = 3,800$ RAD/S
$R_2 = 5.5\,k\Omega$
$L_2 = 1.35\,H$

c) FROM PART a), $R_1 = 2,559\ \Omega$

d) FROM PART b), $L_1 = 0.7219\,H$

9.24



$R = 400\,\Omega$
$L = 400\,mH$
$C = 50\,\mu F$

$$Z_{eq} = \frac{1}{j\omega C} + \frac{R \cdot j\omega L}{R + j\omega L}$$

$$= -\frac{j}{\omega C} + \frac{j\omega RL}{R + j\omega L} \frac{(R - j\omega L)}{(R - j\omega L)}$$

$$= \frac{-j}{\omega C} \quad \frac{+j\omega R^2 L}{R^2 + (\omega L)^2} \quad + \frac{\omega^2 R L^2}{R^2 + (\omega L)^2}$$

a) ? ω FOR WHICH Z_{eq} PURELY REAL ?

$$\Rightarrow \mathrm{Im}\{Z_{eq}\} = 0$$

$$-\frac{1}{\omega C} + \frac{\omega R^2 L}{R^2 + (\omega L)^2} = 0$$

$$\frac{\omega R^2 L}{R^2 + (\omega L)^2} = \frac{1}{\omega C}$$

$$\omega^2 R^2 LC = R^2 + (\omega L)^2$$

$$\omega^2(R^2LC - L^2) = R^2$$

$$\omega = \frac{R}{\sqrt{R^2LC - L^2}}$$

USING SPECIFIED VALUES, $\omega = 229.4157$ RAD/S

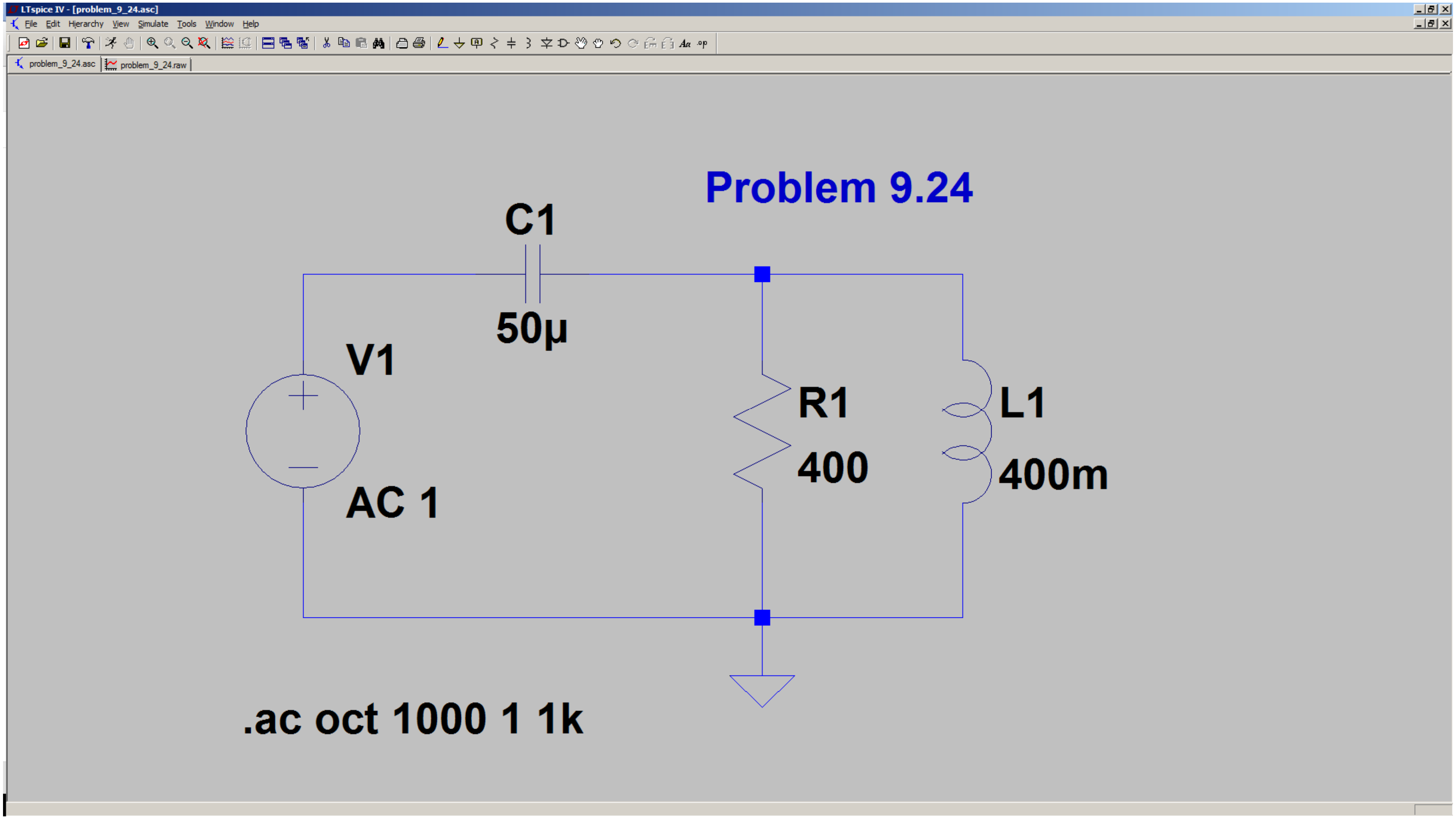
b) NOW $Re\{Z_{eq}\} = \dfrac{\omega^2 RL^2}{R^2 + (\omega L)^2}$

AT THIS FREQUENCY (PART a),

$$Re\{Z_{eq}\} = Z_{eq} = 20\,\Omega$$

(PURELY RESISTIVE)

Problem 9.24



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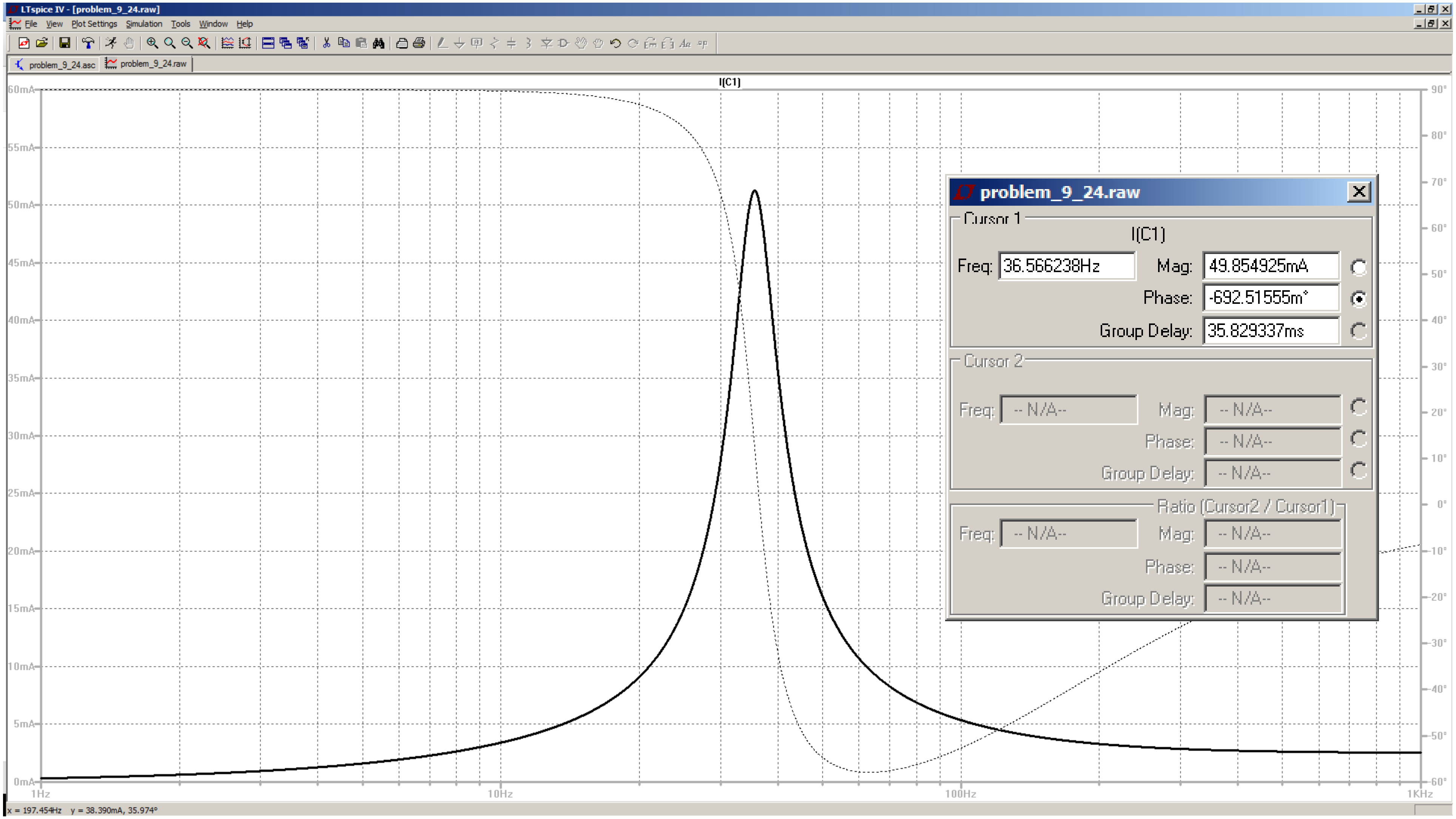
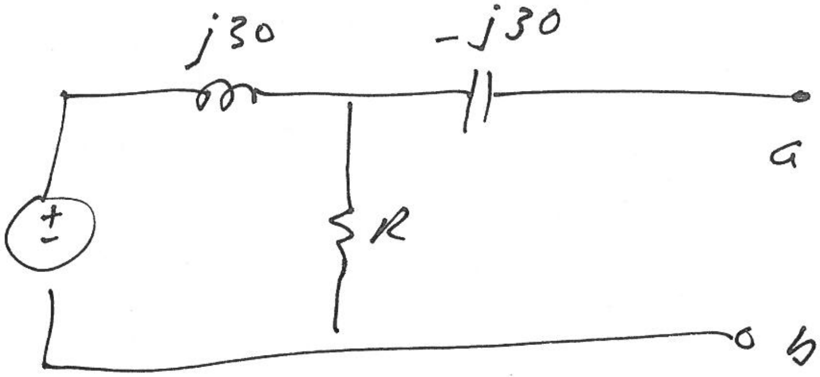
File Edit Hierarchy View Simulate Tools Window Help
problem_9_24.asc
problem_9_24.raw
Problem 9.24
C1
50µ
V1
AC 1
R1
400
L1
400m
.ac oct 1000 1 1k



Zero phase at 36.566 HZ or 229 rad/s

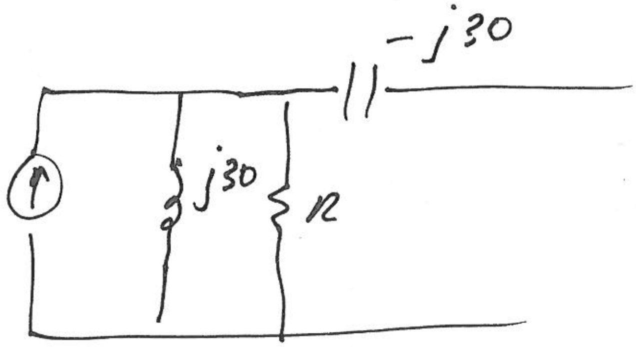
9.44

$180\angle 90^\circ$

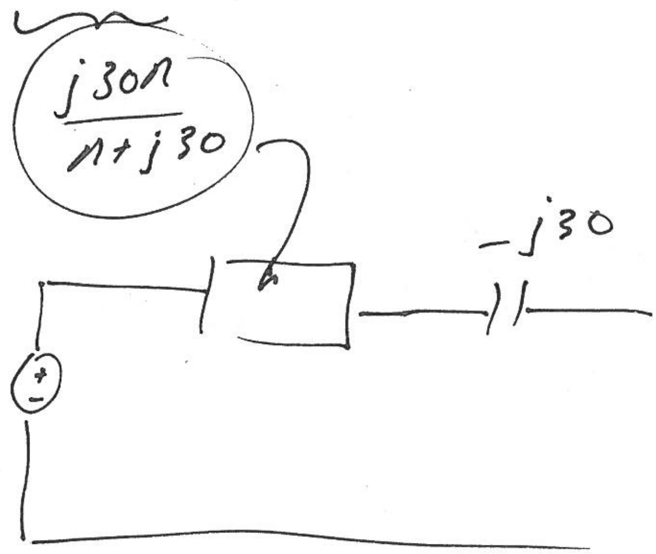


WANT: NORTON EQUIV

$$\frac{180\angle 90}{30\angle 90} = 6\angle 0^\circ$$



$$6\left(\frac{jR30}{R+j30}\right)$$



$$Z_{EQ} = \frac{jR30}{R+j30} - j30 = \frac{jR30 - j30(R+j30)}{R+j30}$$

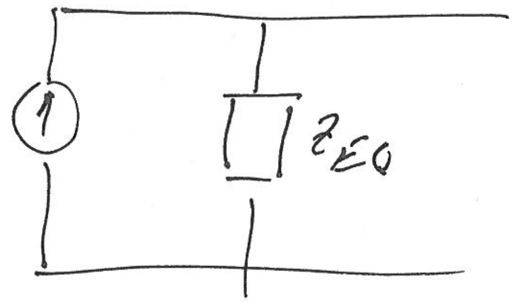
$$Z_{EQ} = \frac{900}{R+j30}$$

9.44, CONT'D.

$$6\left(\frac{j\Omega\, 30}{\Omega + j30}\right)\left(\frac{\Omega + j30}{900}\right)$$

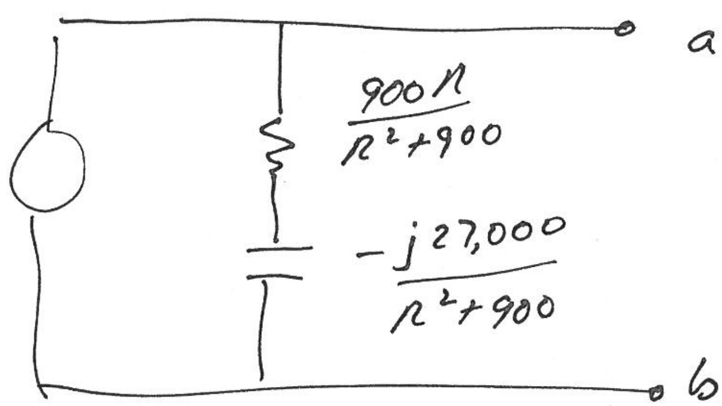
$$=$$

$$\frac{j\Omega}{5}$$

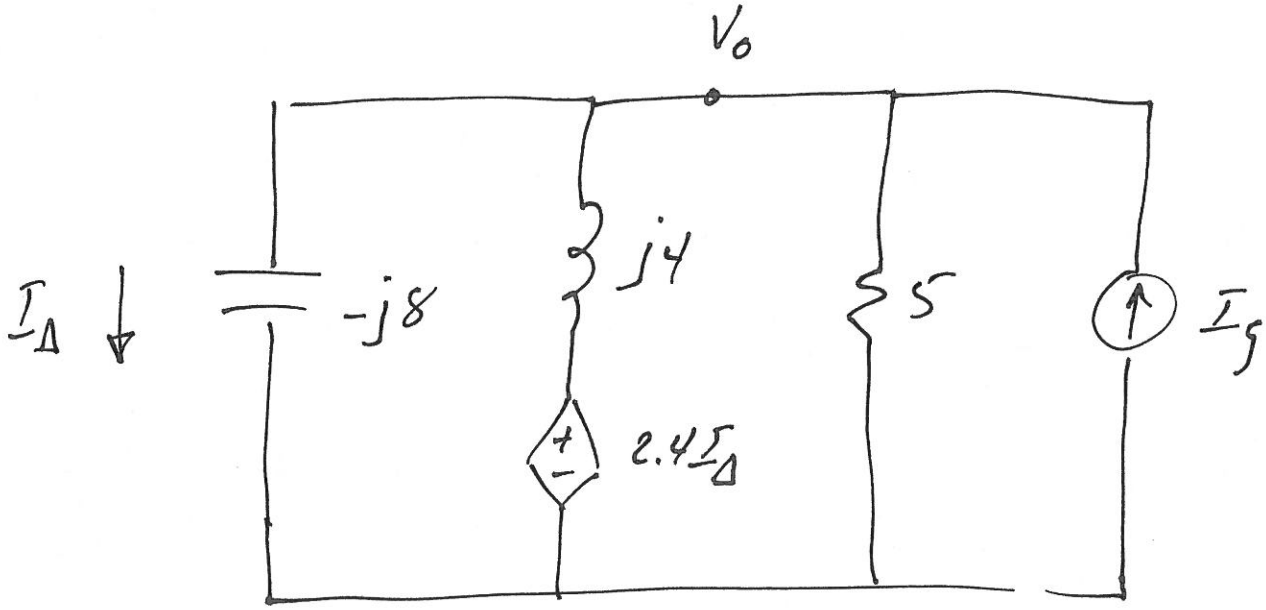


$$Z_{EQ} = \frac{900}{\Omega + j30}\left(\frac{\Omega - j30}{\Omega - j30}\right) = \frac{900\Omega - j27{,}000}{\Omega^2 + 900}$$

$$\frac{j\Omega}{5} = \frac{\Omega}{5}\angle 90^\circ$$



9.58



$I_g = 12 + j12$

NODAL FOR V_o:
$$\frac{V_o - 2.4 I_\Delta}{j4} + \frac{V_o}{5} - (12 + j12) + I_\Delta = 0$$

BUT $I_\Delta = V_o / -j8$

$$\frac{V_o - 2.4\left(\frac{V_o}{-j8}\right)}{j4} + \frac{V_o}{5} - (12 + j12) - \frac{V_o}{j8} = 0$$

$$\frac{V_o + \frac{0.3V_o}{j}}{j4} + \frac{V_o}{5} - 12 - j12 + j\frac{V_o}{8} = 0$$

$$V_o - j0.3V_o + \frac{V_o}{5}(j4) - (12+j12)(j4)$$

$$+ j\frac{V_o}{8}(j4) = 0$$

$$V_o(1 - j0.3 - 0.5 + j0.8) = (12+j12)j4$$

$$V_o(0.5 + j0.5) = 48(-1+j)$$

$$V_o = \frac{96(-1+j)}{(1+j)}\,\frac{(1-j)}{(1-j)}$$

$$= \frac{90(-1+j+j+1)}{2} = j96$$

$$V_o = 96\angle 90^\circ$$

OR

$$V_o = j96$$