Ground – ICP (partial homework problem)

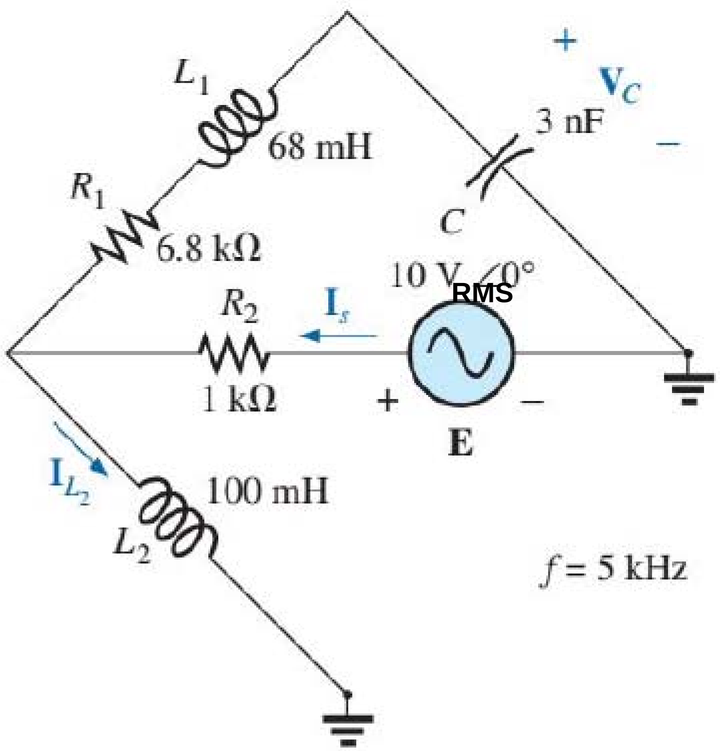

FIG. 17.45

Find: The source current **Is** and the voltage across L_2

One Strategy:

- Redraw the circuit in the phasor domain (f = 5kHz, connect the grounds, combine R_1, L_1 and C)
- Collapse the network about the source to find $\mathbf{Z_T}$ and hence **Is**
- Use voltage-divider to find $\mathbf{V_{L2}}$

At least one check-point

- **Is** on the order of $10V_{RMS}$/4k-Ohms?
- Is the circuit inductive?

NP

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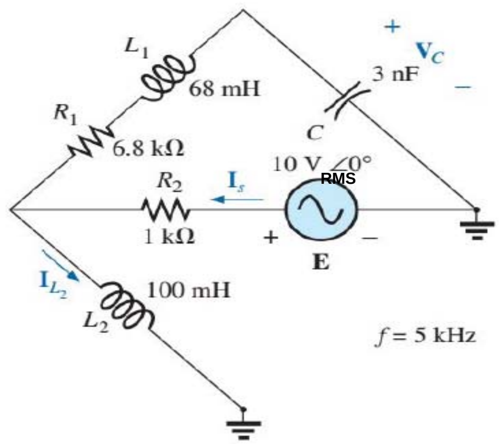
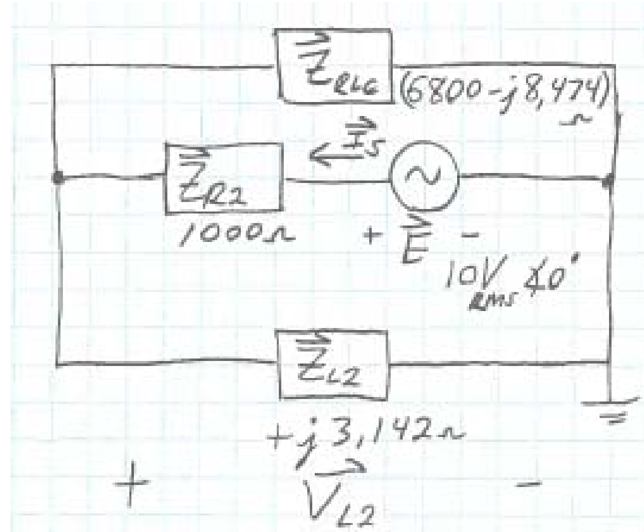


FIG. 17.45



Convert to the phasor domain

R_1, L_1, C : $\quad 68\,mH \rightarrow j2{,}136\,\Omega$

$\quad 3\,nf \rightarrow -j10{,}610\,\Omega$

$6800\,\Omega + j2{,}136\,\Omega - j10{,}610\,\Omega$

$\Rightarrow (6\,800 - j8{,}474)\,\Omega$

L_2 : $100\,mH \rightarrow j3{,}142\,\Omega$

Find $\mathbf{Z_T}$

$$\vec{Z}_T = \vec{Z}_{RLC} \,//\, \vec{Z}_{L2} + \vec{Z}_{R2}$$

$$= (6800 - j8474)\,\Omega \,//\, +j3{,}142\,\Omega + 1000\,\Omega$$

$$= (899 + j3{,}847)\,\Omega + 1000\,\Omega$$

$$\vec{Z}_T = (1{,}899 + j3{,}847)\,\Omega$$

OR

$$4{,}290\,\Omega \angle 63.7^\circ$$

NP

Ground – ICP (partial homework problem)

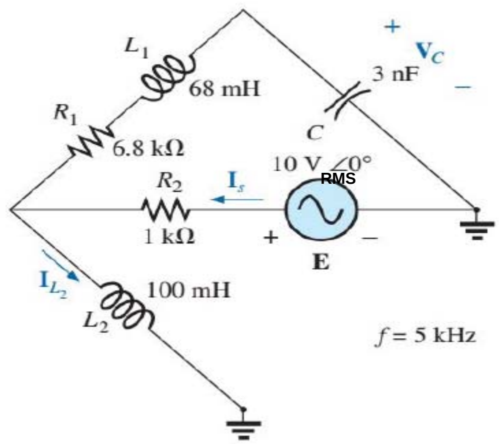
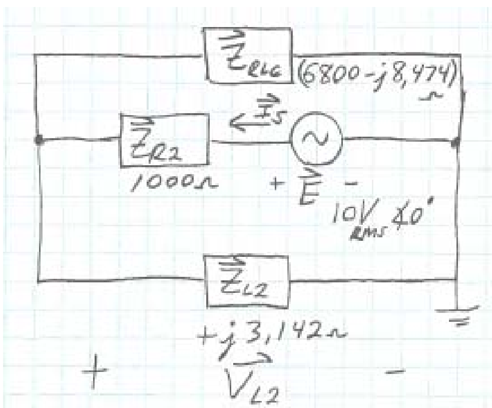


FIG. 17.45



$$\vec{Z}_T = (1,899 + j\,3,847)\,\Omega$$

OR

$$4,290\,\Omega \angle 63.7^\circ$$

Solve for **Is** and check the magnitude

$$\vec{I}_s = \frac{\vec{E}}{\vec{Z}_T} = \frac{10V_{RMS} \angle 0^\circ}{4,290\,\Omega \angle 63.7^\circ}$$

$$\boxed{\vec{I}_s = 2.33\,mA \angle -63.7^\circ}$$

ON THE ORDER OF 2.5mA ✓

($\vec{E}$ LEADS $\vec{I}_s$ BY 63.7°, INDUCTIVE)

Should **E** lead **Is**? Explain

Ground – ICP (partial homework problem)

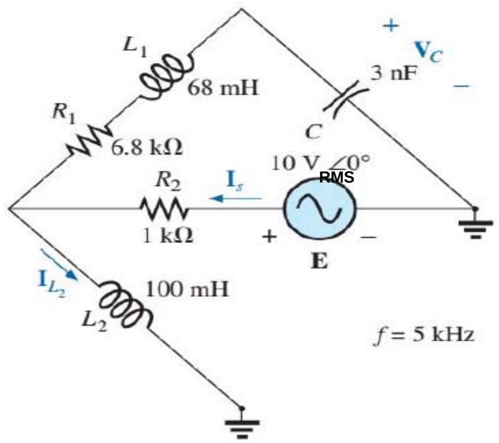
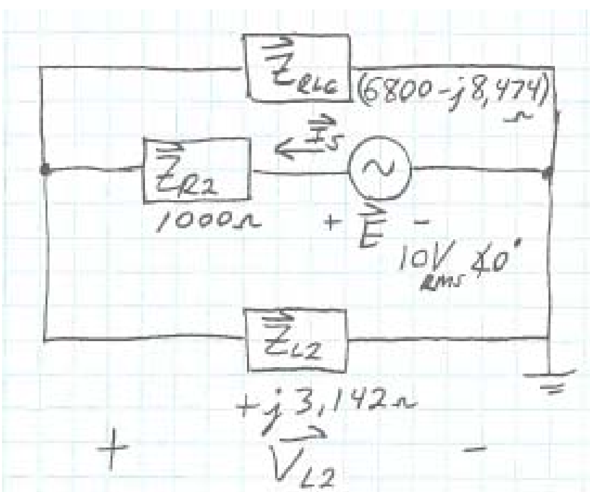
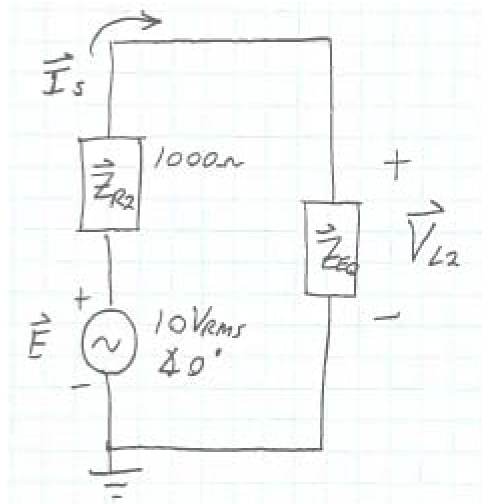


FIG. 17.45



Redrawing to use voltage divider



$$\vec{Z}_{EQ} = \vec{Z}_{RLC} \,//\, \vec{Z}_{L2}$$
$$= (6800 - j\,8474)\,\Omega \,//\, j\,3{,}142$$

$$\vec{Z}_{EQ} = (899 + j\,3{,}847)\,\Omega$$

OR

$$3{,}951\,\Omega \angle 76.8^\circ$$

Voltage Divider

$$\vec{V}_{L2} = \vec{E}\,\frac{\vec{Z}_{EQ}}{\vec{Z}_{EQ} + \vec{Z}_{R2}} = 10\,V_{rms}\angle 0^\circ \; \frac{3{,}951\,\Omega \angle 76.8^\circ}{\underbrace{(899 + j\,3{,}847)\,\Omega + 1000\,\Omega}_{4{,}290\,\Omega \angle 63.7^\circ}}$$

$$\therefore \boxed{\vec{V}_{L2} = 9.21\,V_{RMS} \angle 13.12^\circ}$$