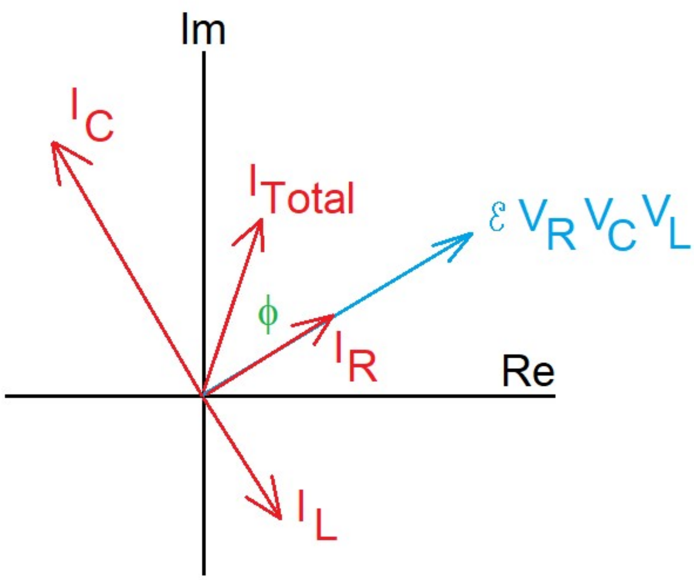
6-10 Soln)

The thing these four components have in common is their potential drops (they are in parallel), but each will have its own current, probably not in phase with any of the other currents.

The properties we determined in the derivation in class, still hold true:

Resistor	The current and potential drop are in phase.	$V_{R\,Max} = R\, I_{MAX}$
Capacitor	The current leads the potential drop.	$V_{C\,Max} = \chi_C\, I_{MAX}$; $\chi_C = 1/\omega C$
Inductor	The current lags the potential drop.	$V_{L\,Max} = \chi_L\, I_{MAX}$; $\chi_L = \omega L$



From this diagram, we see that

$$I_{total\,MAX} = \sqrt{I^2_{R\,MAX} + (I_{C\,MAX} - I_{L\,MAX})^2}$$

$$\frac{\mathcal{E}_{MAX}}{Z} = \sqrt{\frac{V^2_{R\,MAX}}{R^2} + \left(\frac{V_{C\,MAX}}{\chi_C} - \frac{V_{L\,MAX}}{\chi_L}\right)^2} \quad .$$

All of the voltage drops are the same as the *emf*, so

$$\frac{1}{Z} = \sqrt{\frac{1}{R^2} + \left(\frac{1}{\chi_C} - \frac{1}{\chi_L}\right)^2} \quad ,$$

which should make sense, since these are parallel. Cleaning up a little,

$$Z = \left(\frac{1}{R^2} + \left(\frac{1}{\chi_C} - \frac{1}{\chi_L}\right)^2\right)^{-1/2} = \left(\frac{1}{R^2} + \left(\omega C - \frac{1}{\omega L}\right)^2\right)^{-1/2} \quad .$$

The phase angle is then

$$\tan(\varphi) = \frac{I_{C\,MAX} - I_{L\,MAX}}{I_{R\,MAX}} = \frac{\frac{V_{C\,MAX}}{\chi_C} - \frac{V_{L\,MAX}}{\chi_L}}{\frac{V_{R\,MAX}}{R}} = \frac{\frac{1}{\chi_C} - \frac{1}{\chi_L}}{\frac{1}{R}} = R\left(\omega C - \frac{1}{\omega L}\right) \ .$$