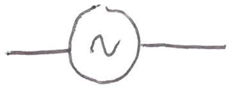
## AC  $i = I \sin(\omega t)$



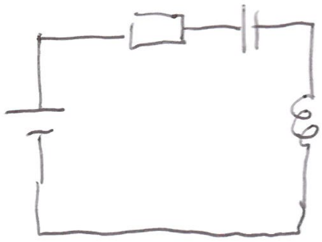
$i = I \sin(\omega t)$

**Resistance** : $v_R = V \sin(\omega t) = IR \sin(\omega t)$

**Capacitors** : $v_C = V \sin\left(\omega t - \frac{\pi}{2}\right) = \frac{I}{\omega C} \sin\left(\omega t - \frac{\pi}{2}\right) = I X_c \sin\left(\omega t - \frac{\pi}{2}\right)$

**Inductors** : $v_L = V \sin\left(\omega t + \frac{\pi}{2}\right) = I \omega L \sin\left(\omega t + \frac{\pi}{2}\right) = I X_L \sin\left(\omega t + \frac{\pi}{2}\right)$

**All together**   LRC circuit



$\rightarrow I e^{j\omega t}$

$\rightarrow V e^{j\omega t}$

$$\boxed{V = I\left(j\omega L + R + \frac{1}{j\omega C}\right) = I Z}$$

Equivalent ohm's law to use in AC

↳ complex impedence

$$Z_R = R$$

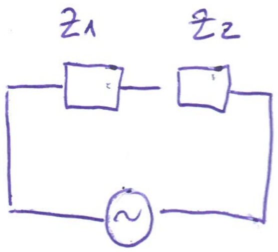
$$Z_C = \frac{1}{j\omega C} = -j\frac{1}{\omega C}$$

$$Z_L = j\omega L$$

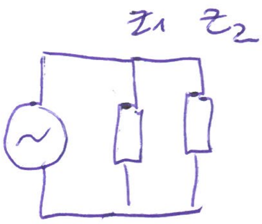
$$Z = R + j(X_L - X_C)$$

Now, V and I is a complex number

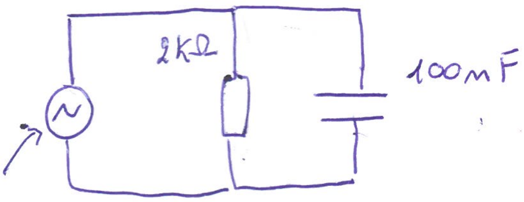
$$\tan\varphi = \frac{Im(Z)}{Re(Z)} \quad ; \quad V = |Z| I e^{i\varphi}$$




$$Z_{eq} = Z_1 + Z_2$$




$$\frac{1}{Z_{eq}} = \frac{1}{Z_1} + \frac{1}{Z_2}$$




$i = 5mA \sin(\omega t)$

$f = 1KHz$

$\omega = \frac{2\pi}{T} = 2\pi f = 2\pi\,(1KHz)$

a) $\frac{1}{Z} = \frac{1}{Z_R} + \frac{1}{Z_C} = \frac{1}{R} + j\omega C$

$$Z = \frac{R}{1+j\omega RC}\,\frac{(1-j\omega RC)}{(1-j\omega RC)} = \frac{R}{1+(\omega RC)^2} - j\,\frac{\omega R^2 C}{1+(\omega RC)^2}$$

$$= (775 - j\,974)\,\Omega$$

$$|Z| = \frac{1}{1+(\omega RC)^2}\sqrt{R^2+\omega^2 R^4 C^2} = \sqrt{775^2+974^2}\ \Omega = \boxed{1245\,\Omega}$$

b) Ohm's law

$$V = I \cdot Z = 5mA \cdot (775 - j\,974)\,\Omega = 3.875V - j\,4.87V$$

$$|V| = I \cdot |Z| = 5mA \cdot 1245\,\Omega = 6.23V$$

c) Ohm's law

$$I = \frac{V}{R} = \frac{V}{Z_R}$$

$$\rightarrow I = \frac{|V|}{R} = \frac{6.23V}{2000\,\Omega} = 3.12\,mA$$

d) $I = \frac{V}{Z_c} = V j\omega C$

$I = \frac{|V|}{Z_c} = |V| j\omega C = j \cdot 3.91\, mA$

e) $\phi = \tan^{-1}\left(\frac{Im\, Z}{Re\, Z}\right) = \tan^{-1}\left(\frac{-\omega C R^2}{(1+(\omega RC)^2)} \cdot \frac{1+(\omega RC)^2}{R}\right)$

$= \tan^{-1}(-\omega RC) = -51.4^\circ$