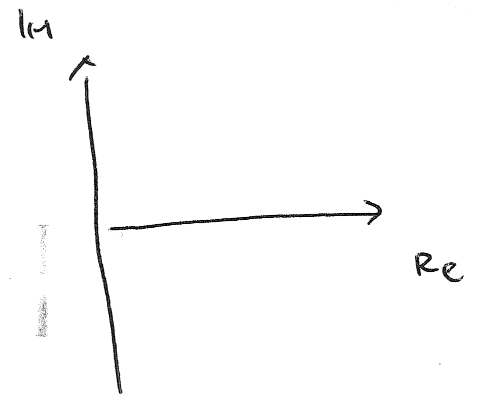
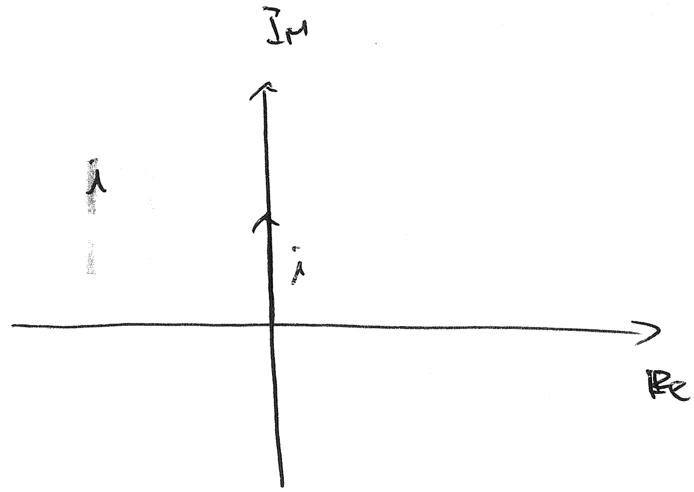
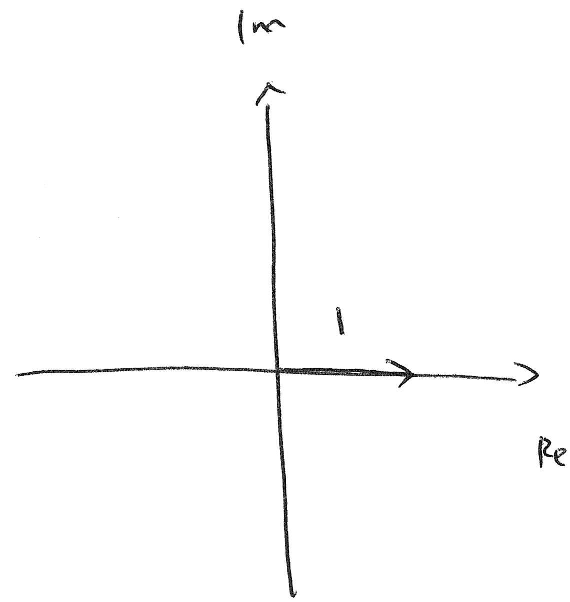
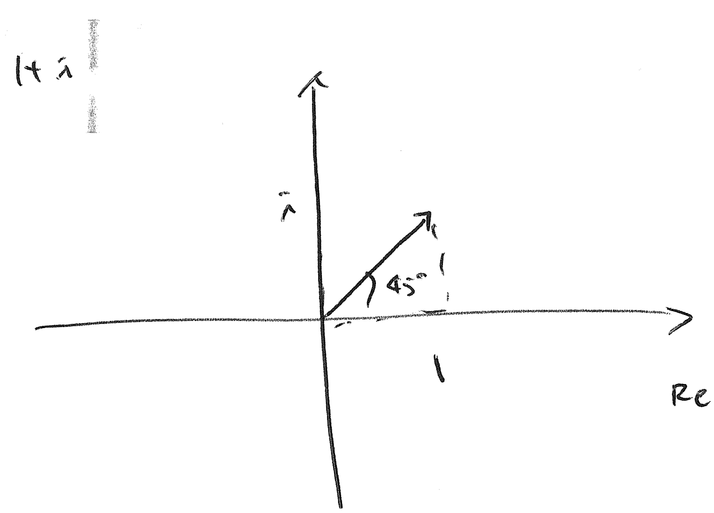
WHO'S BORED W/ PHYSICS?
COMPLEX NUMBERS INTENSE

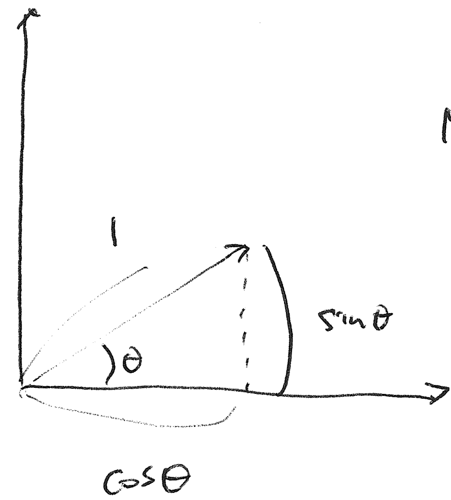
$i = \sqrt{-1}$











MAGNITUDE

$$\frac{\cos\theta + i\sin\theta}{}$$

↓

EULER RELATIONS

CLICKER!

$e^{-i\pi/2}$

a. $1 - i$

b. $1 + i$

c. $\frac{1}{\sqrt{2}} + \frac{i}{\sqrt{2}}$

d. $\frac{1}{\sqrt{2}} - \frac{i}{\sqrt{2}}$

EULER RELATIONSHIP

$$e^{i\theta} = \cos\theta + i\sin\theta$$

$$e^{-i\theta} = \cos\theta - i\sin\theta$$

$$\cos\omega t = \mathrm{Re}\, e^{i\omega t}$$

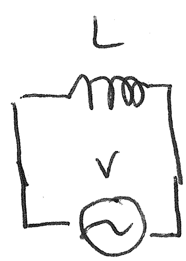
EXAMPLE

~~$V_M = V$~~ $V(t) = V_M \cos\omega t = V_M e^{i\omega t}$

$I(t) = I_M \cos(\omega t - \phi) = I_M e^{i(\omega t - \phi)}$

$$\frac{V(t)}{I(t)} = R? = \frac{V_M e^{i\omega t}}{I_M e^{i(\omega t - \phi)}} = \frac{V_M}{I_M} e^{i\phi}$$

O.K. TRY THIS



$$V(t) = V_M e^{i\omega t}$$

$$V(t) - L\frac{dI}{dt} = 0$$

$$V_M e^{i\omega t} - L\frac{dI}{dt} = 0$$

$$V_M e^{i\omega t} = L\frac{dI}{dt}$$

$$\frac{dI}{dt} = \frac{V_M}{L} e^{i\omega t}$$

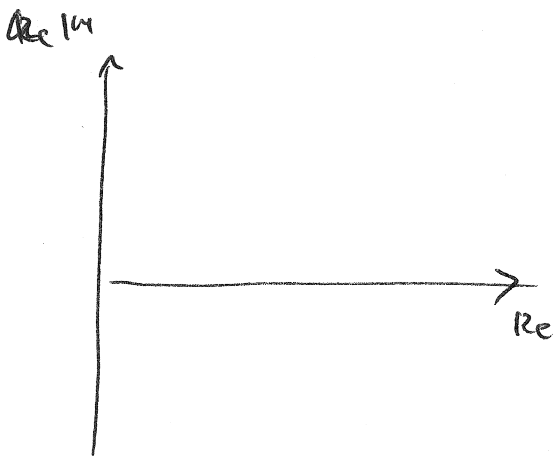
$$I(t) = \frac{V_M}{i\omega L} e^{i\omega t}$$

$$I(t) = \frac{-i V_M}{\omega L} e^{i\omega t}$$

$$-i = e^{-i\pi/2}$$

$$I(t) = \frac{V_M}{\omega L} e^{i(\omega t - \pi/2)}$$ LAGS!

COMPLEX NUMBERS



$$V = IR$$

$$Z_C = \frac{1}{i\omega C}$$

$$Z_L = i\omega L$$

COMPLEX IMPEDANCE

$$I(t) = \frac{V_M}{i\omega L} e^{i\omega t}$$

$$I(t) = \frac{V(t)}{i\omega L}$$

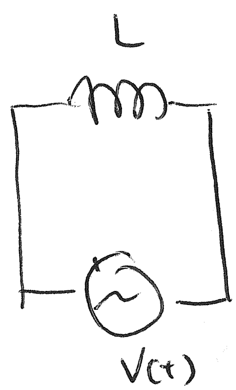
$$V(t) = I(t)\, i\omega L$$

$$V(t) = I(t)\, Z_L$$

$$\boxed{Z_L = i\omega L}$$

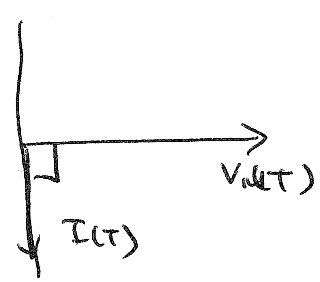
$$Z_C = \frac{1}{i\omega C}$$

HOW DO I USE IT?

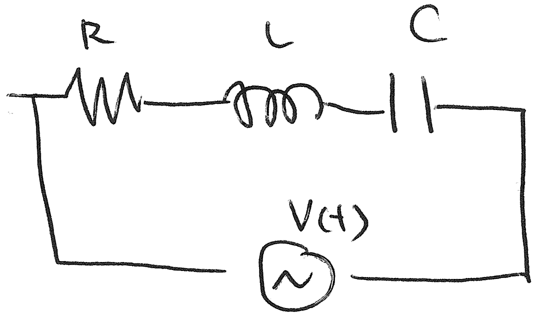


$$V(t) = I(t)\, i\omega L$$

$$I(t) = \frac{V(t)}{i\omega L} = -i\,\frac{V(t)}{\omega L}$$



90° LAGGING!



$$Z_{TOTAL} = R + i\omega L + \frac{1}{i\omega C}$$

$$= R + i\left(\omega L - \frac{1}{\omega C}\right)$$

$$|Z_{TOTAL}| = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

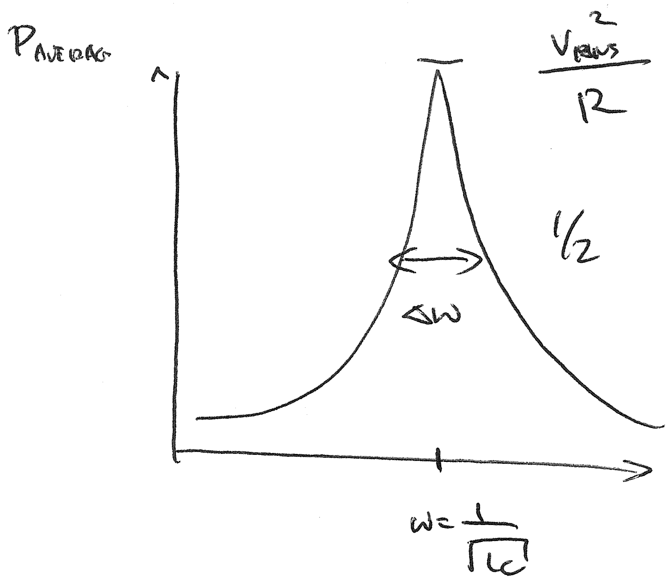
$$I(t) = \frac{V_m(t)}{Z_{TOTAL}}$$

$$= V(t) \frac{R - i\left(\omega L - \frac{1}{\omega C}\right)}{\left[R + i\left(\omega L - \frac{1}{\omega L}\right)\right]\left[R - i\left(\omega L - \frac{1}{\omega C}\right)\right]}$$

$$= V(t) \frac{R - i\left(\omega L - \frac{1}{\omega C}\right)}{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

$$I(t) = V_m \, e^{i(\omega t - \phi)}$$

$$\phi = \tan^{-1} \frac{\left(\omega L - \frac{1}{\omega C}\right)}{R}$$



P AVERAGE
V RMS 2
R
1/2
Δω
ω = 1 / √LC

$$P(t) = I_M V_M \left[\cos^2 \omega t \cos\phi + \sin(2\omega t) \sin\phi \right]$$

$$P_{AVE\ EF} = I_M V_M \frac{1}{2} \cos\phi$$

$I_M V_M$

$$P_{AVE} = \frac{V_M^2}{|Z|} \frac{1}{2} \cos\phi = \frac{1}{|Z|} V_{RMS}^2 \cos\phi$$

$\cos\phi$ POWER FACTOR

RLC CIRCUIT

$$P_{AVERAGE} = \frac{1}{|Z|} V_{RMS}^2 \cos\phi$$

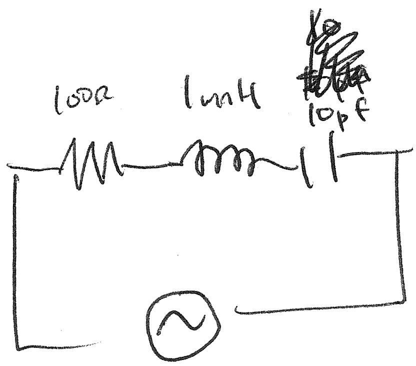
$\cos\phi =$

$$= \frac{V_{RMS}^2}{\sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2}} \cdot \frac{R}{\sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2}}$$

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

$$Q = \frac{\omega_0}{\Delta\omega}$$

$$Q = \frac{\omega_0 L}{R}$$



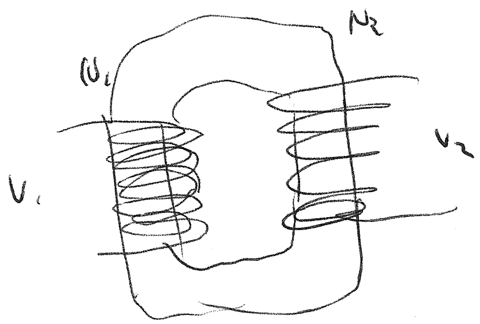
$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$$= \frac{1}{\sqrt{0.001\,H \times 10\times10^{-12}}} = \frac{1}{\sqrt{10^{-14}}}$$

$$\omega_0 = 10^7 \text{ RAD/s}$$

$$Q = \frac{10^7/s \;\; 1\times10^{-3}\,H}{100\,\Omega} = \frac{10^4}{100} = 100$$

TRANSFORMERS



Φ

$$V_2 = N_2 B_1 = -N_2 \frac{dB_1}{dt}$$

$$V_1 = -N \frac{dB_1}{dt}$$

$$B_1 = \mu_0 \frac{N_1}{l_1} I_1$$

$$V_2 = -\mu_0 \frac{N_1 N_2}{l_1} \frac{dI_1}{dt}$$