Phasors (sinusoidal steady state)

- transform your circuit
  - R, L, C → impedance
  - sources → phasors
  - currents, voltages → phasors
- solve circuit algebraically
  - Ohm's Law, KVL, KCL, superposition
- inverse transform your answer back to time domain

impedance (use Z to indicate impedance)

Z_R, Z_C, Z_L

$R \to R$

$C \to \frac{1}{j\omega C}$

$L \to j\omega L$

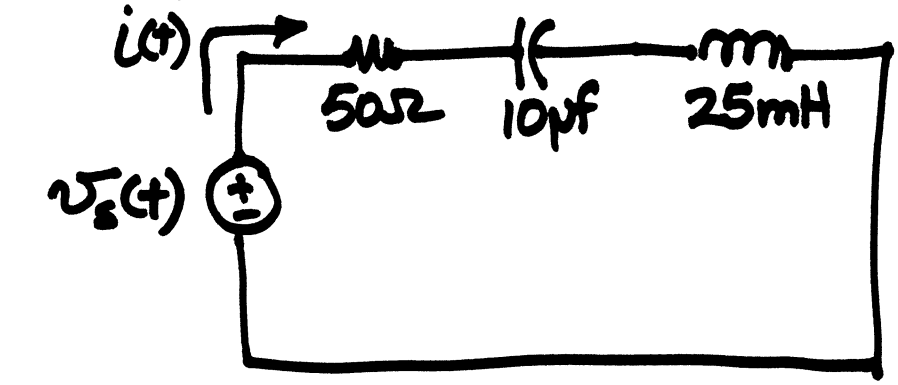
impedances behave just like resistances

impedances in series $Z_{EQ} = Z_1 + Z_2 + \dots + Z_N$

impedances in parallel $\frac{1}{Z_{EQ}} = \frac{1}{Z_1} + \frac{1}{Z_2} + \dots$

Example 8-6

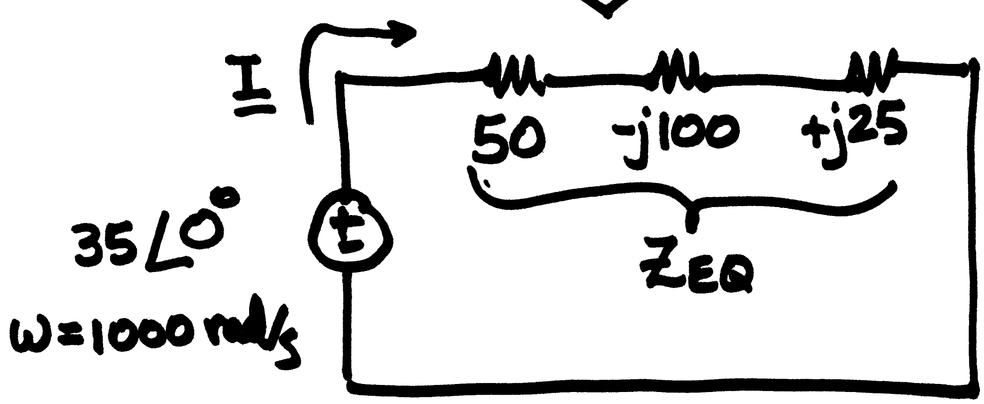
operating in sinusoidal steady state



$v_s(t) = 35\cos 1000t$

$\therefore$ we can use Phasors

$\Downarrow$ transform circuit



$Z_R = 50\,\Omega$

$Z_L = j\omega L$

$= j(1000)(25\times 10^{-3})$

$Z_L = +j25\,\Omega$

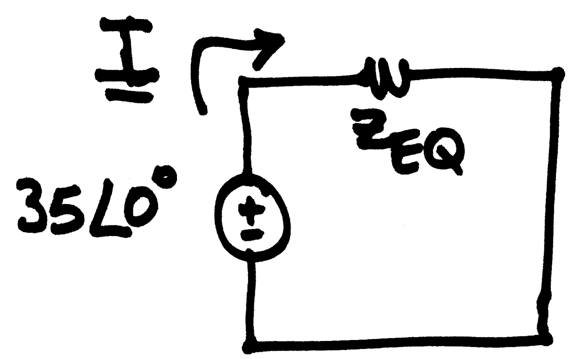
$Z_C = \frac{1}{j\omega C} = \frac{1}{j(1000)(10\times 10^{-6})}$

$Z_C = \frac{100}{j}\cdot\frac{j}{j} = -j100$

$\boxed{\frac{1}{j} \rightarrow -j}$

series: $Z_{EQ} = 50 - j100 + j25$

$= 50 - j75\ \Omega$



Ohm's Law $\underline{I} = \frac{35\angle 0^\circ}{Z_{EQ}} = \frac{35 + j0}{50 - j75} = 0.215 + j0.323$

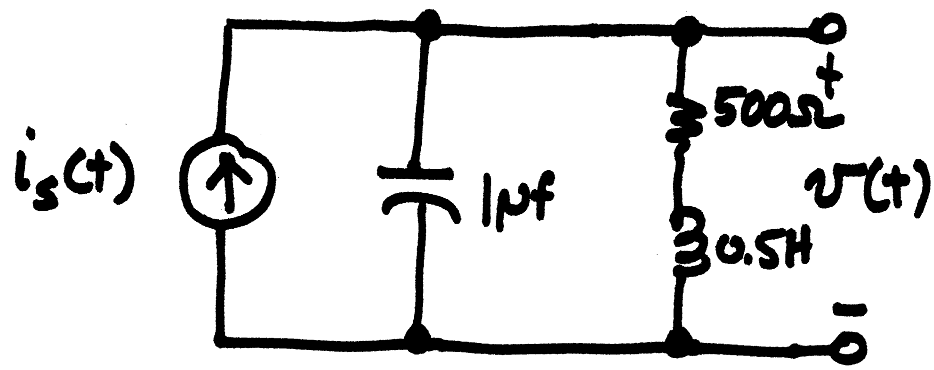
rect $\rightarrow$ polar

$\underline{I} = 0.388\angle +56.3^\circ$

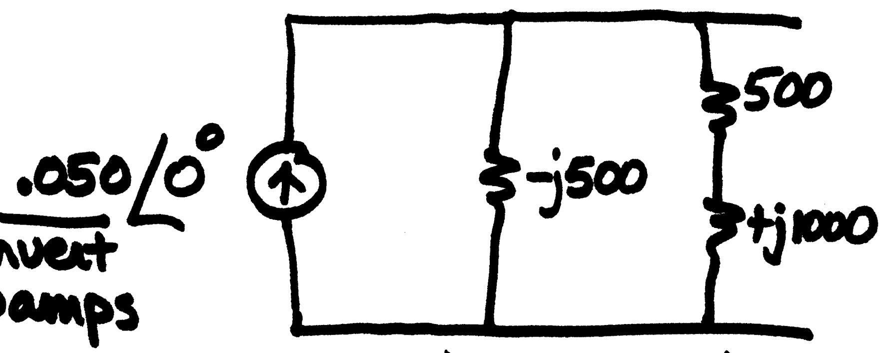
$i(t) = 0.388\cos(1000t + 56.3^\circ)$

Example 8-9

sinusoidal steady state
$i_s(t) = 50\cos 2000t$ mA



$\Downarrow$ phasors



convert to amps

Z_{EQ}

$Z_R = 500$

$Z_L = j\omega L$
$= j(2000)(0.5)$

$Z_L = +j1000$

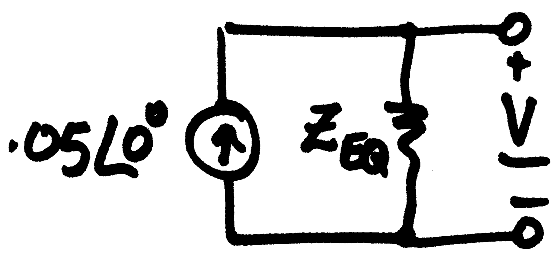
$Z_c = \frac{1}{j\omega c}$
$= \frac{1}{j(2000)(1\times 10^{-6})}$

$Z_c = \frac{500}{j} = -j500$

$Z_{EQ} = (-j500) \parallel (\underbrace{500 + j1000}_{\text{in series}})$

$$Z_{EQ} = \frac{(-j500)(500+j1000)}{-j500+500+j1000} = \frac{-j500(500+j1000)}{500+j500}$$

$Z_{EQ} = 250 - j750\ \Omega$



$\underline{V} = \underline{I}\, Z_{EQ} = (.05)(250 - j750)$

$\underline{V} = 12.5 - j37.5 \rightarrow 39.5\angle -71.6^\circ$

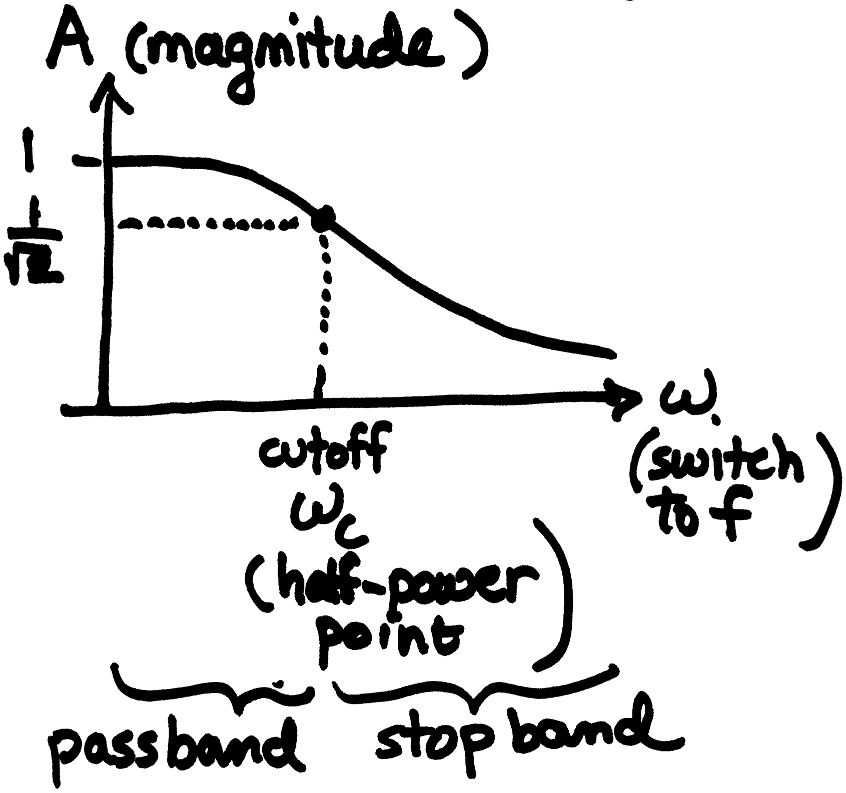
rectangular $\rightarrow$ polar

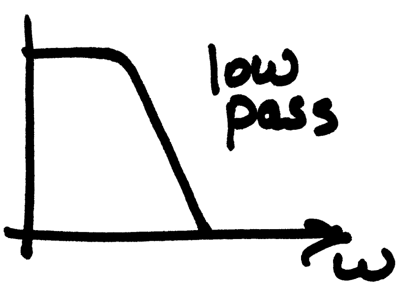
$v(t) = 39.5\cos(2000t - 71.6^\circ)$

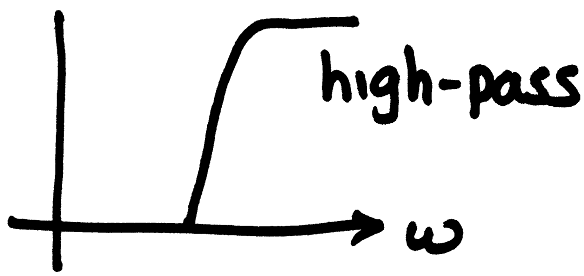
Chapter 12 – Frequency Response

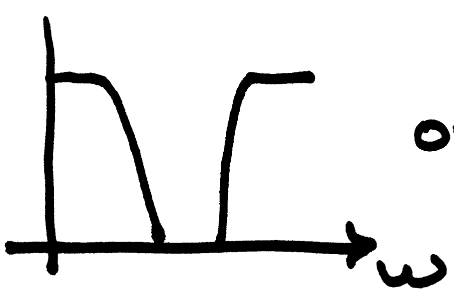
what happens when ω changes

Frequency response
(sinusoidal steady state)









or