Physics 326a-2011 Class 2 Thursday/Friday 9/1-2/11 Summary

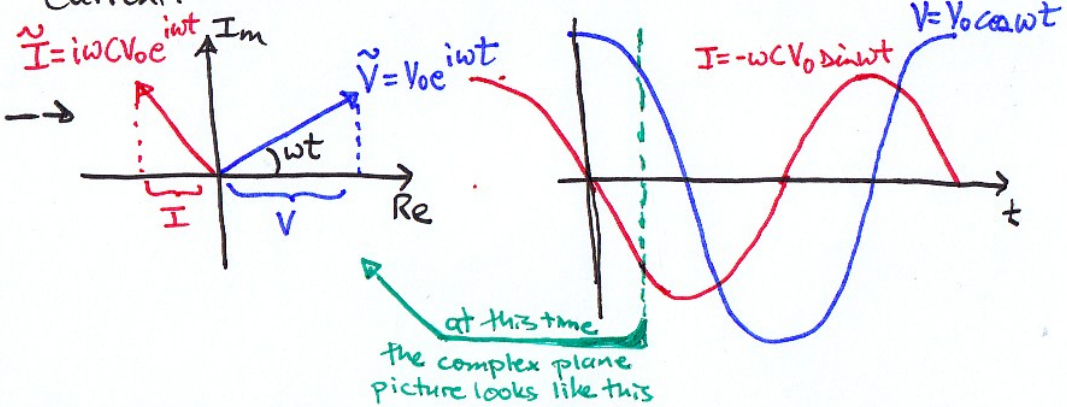
Complex version of Ohm's Law

$\tilde{V} = \tilde{I} Z$, where actual $V = \mathrm{Re}\,\tilde{V}$
actual $I = \mathrm{Re}\,\tilde{I}$

Impedance of a capacitor

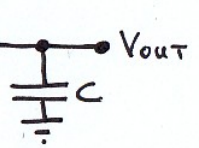
$\left.\begin{array}{l} \tilde{V} = \tilde{I} Z \\ Q = CV \end{array}\right\} \longrightarrow \boxed{Z_C = \frac{1}{i\omega C}}$ **

Apply $V = V_0 \cos\omega t$ to a capacitor. What is the resulting current?



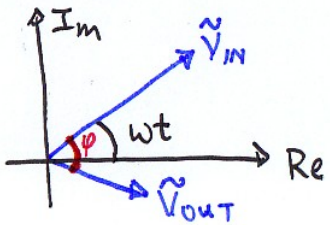
The current leads the voltage. (Must charge up the capacitor for voltage to appear.)

Phase shift in a low-pass filter

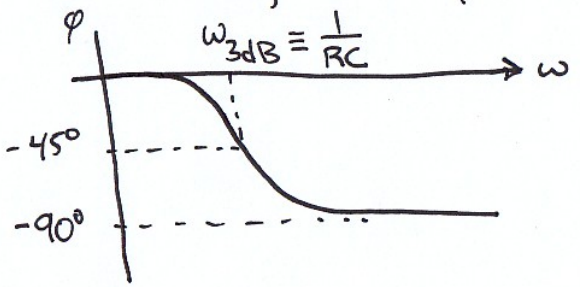


→ At low freq, $V_{OUT} = V_{IN}$ (no phase shift)
At high freq, phase shift → $-90°$.

At medium frequency:



One can show, for low-pass filter:



Decibels

$\boxed{dB \equiv 20 \log_{10} \frac{V}{V_{ref}} \Rightarrow V = V_{ref}\, 10^{dB/20}}$ **

→ change of 3dB ↔ factor of $\sqrt{2}$

→ at $\omega = \omega_{3dB}$, for low pass $\left|\frac{V_{OUT}}{V_{IN}}\right| = \frac{1}{\sqrt{2}}$

Note: $P \propto V^2 \Rightarrow$ 10 dB ↔ factor of $\sqrt{10}$ change in V
factor of 10 change in P

Bandwidth of an amplifier

The frequency at which the gain is reduced by $\sqrt{2}$

Better model for 10X probe