Approximate Graphical Analysis

1. Multiplication (linear) → Addition (log)
2. $\|\omega^n\|$ → $20(n)\log(\omega)$ → $20(n)$ dB/dec slope
3. "formulas" for pole/zero/complex pair
4. Approximation

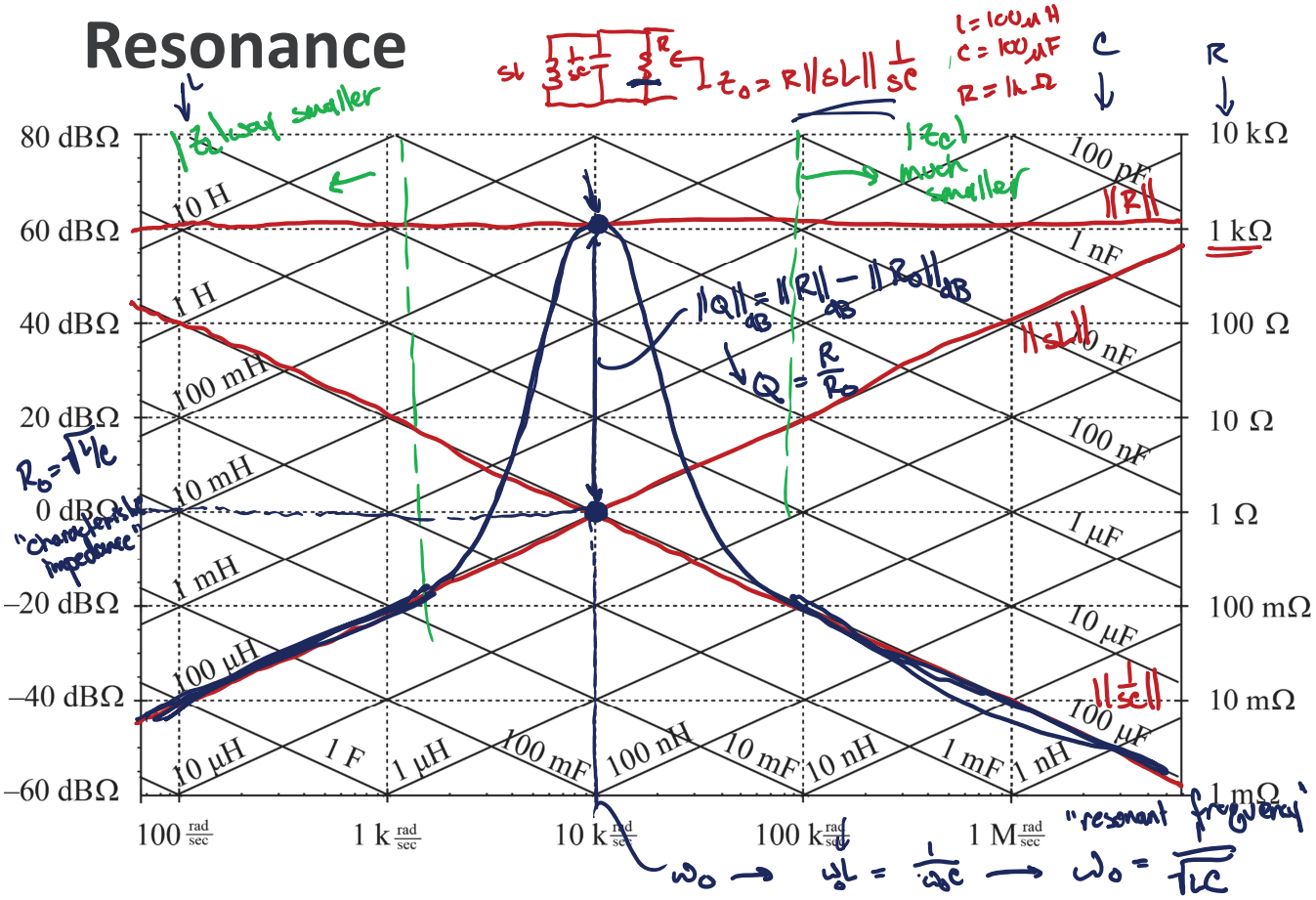
$\left\|\frac{\omega}{\omega_0}\right\| \rightarrow \|\omega\| - \|\omega_0\|$

Addition (linear) → max() (log)

↳ Series $|Z_1 + Z_2| = \begin{cases} |Z_1|, & |Z_1| \gg |Z_2| \\ \text{depends}, & |Z_1| = |Z_2| \\ |Z_2|, & |Z_1| \ll |Z_2| \end{cases}$

Parallel $|Z_1 \| Z_2| = \left|\frac{Z_1 Z_2}{Z_1 + Z_2}\right| = \begin{cases} |Z_2|, & |Z_1| \gg |Z_2| \\ \text{depends}, & |Z_1| = |Z_2| \\ |Z_1|, & |Z_1| \ll |Z_2| \end{cases}$

Resonance



$Z_0 = R \| sL \| \frac{1}{sC}$

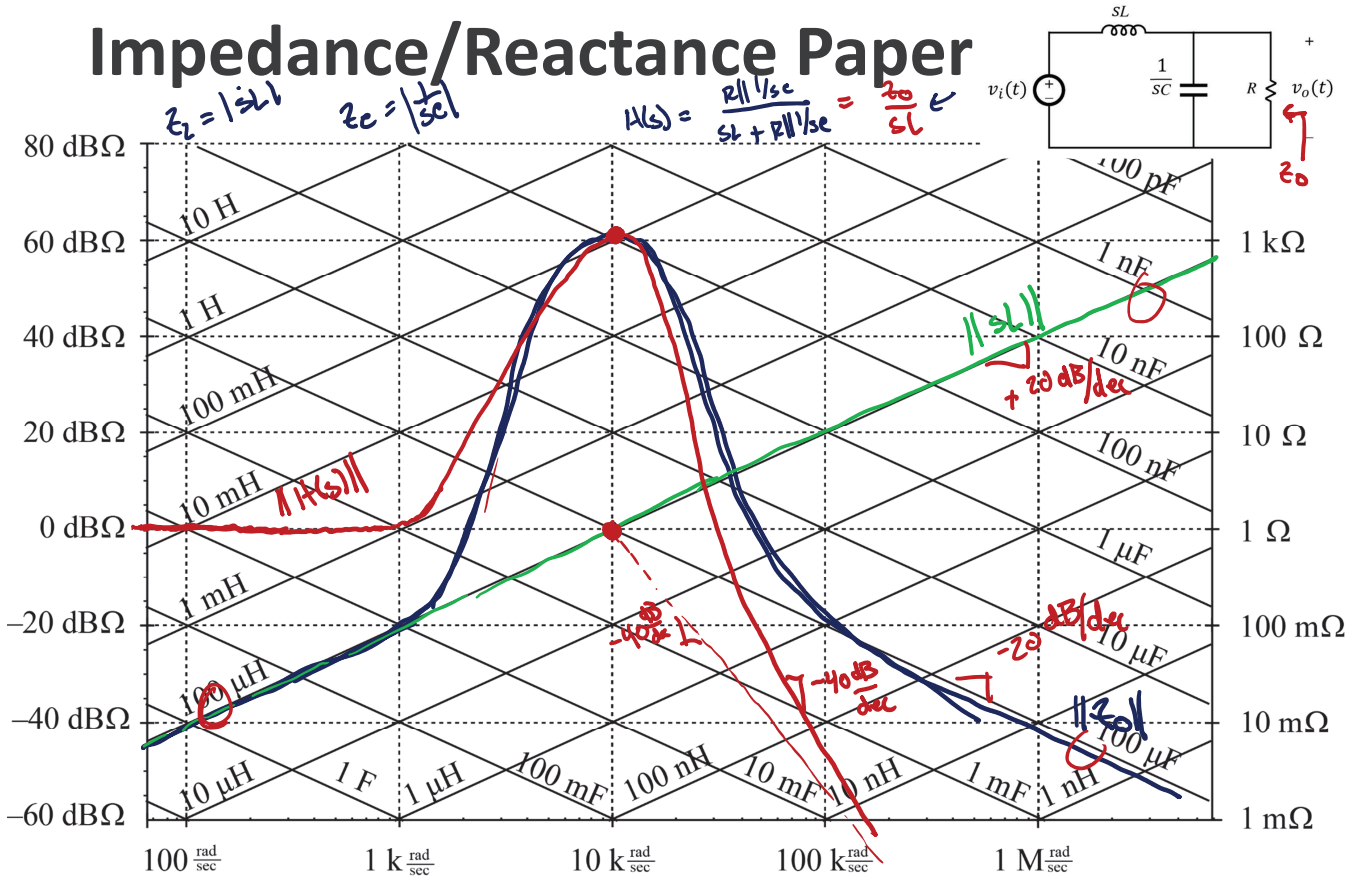
$\|Q\|_{dB} = \|R\|_{dB} - \|R_0\|_{dB}$

$Q = \frac{R}{R_0}$

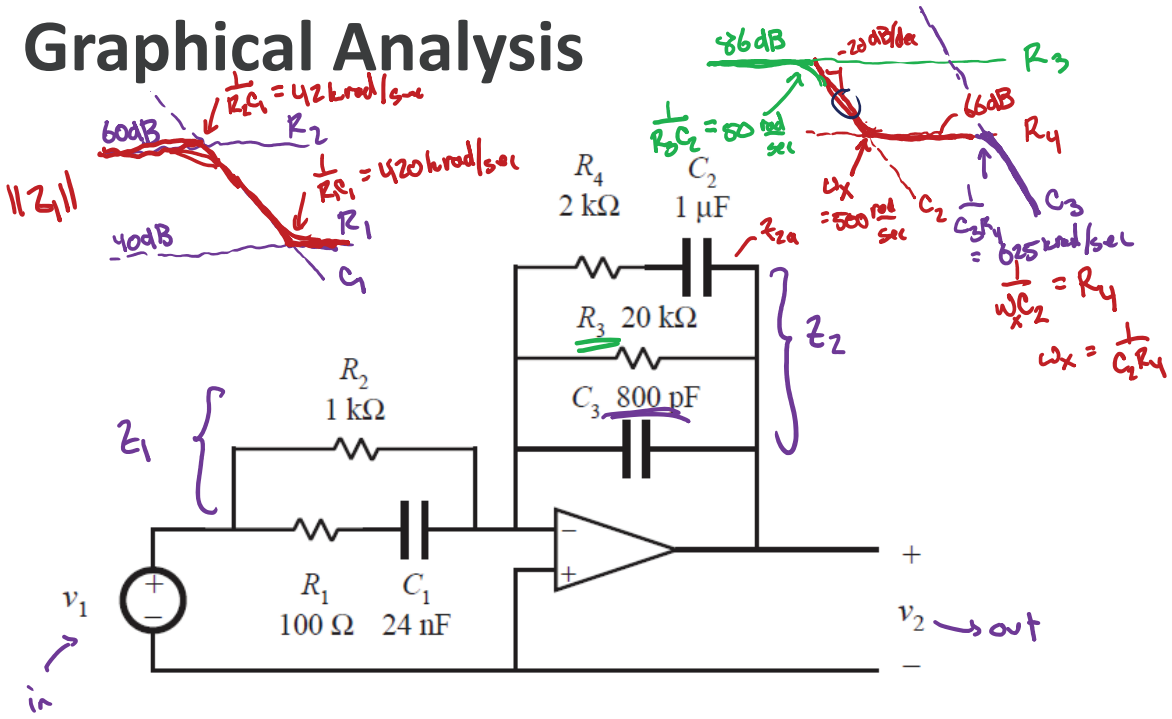
$R_0 = \sqrt{L/C}$

$\omega_0 \rightarrow \omega L = \frac{1}{\omega C} \rightarrow \omega_0 = \frac{1}{\sqrt{LC}}$

Impedance/Reactance Paper

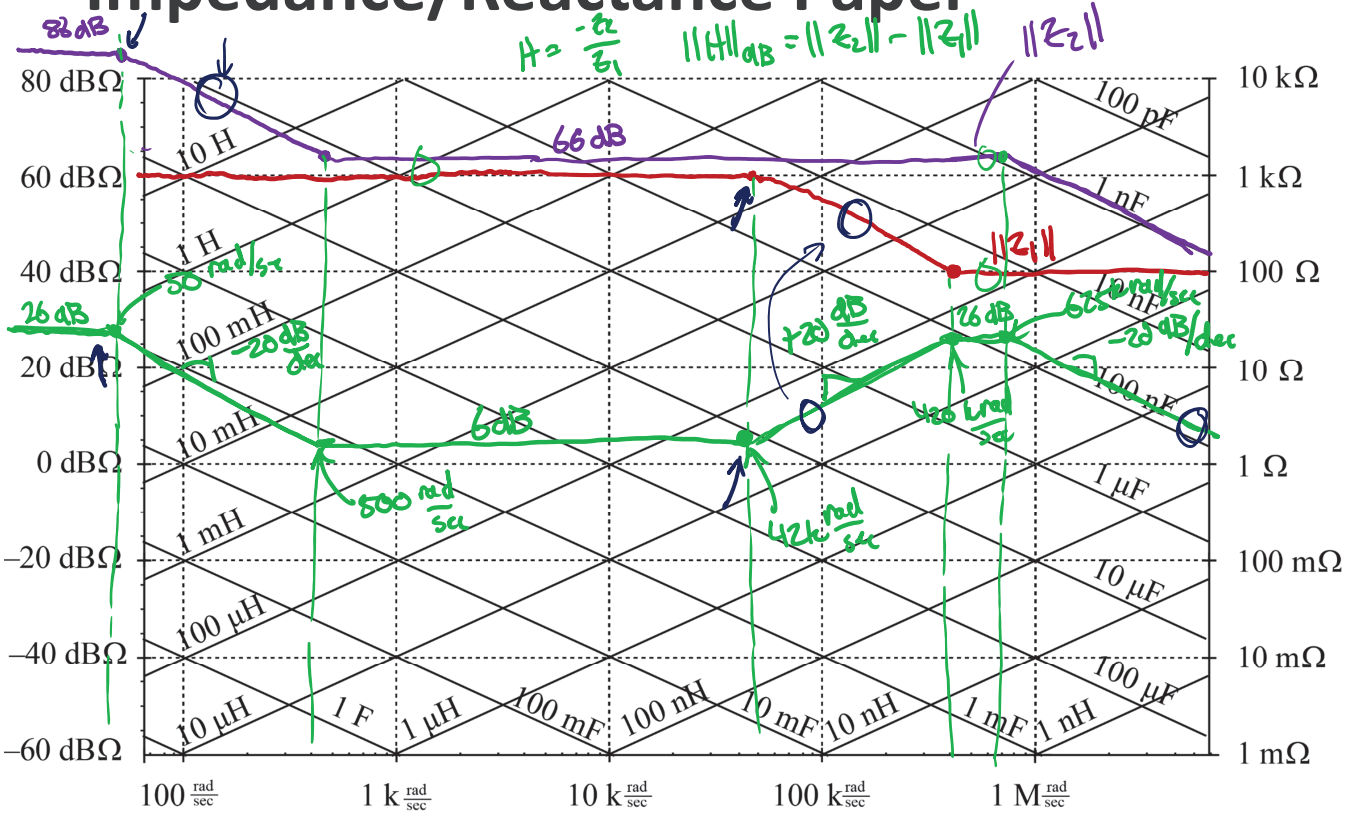


Graphical Analysis



$$A(s) = \frac{V_2(s)}{V_1(s)} = \frac{-z_2}{z_1}$$

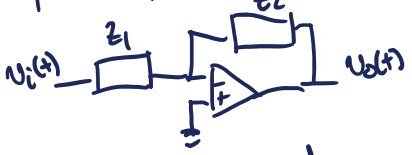
Impedance/Reactance Paper



Transfer Function Synthesis

Have some H(s) & want to realize it with a circuit

if all poles & zeros are real ⇒ can use just op-amp, R, C



$H(s) = \frac{-Z_2}{Z_1}$

any asymptotes going down at 20dB/dec realized with caps in Z_2

any asymptotes going up at +20dB/dec realized with caps in Z_1

"Height" depends on $||Z_2|| - ||Z_1||$ so $H(s) = \frac{Z_2}{Z_1} = \frac{10Z_2}{10Z_1} = \frac{kZ_2}{kZ_1}$

General design guidelines:

- very small R & large C increases power
- very large R & small C increases noise sensitivity