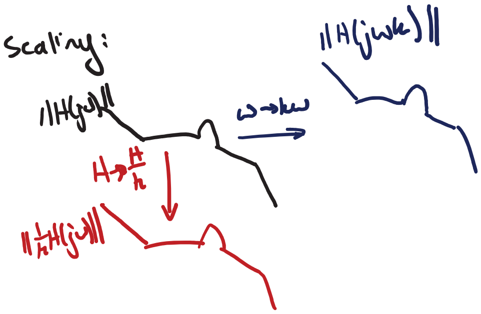
Scaling and Bandwidth

Scaling:



frequency Scaling

$\|H(j\omega)\| \to \|H(jk\omega)\|$

$R \to R$
$C \to C/k$
$L \to L/k$

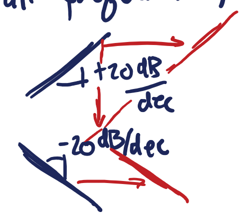
useful to miniaturize

$Z_R = R$ (same for all frequencies)

$Z_L = sL \Rightarrow j\omega L$

$j(\omega/k)L$

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



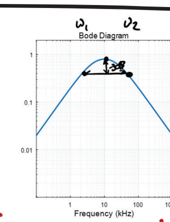
Magnitude Scaling

$\|H(j\omega)\| \to \frac{1}{k}\|H(j\omega)\|$

$R \to R\,{}^1\!/_k$
$C \to Ck$
$L \to L\,{}^1\!/_k$

Bandwidth = $|\omega_2 - \omega_1|$ → some range of frequencies

commonly "-3dB bandwidth" or "half power bandwidth"



For 2nd order resonance (complex pair)

$B = BW = \frac{\omega_0}{Q}$ Higher Q = Less B = More frequency selective

Filter Design

$H(s) = \underline{\ ---\ }$ → How to realize as a circuit

Approximate Graphical Analysis

- $\|H_1 \cdot H_2\|_{dB} = \|H_1\|_{dB} + \|H_2\|_{dB}$ Multiplication (linear) → Addition (log)
- $\|\omega^n\|_{dB} = 20(n)\log(\omega) \Rightarrow 20(n)$ dB/dec line
- $\|1 + jx\|_{dB} \simeq \begin{cases} \|x\|_{dB}, & x >> 1 \\ \sqrt{2} = -3\text{dB}, & x = 1 \\ 1, & x << 1 \end{cases}$

Addition (linear) $\simeq$ max( ) log (+ look at intersection)

Series $\|Z_1 + Z_2\|_{dB} = \begin{cases} \|Z_1\|_{dB}, & |Z_1| >> |Z_2| \\ \text{look closer}, & |Z_1| = |Z_2| \\ \|Z_2\|_{dB}, & |Z_1| << |Z_2| \end{cases}$

Parallel $\|(Z_1 \| Z_2)\|_{dB} = \left\| \frac{Z_1 Z_2}{Z_1 + Z_2} \right\|_{dB} = \begin{cases} \|Z_2\|_{dB} & |Z_1| >> |Z_2| \\ \text{look closer} & |Z_1| = |Z_2| \\ \|Z_1\|_{dB} & |Z_1| << |Z_2| \end{cases}$

Reactance Paper

find $Z_{eq} = sL \| \frac{1}{sC} \| R$

$L = 100\mu H$
$C = 100\mu F$
$R = 1k\Omega$