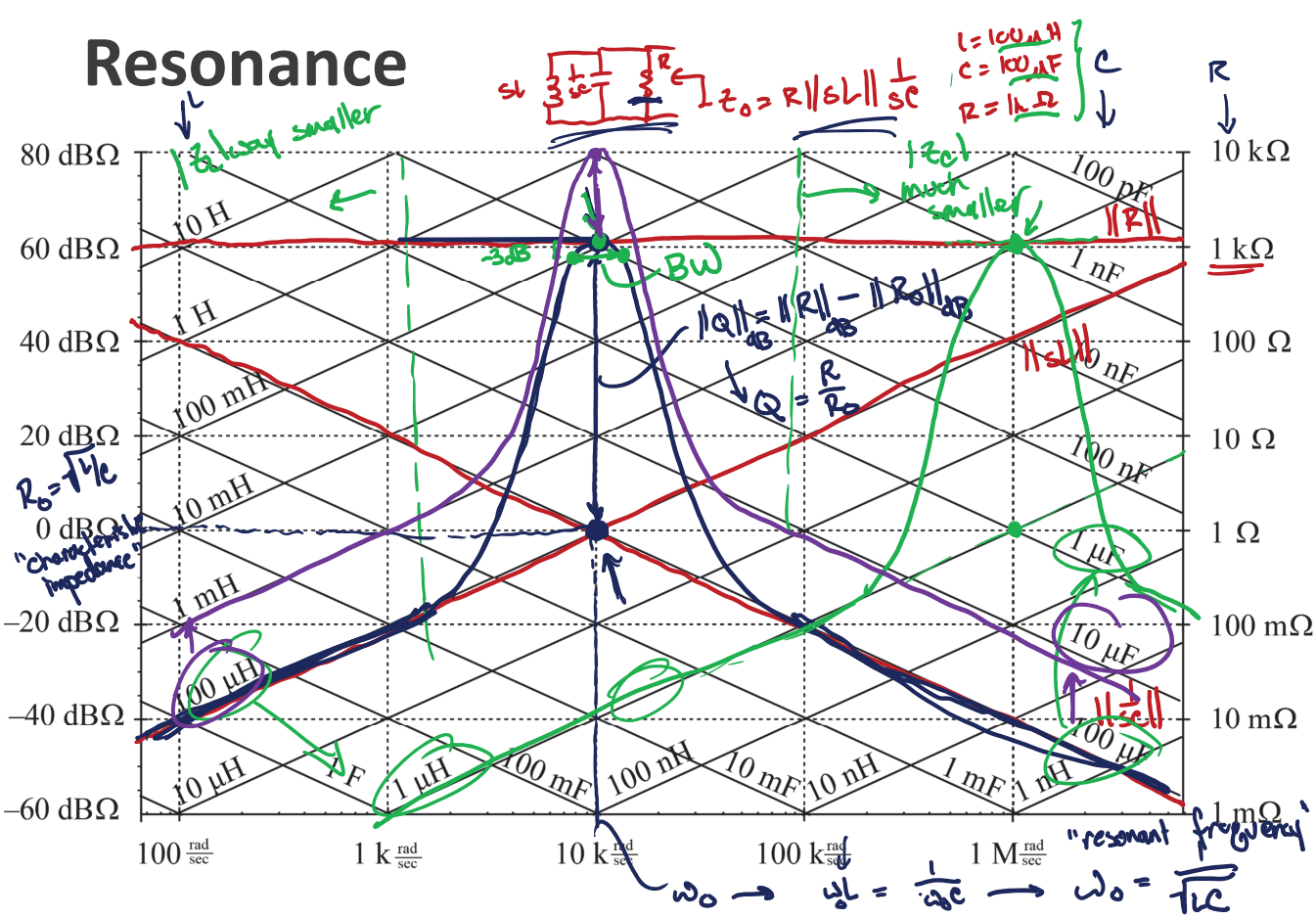
Announcements

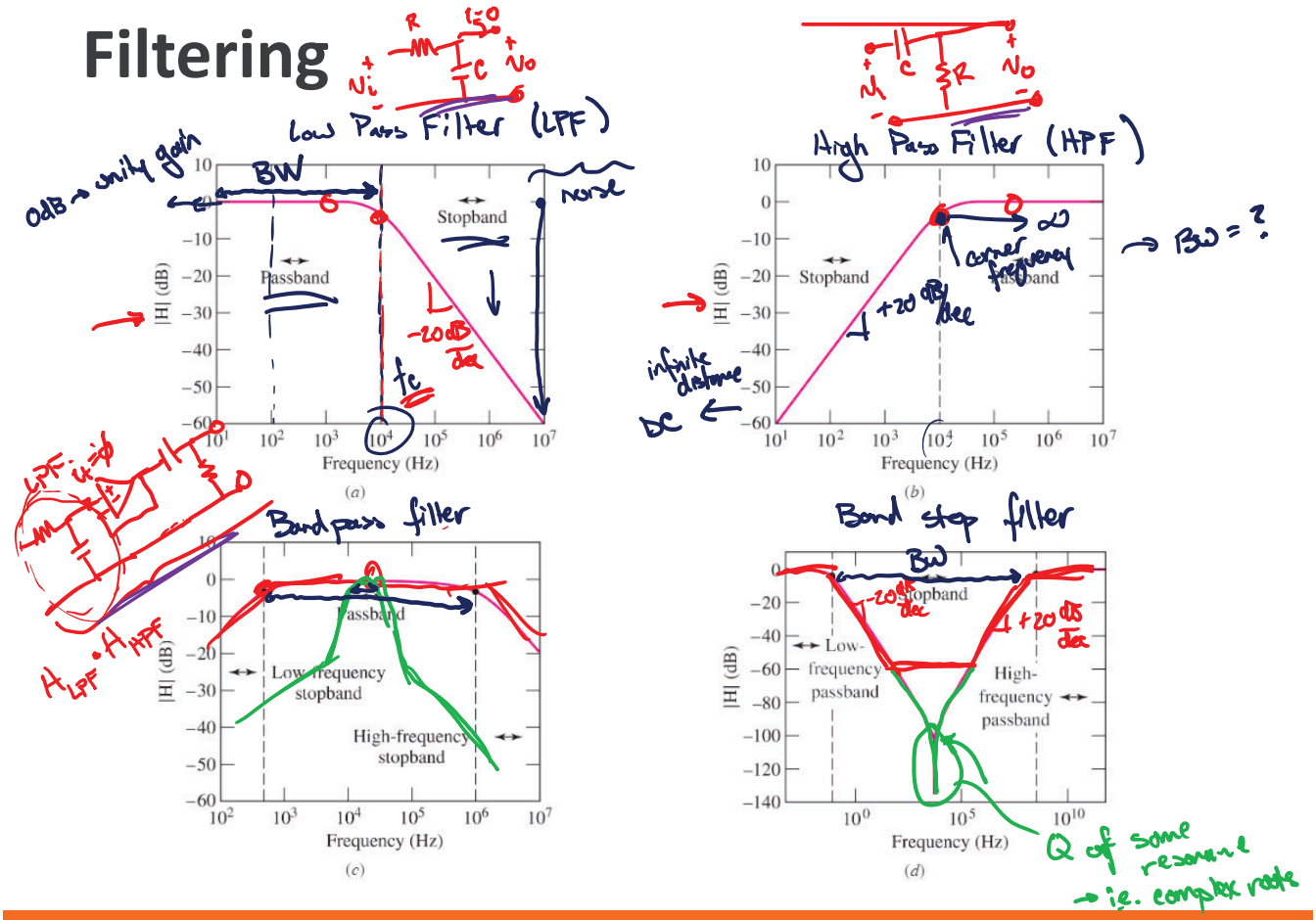
- HW10 posted, includes Quiz problem
  - Bode plots should be created by hand unless otherwise stated
- Experiment 2 discussion → Purely EC assignment
- TNvoice evaluations
  - 5 points EC on final if we get 100% participation

Slido: #Q711

Resonance



Filtering



Scaling and Bandwidth

Scaling (Impedances)

frequency scaling
$f \to kf$

$$\left\{\begin{array}{l} R \to R \\ L \to L/k \\ C \to C/k \end{array}\right\}$$

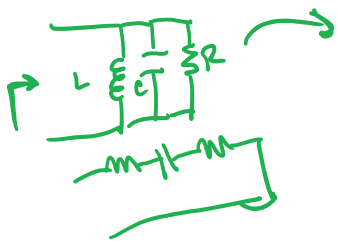
useful for miniaturization

Magnitude scaling
$Z \to kZ$

$$\left\{\begin{array}{l} R \to kR \\ L \to kL \\ C \to \frac{C}{k} \end{array}\right. \quad (Z \to kZ)$$

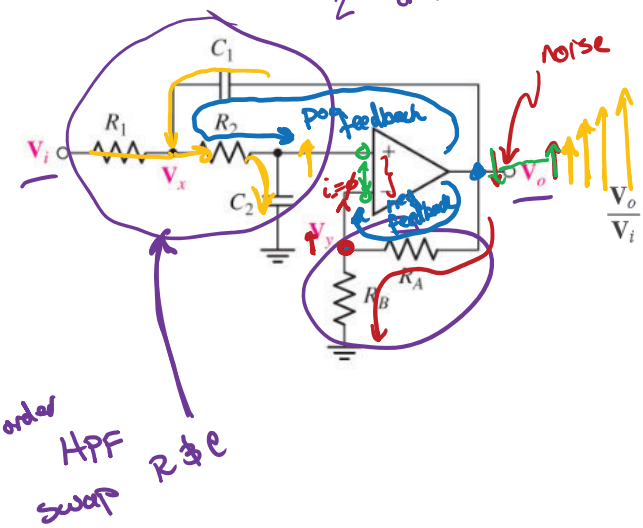
Bandwidth → width of a frequency range
→ "-3dB bandwidth"

$BW = \frac{\omega_0}{Q}$ ✓ → Higher Q = smaller bandwidth
"frequency selective"



The Sallen-Key Amplifier

2nd order LPF



$$G \equiv \frac{R_A + R_B}{R_B}$$

$$\frac{V_o}{V_i} = \frac{G/R_1R_2C_1C_2}{s^2 + \left[\frac{1}{R_1C_1} + \frac{1}{R_2C_1} + \frac{1-G}{R_2C_2}\right]s + \frac{1}{R_1R_2C_1C_2}}$$

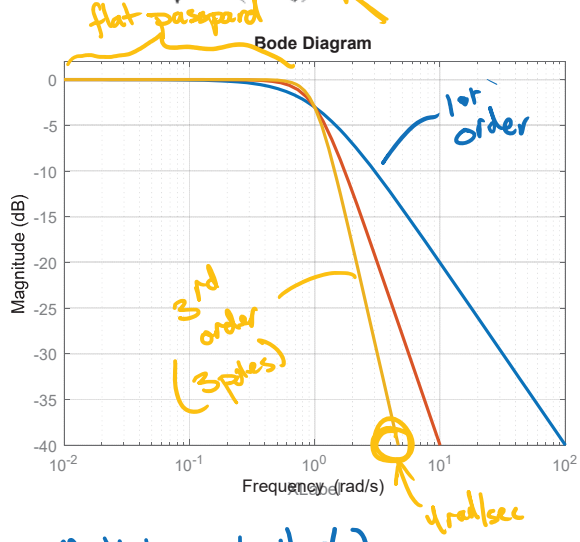
2nd order

Canonical 2nd Order Filter Designs

Butterworth

$$|\mathbf{H}(j\omega)| = \frac{K}{\sqrt{1 + (\omega/\omega_c)^{2n}}} \qquad n = 1, 2, 3, \ldots$$

flat passband

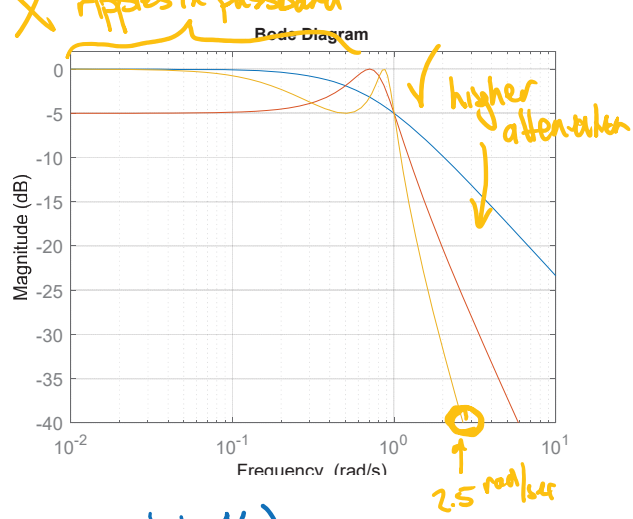


Matlab butter( )

Chebyshev

$$|\mathbf{H}(j\omega)| = \frac{K}{\sqrt{1 + \beta^2 C_n^2(\omega/\omega_c)}} \qquad n = 1, 2, 3, \ldots$$

X ripples in passband



cheby1( )