Discussion #3 02/11/2014

Inspection Formulas for Frequency-response analysis

1. Miller's theorem

\[ I_x = \frac{V_x - AV_x}{z_x} = \frac{V_x - 0}{z_y} \Rightarrow z_y = z_x \cdot \frac{1}{1 - A} \]

\[ AV_x - \frac{V_x}{z_x} = AV_x \Rightarrow z_x = -z_x \cdot \frac{A}{1 - A} \]

Now approximate \( H(s) \) with \( H_0 \) good for dominant pole.

2. Zero-Value (open circuit) time constants ZVTC

\[ \frac{1}{P_{ZVTC}} = \sum_{i=1}^{n_p} \tau_{p_i} = \sum_{i=1}^{n_p} C_i R_i \] with \( R_i \)-resistance seen by \( C_i \)

Dominant poles

3. Short-circuit time constant STC

\[ P_{STC} = \frac{1}{P_{STC}} \frac{1}{z_i} = \sum_{i=1}^{n_p} \frac{1}{z_i} \frac{1}{R_i \cdot C_i} \] with \( R_i \)-resistance seen by \( C_i \) when all other capacitors are short circuits.
Amplifier frequency response

1. Consider the bias domain
   - all parasitic caps are open
   - use SC TC to compute \( \omega_L \)

2. Consider the signal frequency domain
   - all bias caps are shorts
   - use 2VTC to compute \( \omega_H \)
   - use SC TC to compute the highest freq. pole
     (useful in 2-pole systems)

Remember: every independent reactive component introduces a pole.

\[
A_v = \frac{V_{out}}{V_{in}}
\]

\[
R_S = 500 \Omega
\]

\[
R_L = 1 \text{ k}\Omega
\]

\[
C_{GS} = 64.25 \text{ FF}
\]

\[
C_{AB} = 1.25 \text{ FF}
\]

\[
C_{BB} = C_{BB} = 0
\]

\[
\tau_A = R_S \left[ C_{GS} + \left( 1 + \frac{\frac{64.25}{500}}{\frac{1.25}{500}} \right) C_{BB} \right]
\]

\[
= 500 \left( 64.25 \text{ FF} + 2 \cdot 1.25 \text{ FF} \right) = 44.875 \text{ ps}
\]

\[
\tau_B = \frac{A}{\frac{64.25}{500}} \left[ C_{GS} + \left( 1 + \frac{\frac{1.25}{500}}{\frac{64.25}{500}} \right) C_{BB} \right]
\]

\[
= 50 \frac{A}{64.25} \left( 64.25 \text{ FF} + 2.41.25 \text{ FF} \right) = 4.2 \text{ ps}
\]
\[ P_1 = \frac{\lambda}{\sum_{i=1}^{\infty} \tau_i^S} = \frac{1}{C_{ab}R_s + C_{gs} \frac{R_s + R_{l1}}{1 + \beta_{m} R_{l1}}} \]

\[ \tau_1^S = R_s C_{gs} \]

\[ \tau_2^S = R_s C_{gs} \]

\[ R_{l1} = \frac{R_s}{1 + \beta_{m} R_{l1}} \]

\[ R_{l2}^S = R_{l1} || R_s \]

\[ P_2 = \frac{\lambda}{C_{gs} \frac{R_{l2}}{1 + \beta_{m} R_{l2}} + \frac{1}{C_{gs} \cdot R_{l2} || R_s}} \]