Lecture 30: Miller Effect & Other Amplifier Configurations

• Announcements:
  - HW#10 online soon and due next Friday
  - Lab#5 1st checkpoint due next week
  - Z-scores available soon
  - I hope you enjoyed the Panel Session on “Analog Mixed Signal Engineering” and found it informative

• Lecture Topics:
  - C.E. Design Project Hints
  - The Miller Effect
  - Other Amplifier Configurations
  - Generally-Loaded Transistor

• Last Time:
  - Did a first inspection analysis
  - Now, continue with lab hints ...

Intro. to Inspection Analysis (w/ Lab#5 hints)

Strategy:
1. Go nodo by nodo.
2. Get gains from one nodo to the next, then combine.
3. Account for next stage load resistance in each stage gain calculation.

Get SS Gain (midband)

\[
\begin{align*}
\frac{V_D}{V_S} &= \frac{R_F}{R_S} \\
\frac{V_D}{V_S} &= \frac{1}{1 + \frac{R_F}{R_S}} \\
\frac{V_D}{V_S} &= \frac{1}{1 + \frac{R_F}{R_S}}
\end{align*}
\]
Miller Effect & Other Amplifier Configurations

High Freq. Response:

\[ \frac{1}{\omega_0} = \frac{1}{\omega_0 + \tau_{FB}} = \frac{1}{R_0 C_0 + R_1 C_1 + C_m R_2} \]

\[ \tau_{DF} = C_m (R_1 + R_{FB}) \]

\[ \tau_{CO} = (C_{cs} + C_m) \frac{R_{r1} R_{r2}}{R_1 R_2} \]

\[ \tau_{FB} = \tau_{CO} \]

\[ \omega_H = \frac{C_{pi} R'}{C_{pi} R' + C_{rs} R_0 + C_m (R_1 + R_m R')} \]

Often most important, since \( R_{20} \) is huge!
The Miller Effect

⇒ useful to transform a ckt. with FB into a simpler ckt. (without FB)

Formal Derivation:

\[
\frac{i_1}{V_i} = \frac{i_2}{V_o} = Miller \quad \frac{V_i}{N_1} \quad \frac{V_o}{N_2} \quad X\text{formation}
\]

Find \( Y_1 \): (evaluate \( i_1 \) for both ckt.)

\[
Y_1 = Y(1-K)
\]

Find \( Y_2 \): (evaluate \( i_2 \) for both ckt.)

\[
Y_2 = Y(1-\frac{1}{K})
\]

No longer has FB makes analysis easier
• By merely altering the placements of input/output signals and bypass/coupling capacitors, one can realize other amplifier configurations

• Some examples:

\[ Z_0 = \frac{C_n + C_m + \frac{1}{1 + gm(R_{E} + R_c)}}{R_s} \]

\[ Z_0 = \frac{C_n + C_m + \frac{1}{1 + gm(R_{E} + R_c)}}{R_s} \]

All the same as previous analysis without the need to measure \( R_{2o} \) no need to draw an \( R_{2} \).