Lec 12 - MOS Top Review

Mos small signal again

- Review

- Connects to MOS Symmetry

Lab is office hours this week

|

- \( CS, SF, CG \)
- See below

- Multistage Practice
- Quick Puzzler

- Identical Stages
- \( R_{in} = R_{out} \)
- \( A_v = 20 \text{dB} \)
- Total gain?

- \( 3 \times 10^3 \) dB

Made model of MOSFET last time

\[
\begin{align*}
\text{Symbol} & \quad \text{Large signal} \quad \text{Small signal} \\
V_{gs} & \quad (V_{gs} - V_T) \\
V_{ds} & \quad (V_{ds} - V_T) \\
I_D & \quad \frac{I_D}{2} \\
\end{align*}
\]

Deriving \( g_m \) and \( r_o \) in saturation

\[
\frac{\partial I_D}{\partial V_{ds}} = \frac{m_n \mu C_{ox} (V_{gs} - V_T)(1 + \lambda V_{ds})}{2} \approx \frac{m_n \mu C_{ox} I_D}{2}
\]

\( \Rightarrow \) Note \( \sqrt{I_D} = \sqrt{\frac{m_n \mu C_{ox}}{2} (V_{gs} - V_T)^2 (1 + \lambda V_{ds})} \) \( \frac{V_{ds}}{2} \)

\( \Rightarrow \) Assume \( \lambda V_{ds} \) small

\[
\frac{\partial I_D}{\partial V_{gs}} = \frac{m_n \mu C_{ox}}{2} (V_{gs} - V_T)^2 \cdot \lambda \approx \lambda I_D
\]

PMOS

\[
\begin{align*}
V_{gs} & \quad - \\
V_{ds} & \quad + \\
G & \quad + \\
D & \quad -
\end{align*}
\]

- \( V_{gs} \)
- \( V_{ds} \)
- \( G \)
- \( D \)
- \( I_D \)
- \( \lambda I_D \)
Going to review Amp analysis by looking @ mos single stage amps.

- Want to talk a few general tips & tricks

**Tip:** Common structures

- Looks like \( \frac{1}{g_m} \)
- \( \frac{1}{g_c} \) controlling depth, sig. directly
- Hard to analyze
- Boosts to
- More gain
- Is feedback

- Boosts \( R_i \)
- Is feedback

**Tip:** parallel impedences

- Want Amp \( R_i, V_o \) too much mismatch
- Know \( R_i \) @ port \& \( R_i, R_2 \) in parallel w/ Thévenin impedance

Common source Review w/ input bias & find \( R_i, R_{out}, A_v \)

\[ R_{in} = R_i \times R_2 \quad \text{They do} \]

\[ R_{out} = R_0 \times R_0 \]

\[ A_v = -g_m \times R_C \]
- Note this analysis is very different from EEF
  - don't need to use $I_d$
  - Makes MOS look deceptively good, $\frac{g_m}{I_d}$ lower & input cap bigger

- This amp not common b/c $R_E$ already high
  - Does boost $R_{out}$ shows up in current mirrors

Common Gate neglecting $R_o$