ECE 523/421 – Analog Electronics

Lecture 20: Frequency Response: Examples of HF Analysis (CG & Cascode)

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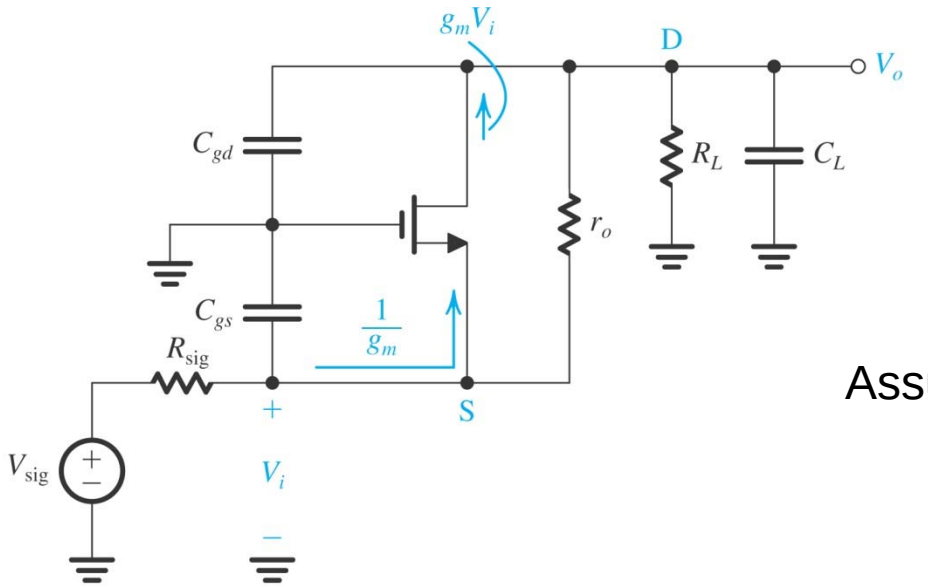
Review of Last Lecture

- **Open-circuit time constants to approximate f_H**
- **Miller Theorem**

Today's Lecture

- High frequency analysis of CG Circuit
- High frequency analysis of MOS Cascode Circuit
- High frequency analysis of BJT Cascode Circuit

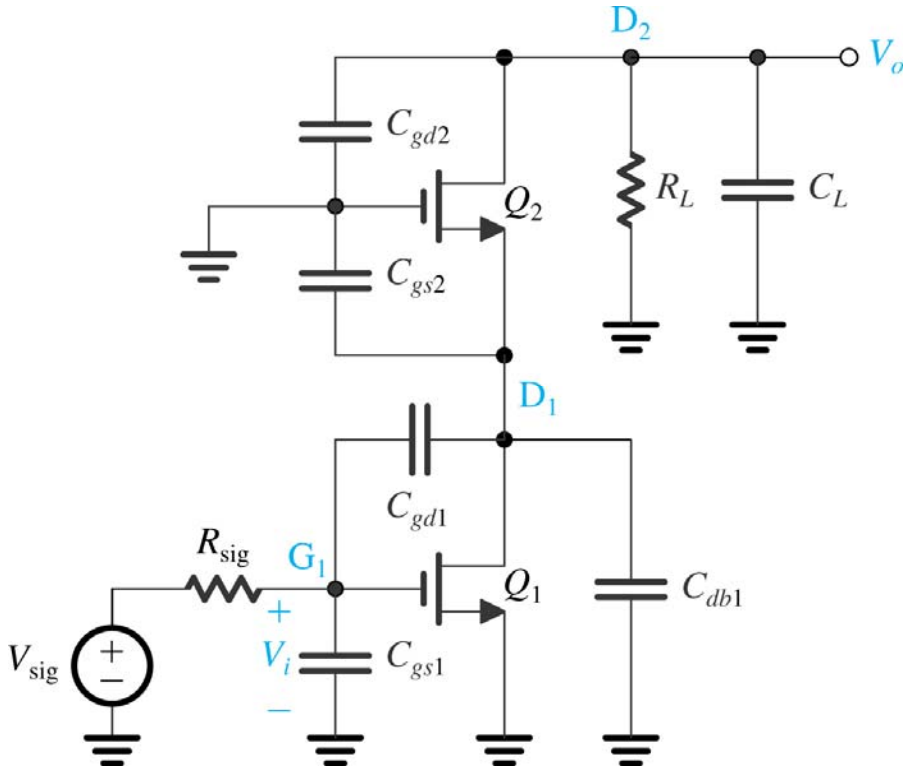
High Frequency Analysis of CG Circuit



Assuming large r_o

$$f_H \approx \frac{1}{2\pi}\frac{1}{\sum_i R_{io}C_i} = \frac{1}{2\pi}\frac{1}{C_{gs}\left(R_{sig}\left\|\frac{1}{g_m}\right.\right)+\left(C_{gd}+C_L\right)\left(R_L\right)}$$

High Frequency Analysis of MOS Cascode

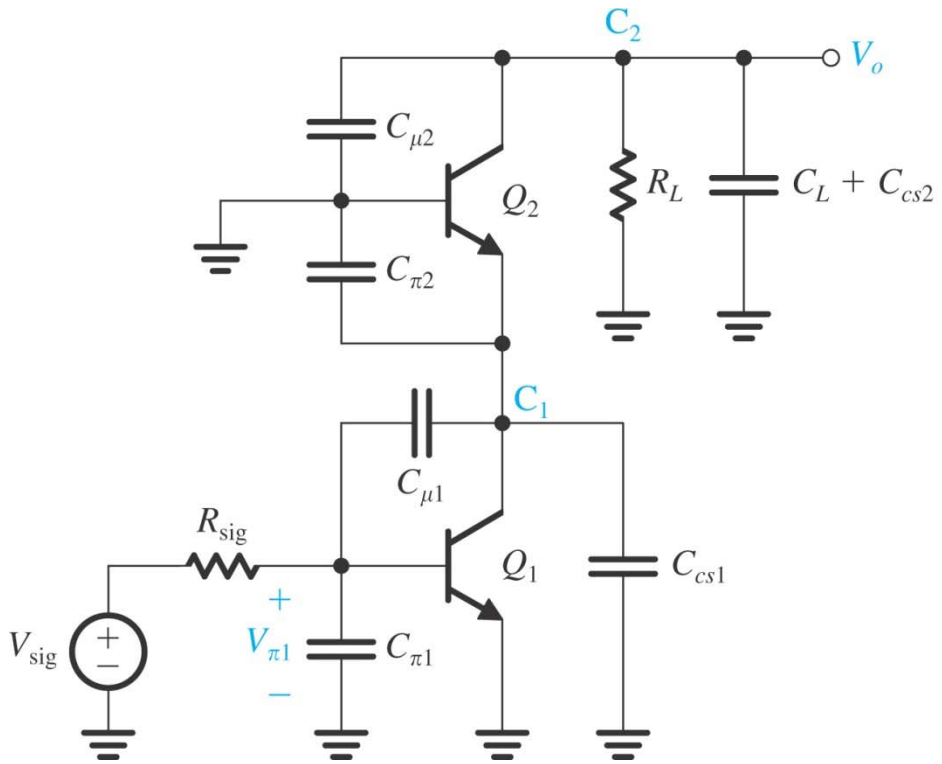


$$f_H \approx \frac{1}{2\pi\tau_H}$$

$$\begin{cases} R_o = r_{o1} + r_{o2} + (g_{m2}r_{o2})r_{o1} \approx (g_{m2}r_{o2})r_{o1} \\ R_{d1} = r_{o1} \left\| \dfrac{r_{o2} + R_L}{g_{m2}r_{o2}} \right. \end{cases}$$

$$\tau_H \approx R_{sig}\left[C_{gs1} + C_{gd1}\left(1 + g_{m1}R_{d1}\right)\right] + R_{d1}\left(C_{gd1} + C_{db1} + C_{gs2}\right) + \left(R_L \| R_o\right)\left(C_L + C_{gd2}\right)$$

High Frequency Analysis of BJT Cascode



$$R'_{\text{sig}} = r_{\pi 1} \| (r_{x1} + R_{\text{sig}})$$

$$R_{\pi 1} = R'_{\text{sig}}$$

$$R_{\mu 1} = R'_{\text{sig}}(1 + g_{m1}R_{c1}) + R_{c1}$$

$$R_{c1} = r_{o1} \left\| \left[r_{e2} \left(\frac{r_{o2} + R_L}{r_{o2} + R_L/(\beta_2 + 1)} \right) \right] \right.$$

$$\tau_H = C_{\pi 1}R_{\pi 1} + C_{\mu 1}R_{\mu 1} + (C_{cs1} + C_{\pi 2})R_{c1} + (C_L + C_{cs2} + C_{\mu 2})(R_L \| R_o)$$

$$R_o \simeq \beta_2 r_{o2}$$

$$f_H \simeq \frac{1}{2\pi\tau_H}$$

$$A_M = -\frac{r_\pi}{r_\pi + r_x + R_{\text{sig}}} g_m(\beta r_o \| R_L)$$