Lecture 4: Inspection Analysis

Announcements:
- Inspection formula sheet handed out in class
  - It's also online
- HW#1 due tomorrow at 8 a.m. in the EE140/240A box near 125 Cory
- No labs this week

Lecture Topics:
- Procedure for Small Signal Analysis
- Inspection Formulas
- 1-Tx Amplifier Examples

Procedure for Small-Signal Analysis

Ex. Discrete Common-Emitter Ckt.

![Circuit Diagram]

Want $R_x, R_o \approx \text{gm} = \frac{V_o}{I}$.

Procedure:

1. Find the DC operating pt. — get voltages & currents at all nodes & all branches, respectively

2. Determine the small-signal (s.s.) parameters for devices in the signal path (e.g., $g_m, r_i, ...$)

3. Convert the full ckt. to the s.s. ckt.
   - zero out the dc sources
   - DC voltage source → short
   - DC current source → open
   - short out large capacitors

4a. If needed, replace the Xrator w/ its model (e.g., hybrid-$\pi$, $T$, ...)
   - this should NOT be needed often
   - when is it needed? → generally, in cases where there is feedback!

4b. Analyze by inspection based on prior s.s. analysis experience!
   - Don't draw the hybrid-$\pi$ model!
   - This should be 99% of the time
Signal paths (to answer a question that came up)

Nonlinearities:
- $V_i \ll $ DC
- $V_o \rightarrow$ full signal
- $n_c \ll $ small-signal
- $V_c = V_i + n_c$

What did I not do? Did it draw the hybrid-$

T-Model - S.S. equiv. chf for a transistor (like the hybrid-$

Copyright © 2013 Regents of the University of California
Now, go through the inspection analysis sheet:
- Show how some things are a bit easier to visualize w/ the T-model
- Others easier to visualize with the hybrid-pi

Then, back to the small-signal analysis example:

\[ G_{m} = \frac{V_{o}}{V_{s}} = \frac{V_{o}}{V_{s}} = \frac{V_{o}}{V_{s}} = \frac{V_{o}}{V_{s}} = \frac{V_{o}}{V_{s}} \]

Assume \( Q_{1} \) \( \neq \) \( Q_{2} \) identical.

First, get DC operating pt.

\[ I_{c1} = I_{c2} = \frac{V_{EE}}{2} \rightarrow I_{m} = \frac{V_{m}}{2} \]

\[ R_{o1} = R_{o2} = R_{o} \]

Small-signal ac ckt.

\[ G_{m} = \frac{g_{m}}{1 + g_{m}R_{L}} \]

\[ R_{C} = \frac{1}{g_{m}} \]

\[ R_{C} = \frac{1}{g_{m}} \]
\[ R_t = r_{in} + (B+1)R_E \]
\[ = r_{in} + (B+1) \left( RE \left( \frac{1}{g_m} \right) \right) \]
\[ \text{for completeness!} \]
\[ \text{(but usually)} \]
\[ \text{they are big, so} \]
\[ \text{can be ignored!)} \]

\[ R_0 = R_\text{f2} \frac{1}{R_\text{o2}} \left( 1 + \frac{\beta m_2 (g_m)}{1 + \beta} \right) \]
\[ = \frac{R_\text{f2}}{2R_\text{o2}} \approx R_\text{f2} \]

Assume \( R_\text{o1}, R_\text{o2} \) are very large.
Also, given that \( R_0 \) is small, which it usually is...