

Lecture 4: Inspection Analysis

- Announcements:
- Inspection formula sheet online in "Handouts" link
- HW#1 due tomorrow at 8 a.m. in the EE140/240A box near 140 Cory
- No labs this week
- EE 240A lecture increased to accommodate all
- Need to equalize labs, so go to the lab that is available if you still must get into the class
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- Lecture Topics:
  - Procedure for Small Signal Analysis
  - Inspection Formulas
  - 1-Tx Amplifier Example
  - Multi-Tx Amplifier Examples
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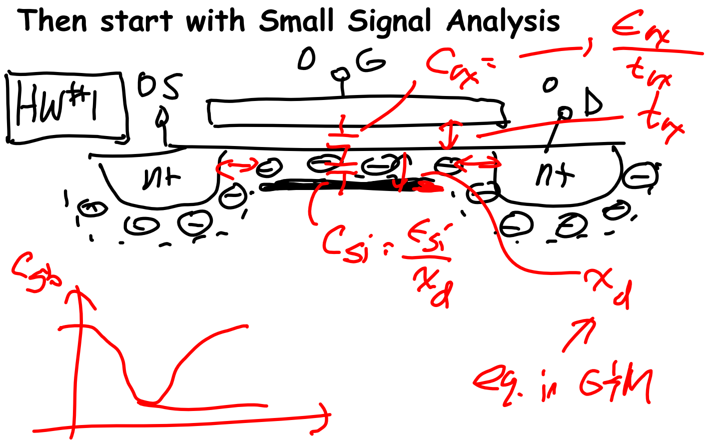
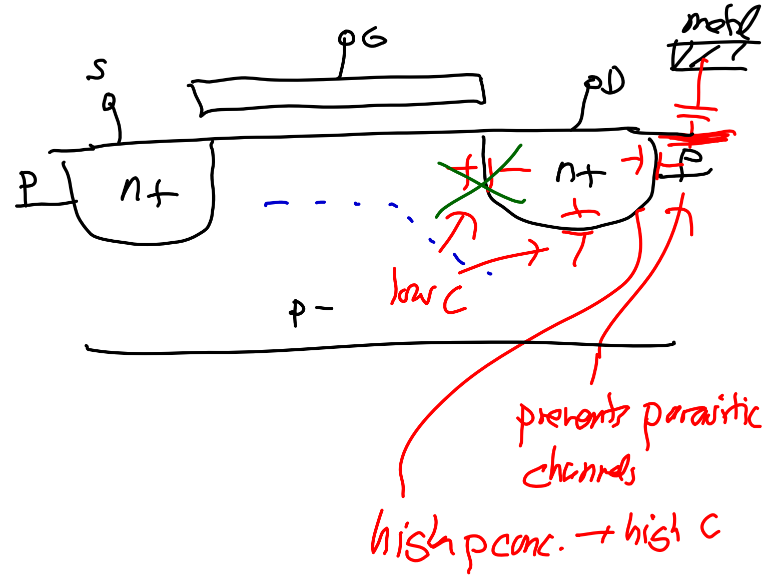
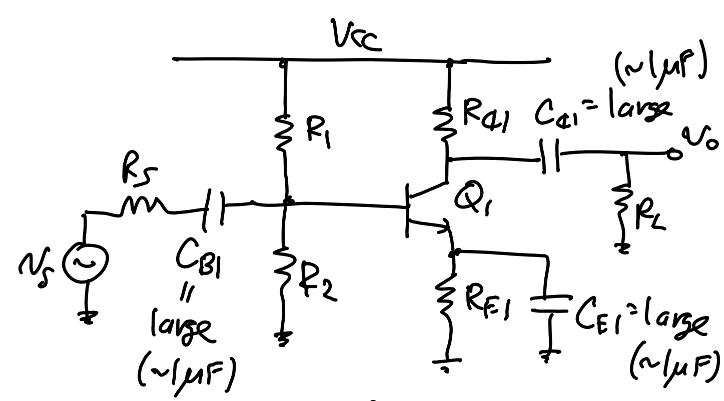
- Last Time:
- Going through MOS device modeling
- Finish this now
- Then start with Small Signal Analysis





Procedure for Small-Signal Analysis

Ex. Discrete Common-Emitter Ckt.

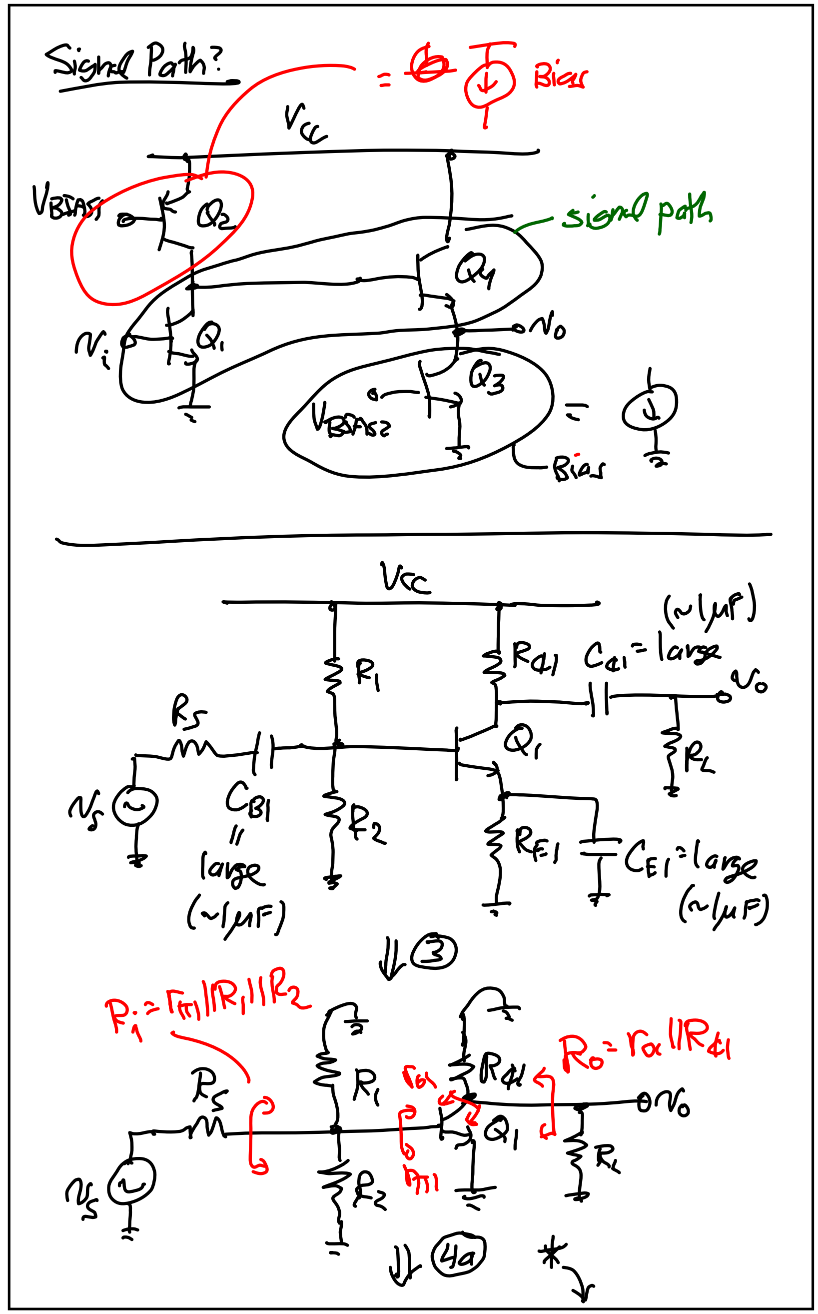


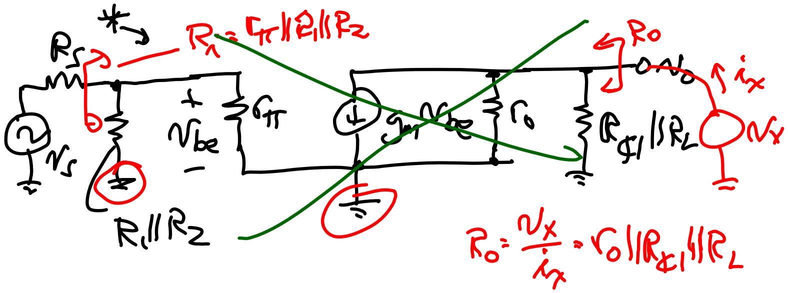
Want R_i, R_o, & gain $= \frac{v_o}{v_s}$.

Procedure:

1. Find the DC operating point
   - Get all the voltages & currents at all nodes & branches, respectively
2. Determine S.S. parameters for devices in the *signal path* (e.g., g_m, r_π, r_o, …)
3. Convert the full circuit to the S.S. circuit
   - Zero out DC sources
   - Short out large capacitors (e.g., with values greater than nF's)
4. (a) If needed, replace transistor with its S.S. model (e.g., hybrid-π, T-model, …)
   - This should NOT be needed often!
   - When is it needed? → generally in cases where there is feedback

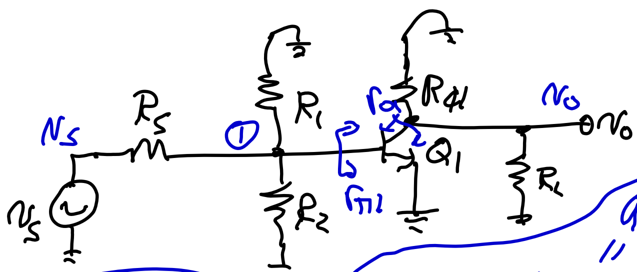
4. (b) Analyze by inspection based on prior S.S. analysis experience! (This should be 99% of the time.)



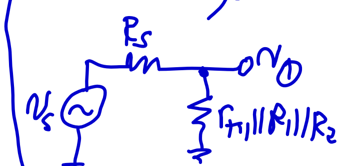


$$R_o = \frac{v_x}{i_x} = r_o \| R_{C1} \| R_L$$

Get Gain: (by inspection)



$$a_v = \frac{v_o}{v_s} = \frac{v_{①}}{v_s} \cdot \frac{v_o}{v_{①}} = -\left(\frac{r_\pi \| R_1 \| R_2}{r_\pi \| R_1 \| R_2 + R_S}\right) g_{m1} (R_{C1} \| R_L)$$



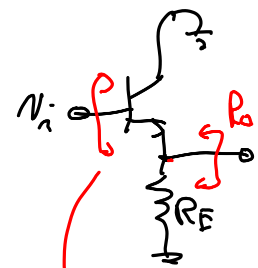
$$\frac{v_{①}}{v_s} = \frac{r_\pi \| R_1 \| R_2}{r_{\pi 1} \| R_1 \| R_2 + R_S}$$

base-to-collector gain (w/ emitter grounded)

$$\frac{v_o}{v_{①}} = -G_m R_{ⓞ} = -g_{m1}(r_{o1} \| R_{C1} \| R_L) \simeq -g_{m1}(R_{C1} \| R_L)$$

$[r_{o1} \gg R_{C1} \| R_L]$

Ex. Common-Collector



$$R_o = \frac{1}{g_m} \| (r_o \| R_E) \simeq \frac{1}{g_m} \| R_E$$

$$\frac{v_o}{v_i} = \frac{R_E}{r_e + R_E} = \frac{(\beta+1)R_E}{r_\pi + (\beta+1)R_E}$$

$$r_e \simeq \frac{1}{g_m}, \quad r_\pi = \frac{\beta}{g_m}$$

$$R_i = r_\pi + (\beta+1)R_E$$