Lecture 4: Inspection Analysis

- **Announcements**:
- Inspection formula sheet handed out in class
  - It's also online
- Some issues with HW#1
  - Problem 1: junction area = 1e-5 cm^2
  - Problem 4: some missing info for the MOS transistor
  - A fix will be posted
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- **Lecture Topics**:
  - Procedure for Small Signal Analysis
  - Inspection Formulas
  - 1-Tx Amplifier Examples
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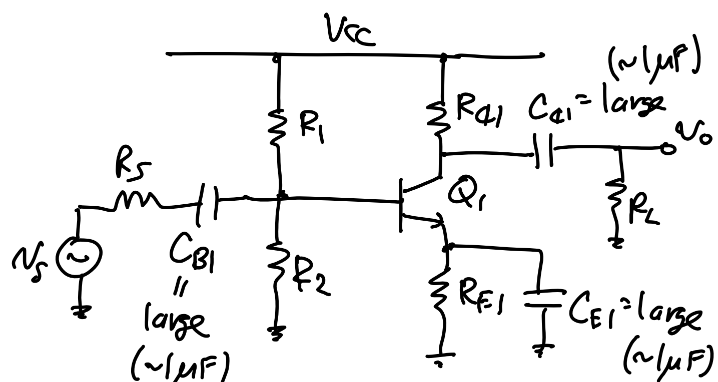
Procedure for Small-Signal Analysis (a quick run down)

Ex. Discrete Common Emitter Ckt.



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

convert to S.S. ckt. *

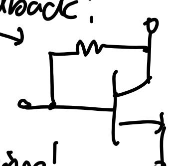
Procedure:

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

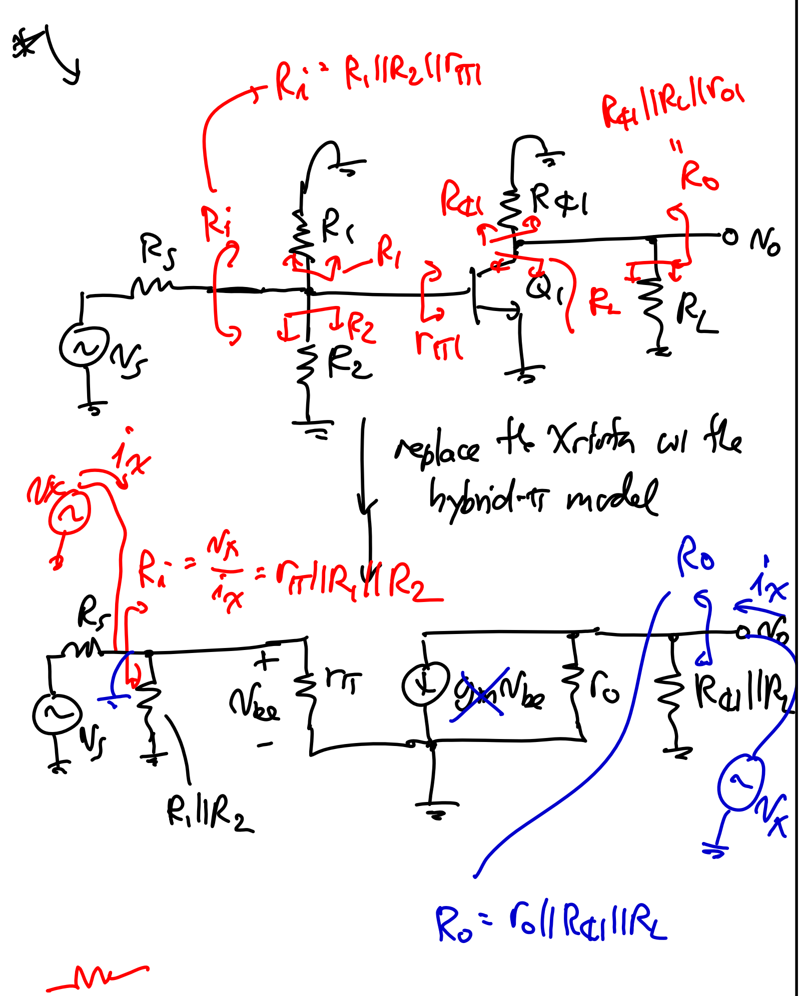
② Determine the small-signal (s.s.) parameters for devices in the signal path (e.g., g_m, r_π, ...)

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

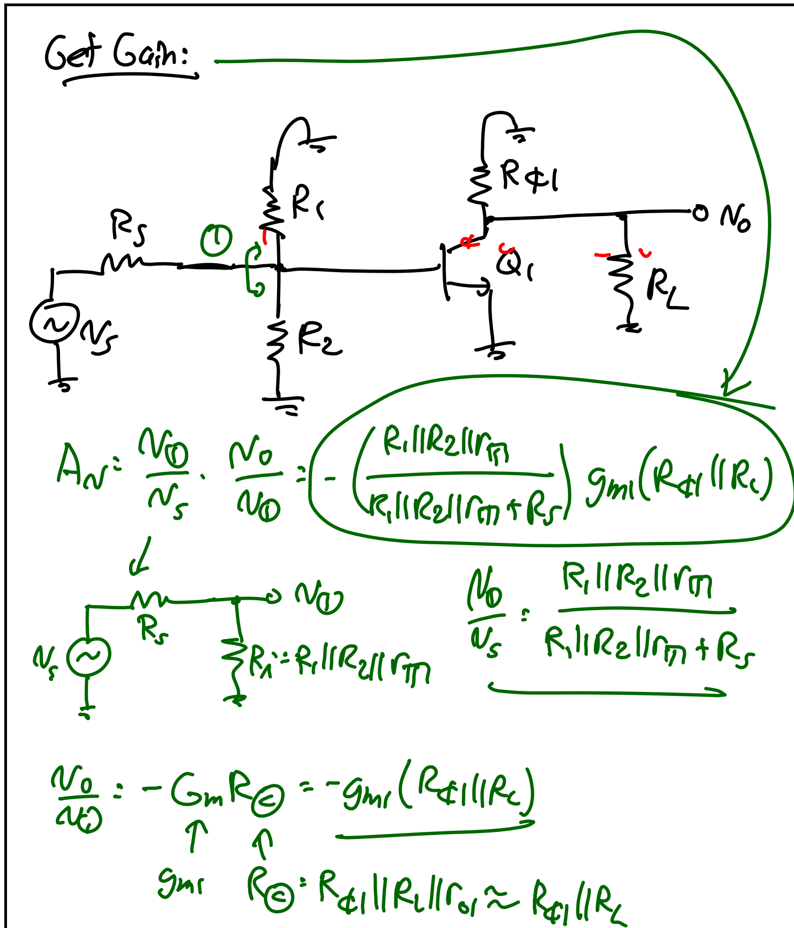
4a) If needed, replace the Xsistor w/ it's ~~S.S. ckt.~~ model (hybrid-π)
→ this should NOT be needed often
→ when is it needed? → generally, in cases where there is feedback!



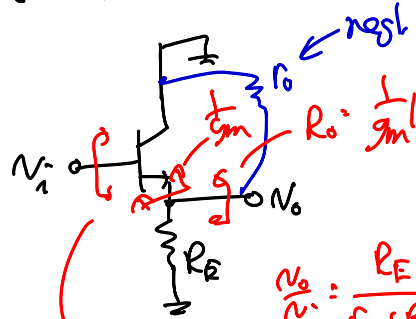
4b) Analyze by inspection based on prior S.S. analysis experience! → don't draw the hybrid-π model!
this should be 99% of the time.



- Go through Inspection Analysis handout
  - Best to commit the equations on this sheet to memory
- Then, redo the analysis via inspection



Ex. Common-Collector:



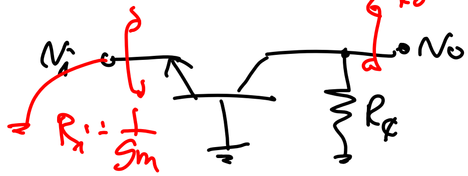
$R_o = \frac{1}{g_m} \| R_E$

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

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

$\frac{1}{g_m} \to \frac{\beta}{g_m} = r_\pi$

Ex. Common-Base:

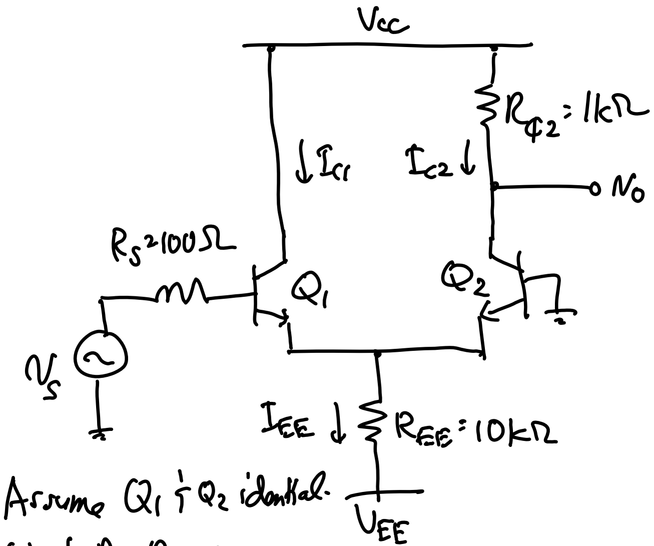


$R_o = r_o \| R_C \approx R_C$

$R_i = \frac{1}{g_m}$

$\frac{v_o}{v_i} = g_m(r_o \| R_C) \approx g_m R_C$

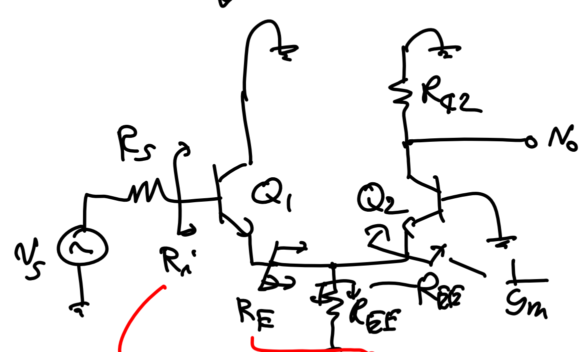
Inspection Analysis of a Multi-Transistor Ckt.



Assume Q_1 & Q_2 identical.
Want R_i, R_o, gain.

$I_{C1} = I_{C2} = \frac{I_{EE}}{2} \longrightarrow r_{\pi1} = r_{\pi2} = r_\pi$, $r_{o1} = r_{o2} = r_o$, $g_{m1} = g_{m2} = g_m$

S.S. Ckt. ⇓



(for $I_C = 1mA$) 25Ω

$R_i = r_\pi + (\beta+1)(\,?\,) = r_\pi + (\beta+1)\left(\frac{1}{g_m} \| R_{EE}\right)$ *

$*$

$$R_{x'} = r_\pi + \underbrace{(\beta+1)\frac{1}{g_m}}_{r_\pi} \Rightarrow R_{x'} = 2r_\pi$$