Lecture 29: Generally Loaded Transistor

- Announcements:
- HW#9 online and due Friday via Gradescope
- Extend Lab#5 due date by one week
  - Now due Tuesday, Nov. 6, 5 p.m.
- Midterm 2 coming up in about 2 weeks
  - Friday next week, Nov. 9, @ 5 p.m., in 277 Cory (just like last time)
  - More info this coming Friday
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- Lecture Topics:
  - Other Amplifier Configurations
  - Generally-Loaded Transistor
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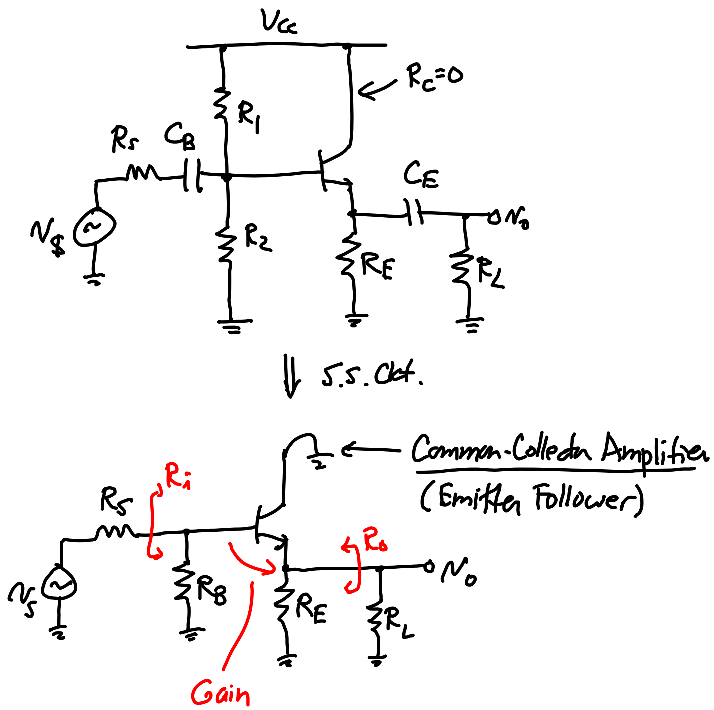
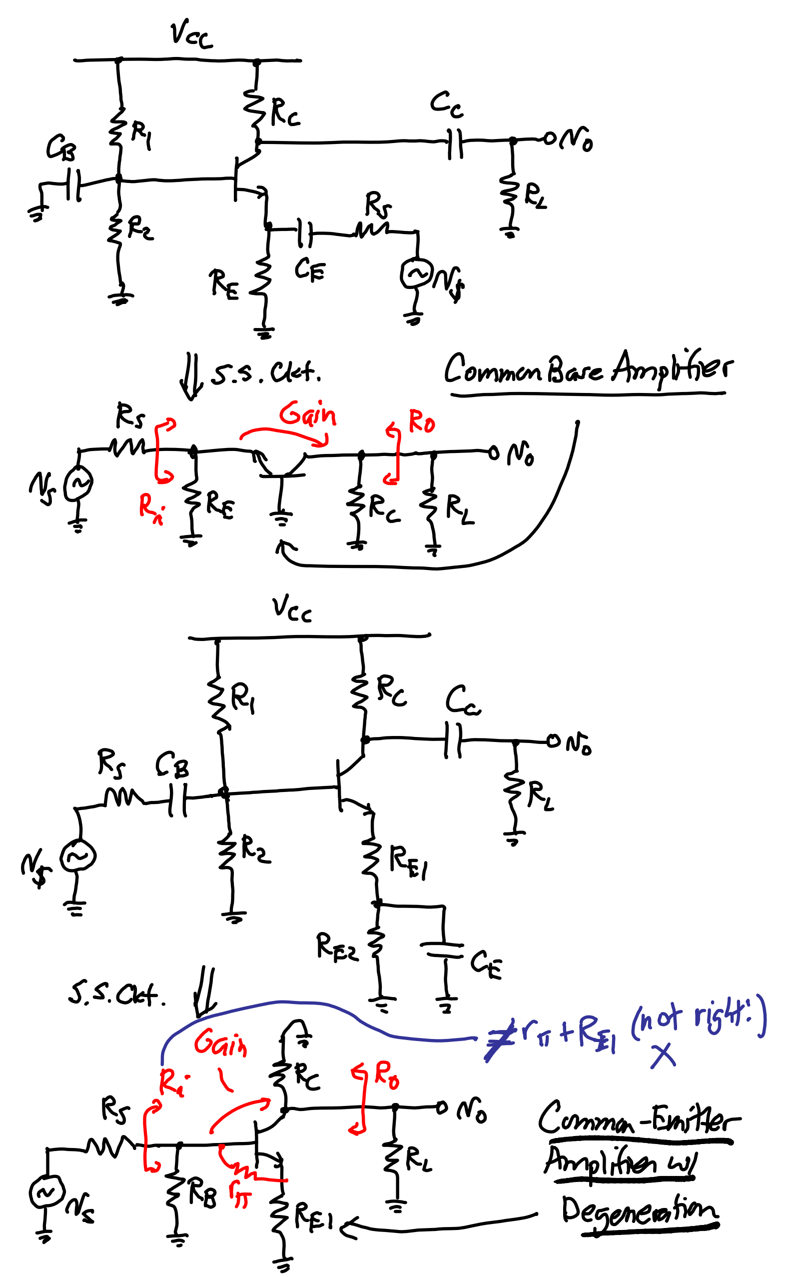
- Last Time:
- Introduced inspection analysis and Miller effect
- Now provide the knowledge needed to properly inspect analyze general circuits

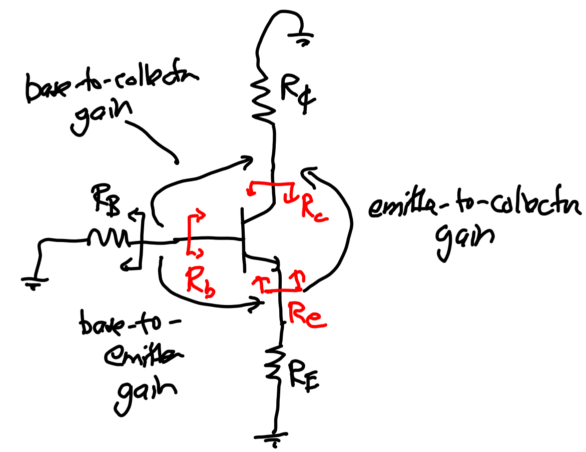
Other Popular Amplifier Configurations

- By merely altering the placements of input/output signals and bypass/coupling capacitors, one can realize other amplifier configurations
- Some examples:





Generally Loaded Transistor



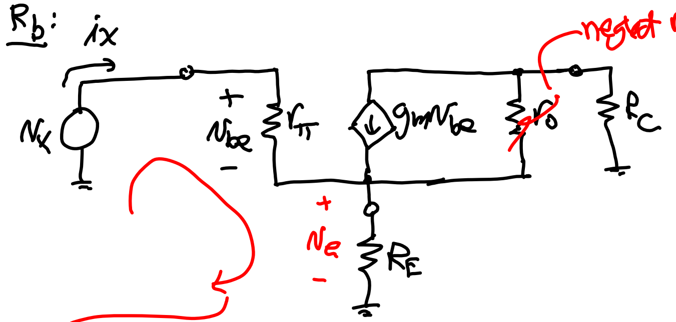
Find the terminal resistances: (i.e., the resistances seen looking into each terminal)

Re: we've already derived this in association w/ finding R_{Es} for ω_L using SCTC analysis!

$$\boxed{R_e = \frac{r_\pi + R_B}{\beta+1}} \approx \underbrace{\frac{1}{g_m}}_{= r_e} + \frac{R_B}{\beta+1} \quad [r_o \gg R_C]$$

R_b: i_x

neglect r_o = large



KVL: $v_x = v_{be} + v_e$

$v_{be} = i_x r_\pi$

$v_e = (i_x + g_m v_{be}) R_E = i_x (1 + g_m r_\pi) R_E$

$$v_x = i_x r_\pi + i_x (1 + \overbrace{g_m r_\pi}^{\beta}) R_E$$

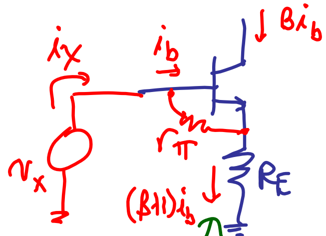
$$= i_x (r_\pi + (\beta+1) R_E)$$

will be a big R!

good for a V→V amplifier

$$\boxed{R_b = \frac{v_x}{i_x} = r_\pi + (\beta+1) R_E \approx r_\pi (1 + g_m R_E)}$$

$[\beta = g_m r_\pi \gg 1]$



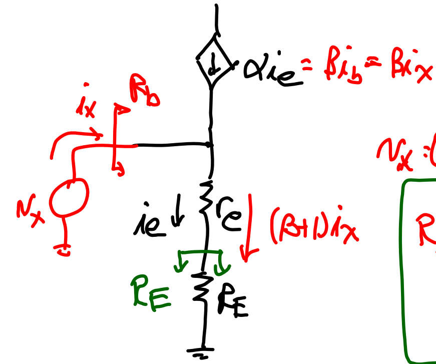
following the currents

$v_x = i_x r_\pi + (\beta+1) i_x R_E$

$$R_b = \frac{v_x}{i_x} = r_\pi + \underbrace{(\beta+1) R_E}$$

this comes about due to amplification of i_b

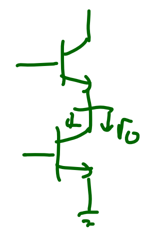
T-Model:



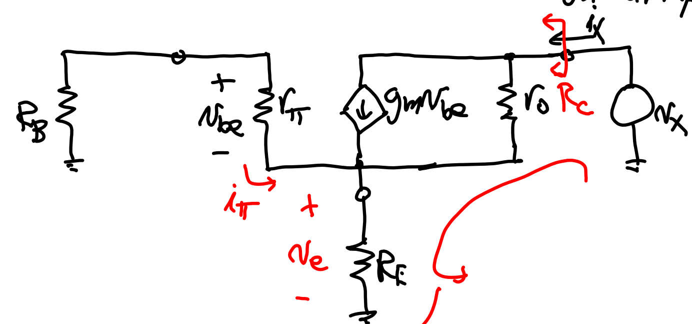
$v_x = (\beta+1) i_x (r_e + R_E)$

$$\boxed{\begin{aligned} R_b = \frac{v_x}{i_x} &= (\beta+1)(r_e + R_E) \\ &= (\beta+1)\left(\frac{1}{g_m} + R_E\right) \end{aligned}}$$

yet another form of the same thing...



Find R_c: (note that R_B can influence, so include in our analysis)



KVL: $v_x = r_o (i_x - g_m v_{be}) + v_e$ → *

[Usually, for cases that matter, $R_E \ll R_B + r_\pi$]

∴ most of i_x flows thru R_E:

for this class

∴ $v_e \approx i_x R_E$

$$i_\pi = -\frac{v_e}{r_\pi + R_B} = -\frac{i_x R_E}{r_\pi + R_B}$$

$$\therefore\ v_{be} = \frac{i_x r_\pi R_E}{r_\pi + R_B}$$

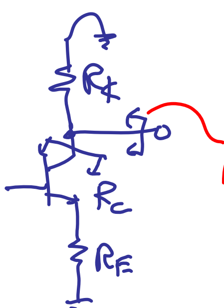
$$* \quad v_x = i_x\left(1 + \frac{g_m r_\pi R_E}{r_\pi + R_B}\right) r_o + i_x R_E$$

$$\therefore\ R_{\not c} = \frac{v_x}{i_x} = r_o\left(1 + \frac{g_m R_E}{1 + (R_B/r_\pi)}\right) + R_E$$

$$\therefore\ \boxed{R_{\not c} \cong r_o\left(1 + \frac{g_m R_E}{1 + (R_B/r_\pi)}\right) \approx r_o(1 + g_m R_E)}$$

[for $r_\pi \gg R_B$]

even bigger than r_o!



$R_o = R_C \| R_{\not c} \approx R_{\not c}$

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