Lecture 28: Generally Loaded Transistor

Announcements:
- HW#9 online and due Friday via Gradescope
- Lab#5 due Tuesday, Nov. 12, 5 p.m.
- Midterm 2 coming up in about 2 weeks
  - Friday next week, Nov. 15, @ 7 p.m., in 160 Kroeber Hall
  - More info this coming Friday
  - Review Session will likely be Tuesday, 6-8 p.m., next week

Lecture Topics:
- Other Amplifier Configurations
- Generally-Loaded Transistor

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

Common Base Amplifier

Common Emitter Amplifier w/ Degeneration

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

\[ R_e = \frac{R_n + R_B}{\beta + 1} \approx \frac{1}{g_m} + \frac{R_B}{R_e} \quad [r_o \gg R_e] \]
In Lecture 28w: Generally Loaded Transistor, the analysis of a transistor circuit is presented. The circuit includes resistors and biasing elements. The following equations are derived:

1. **KVL:**\[ N_x = N_{be} + N_e \]
2. \[ N_{be} = i_x R_T \]
3. \[ N_e = (i_x + g_m N_{be}) R_E = i_x (1 + g_m R_T) R_E \]
4. **T-Model:**
   - \[ R_b: \frac{V_X}{I_X} = R_f + (\beta + 1) R_E \approx R_f (1 + g_m R_E) \]
   - \[ R_f: \frac{N_x}{I_X} = \frac{1}{g_m} (\beta + 1) \frac{R_E}{\beta + 1} \]
   - **Note:** \( \beta R_E \) can influence, so include in analysis.

The analysis also highlights the requirement for a high transconductance condition, \( \beta g_m R_T \gg 1 \).
Remarks:
- $R_c \sim (1 + (0.04)(1k))(100k\Omega) \sim 4.1M\Omega$ (this is huge)
- Rarely use $R_c$ in discrete circuits, since it is generally much larger than $R_c$
- In integrated circuits, however, the loading can be very large, especially if it comes from another transistor
- For example:
Convert to an "equivalent resistor" Y-parameter model:

\[ \frac{N_c}{V_b} = -G_m R_0 \]

All we need is \( G_m \), short ckt. transconductance

\[ G_m = \frac{I_C}{V_b \mid N_c = 0} \]