Common Emitter Derivations
- $R_{in}, R_{out}, \beta$
- Load
- Lees Signal level shift
- \( \frac{1}{2} \alpha \beta \frac{V_s}{V_t} \) control, $R_o$ in $T$ model

Common Base Derivations
- $R_{in}, R_{out}, \beta$ with $R_o$
- Current Follower
- Finite $C_v$ gain, see book
- Low input impedance?

Project Q3-A

Left out hoping for an understanding of the EF

\[ A_v = 1, \frac{V_s}{R_{in}} \text{ high, } R_{out} \text{ low} \rightarrow \text{called a voltage buffer} \]

- Need to include $R_s$ in $R_{out}$ analysis $b/c$ life's not equal

Find $R_{in}$

\[ \text{rearranged: } V_{ce} = \frac{1}{2} V_{t} \]

\[ \text{Similar to CE VI design} \]

- Need to start with $U_t$

\[ U_{be} = i_b \left( \frac{1}{R_E} + \frac{1}{R_o} \right) - \beta \pi i_b \]

\[ i_c (B+1) = \frac{-U_{in}}{R_{E2} \pi} \]

\[ V_o = i_b (B+1) R_{E2} \pi \]

\[ U_t = U_{bo} + U_{ce} = A_t \left( \frac{1}{R_E} + \frac{1}{R_b} \right) \left( \frac{R_{E2} \pi}{R_b} \right) \]

\[ R_{in} = \frac{R_{E2} \pi}{B+1} \approx R_E \]
Calc $A_v$

$$V_0 = I_t (B+1) (R_{E//R_o}) \quad \text{from above}$$

$$A_v = \frac{(B+1) (R_{E//R_o})}{r_t + (B+1) (R_{E//R_o})} \quad V_i \quad I_t = \frac{V_i}{R_{in}}$$

$\rightarrow A_v \approx 1$

Let's look at a large signal to check this.

- Gain is 1, y level shifted down
- Used to get DC voltages right
- $V_{BE}$ stays ~0.7, small sig capturs changes

Calc $R_{out}$

- Need to include $R_s$
- Start w/ $V_c$ this time!

$$I_t = \frac{V_b}{R_E} + \frac{V_b}{R_o} + \frac{V_b}{r_t + R_s} - g_m V_{be}$$

and

$$V_{be} = -\frac{R_{b\pi}}{r_{b\pi + R_s}} V_c$$

So

$$I_t = \frac{V_c}{R_E} \left( \frac{1}{R_E} + \frac{1}{R_o} + \frac{1}{r_{b\pi + R_s}} + \frac{g_m}{r_{b\pi + R_s}} \right)$$

$$R_{out} = R_E \parallel R_o \parallel \frac{r_{b\pi + R_s}}{B+1} \approx \frac{1}{r_{b\pi}} + \frac{R_s}{B+1}$$

- Backward's gain of $\frac{r_{b\pi}}{R_s + r_{b\pi}}$
  - Ignore in 2 port model
  - Say this small...

- Why $\frac{1}{g_m}$? Voltage applied directly
  across $g_m$ control terminals receives controlled current
  $\rightarrow$ watch for this pattern!
Last type of amplifier is called common base.

\[ V_B = V_o \]

- Hard to bias.
- Ignore \( R_o \) for now.
- See Gm for full derivation.
- w/ finite \( R_o \) = a pain.
- net unilateral.

Common to draw:

\[ U_c = \frac{1}{g_m} + g_m U_{bc} \]

Some \( g_m \) pattern from controlling the emitter.

Low input impedance good for antennas & matching to 50Ω RF stuff.

\[ R_{in} = R_c \]

\[ 9_m \text{ sec tuned b/f } U_c \text{ started like CE or degen.} \]

\[ A_v = \frac{-g_m U_{bc} R_c}{1} \]

\[ V_o = -9_m U_{bc} R_c \]

\[ = 9_m (-\frac{V_c}{R_o}) R_c \]

\[ = 9_m R_c \]

- can do this analysis w/ a T-model of BJT.