Finished Common collector (CC)

Common emitter (CE)

Bias:
\[ V_{BB} = \frac{R_{B2}}{R_{B2} + R_{B1}} V_{CC} \]
\[ R_{BB} = \frac{1}{\frac{1}{R_{B2}} + \frac{1}{R_{B1}}} \]
\[ I_B = \frac{V_{BB} - 0.7 V}{R_{BB} + \beta R_E} \]
\[ I_E = \frac{V_E}{R_E} \]
\[ I_C = I_E \]

What if we put in an AC input signal:
\[ i_C(t) = \frac{v_E(t)}{R_E} \]
\[ V_C(t) = V_{CC} - i_C(t) R_C \]

\( v_B(t) = V_B + 0.5 V \cdot \cos \left( 6280 \frac{\text{rad}}{\text{sec}} t \right) \)
\( v_E(t) = v_B(t) - 0.7 V \)

\[ r_e = \frac{V_T}{I_C} = 2.5 \Omega \]

\[ R_C = 3.902 \]

\[ \frac{R_C}{R_E + r_e} = 4 \]

\[ V_C \] is 4 times bigger and inverted

Actually, to be more correct, we should account for the small-signal resistance of the base-emitter junction.

\[ r_e = 2.5 \cdot \Omega \]

Gain is really:
\[ \frac{R_C}{R_E + r_e} = 3.902 \]
**Common emitter (CE), continued**

Input impedance: \( R_i = R_{B1} || R_{B2} || \beta (r_e + R_E) \)

Output impedance: \( R_o = R_C || r_o \)

Often neglected \( r_o = \frac{V_A}{I_C} \) \( \text{Early voltage. } \) (guess \( V_A \approx 100 \text{V} \) if no data)

AC collector resistance: \( r_c = R_C || R_L || r_o \)

More correct, use: \( r_o = \frac{A_v}{A_v + 1} \)

instead of \( r_o \) very rarely done.

Voltage gain: \( A_v = \frac{v_o}{v_b} = \frac{r_c}{r_c + R_E} \)

Current gain: \( A_i = \frac{i_o}{i_i} = \frac{r_c}{r_c + R_E \cdot R_L} = \frac{R_L}{R_L + \frac{R_i}{A_v}} \)

Low frequency corner frequencies

\[
f_{CL1} = \frac{1}{2 \pi (R_S + R_i) C_{in}}
\]

\[
f_{CL2} = \frac{1}{2 \pi (R_L + R_o) C_{out}}
\]

**With bypass capacitor (CE)**

This basically makes the \( R_E \) dissapear at signal frequencies (If the cap is big enough).

Input impedance: \( R_i = R_{B1} || R_{B2} || \beta r_e \) \( \text{Much lower} \)

Output impedance: \( R_o = R_C || r_o \) \( \text{Same as above, but no } r_o \text{ correction needed} \)

AC collector resistance: \( r_c = R_C || R_L || r_o \)

Voltage gain: \( A_v = \frac{v_o}{v_b} = \frac{r_c}{r_c} \)

Current gain: \( A_i = A_v \frac{R_i}{R_L} \)

Another low frequency corner frequency: \( f_{CL3} = \frac{1}{2 \pi C_E \left( \frac{1}{r_e} + \frac{1}{R_E} \right)} \)

Because \( r_e \) is so small, this will usually dominate, even when \( C_E \) is big.

Have a good & a safe Spring Break, see you in a week & a half. Go find some sun....