Common-Collector Amplifier Example - Summer 2000

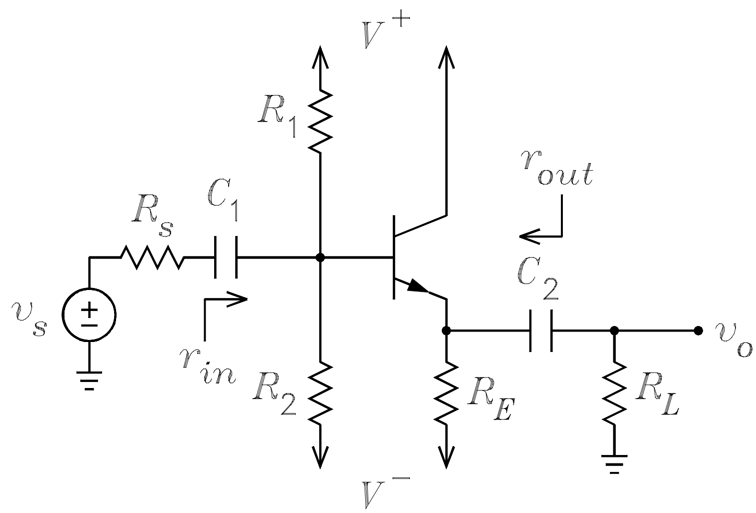
$R_P(x,y) := \frac{x \cdot y}{x+y}$ Function for calculating parallel resistors.

$R_1 := 100000$ $R_2 := 120000$ $R_C := 0$ $R_E := 5600$ $R_S := 5000$ $R_L := 10000$

$V_p := 15$ $V_m := -15$ $V_{BE} := 0.65$ $V_T := 0.025$ $\beta := 99$ $\alpha := 0.99$

$r_x := 20$ $r_0 := 50000$

$v_s := 1$ With $v_s = 0$, the voltage gain is equal to v_o.



DC Bias Solution

$V_{BB} := \frac{V_p \cdot R_2 + V_m \cdot R_1}{R_1 + R_2}$ $V_{BB} = 1.364$

$R_{BB} := R_P(R_1, R_2)$ $R_{BB} = 5.455 \cdot 10^4$

$I_E := \frac{V_{BB} - V_{BE} - V_m}{\frac{R_{BB}}{1+\beta} + R_E}$ $I_E = 2.557 \cdot 10^{-3}$

$$r_e := \frac{V_T}{I_E} \qquad r_e = 9.777$$

AC Solutions

This first solution uses the equations involving R_{tc}, even though $R_{tc} = 0$. It is based on the Thevenin emitter circuit which have v_{eoc} in series with r_{ieo}.

$$v_{tb} := v_s \cdot \frac{R_P(R_1, R_2)}{R_S + R_P(R_1, R_2)} \qquad v_{tb} = 0.916$$

$$R_{tb} := R_P(R_S, R_P(R_1, R_2)) \qquad R_{tb} = 4.58 \cdot 10^3$$

$$R_{te} := R_P(R_E, R_L) \qquad R_{te} = 3.59 \cdot 10^3$$

$$r_{ie} := \frac{R_{tb} + r_x}{1 + \beta} + r_e \qquad r_{ie} = 55.779$$

$$R_{tc} := R_C \qquad R_{tc} = 0$$

$$v_{eoc} := v_{tb} \cdot \frac{r_0 + \frac{R_{tc}}{1+\beta}}{r_{ie} + r_0 + \frac{R_{tc}}{1+\beta}} \qquad v_{eoc} = 0.915$$

$$r_{ieo} := r_{ie} \cdot \frac{r_0 + R_{tc}}{r_{ie} + r_0 + \frac{R_{tc}}{1+\beta}} \qquad r_{ieo} = 55.717$$

$$v_o := v_{eoc} \cdot \frac{R_P(R_E, R_L)}{r_{ieo} + R_P(R_E, R_L)} \qquad v_o = 0.901$$

This is the voltage gain.

$$r_{out} := R_P(R_E, r_{ieo}) \qquad r_{out} = 55.168$$

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$$r_{ib} := r_x + (1+\beta)\cdot\left(r_e + R_P(R_{te}, R_{tc} + r_0)\right) - \frac{\beta \cdot R_{tc} \cdot R_{te}}{R_{tc} + r_0 + R_{te}}$$

$r_{ib} = 3.359 \cdot 10^5$

$r_{in} := R_P(r_{ib}, R_P(R_1, R_2))$ $\qquad r_{in} = 4.693 \cdot 10^4$

The following solution is based on the emitter equivalent circuit. It is the preferred solution when R_{tc} = 0. Note that this is an exact solution, where r_0 is considered to be an external resistor. The answers are the same as the ones in the solution above.

$$v_o := v_{tb} \cdot \frac{R_P(R_E, R_P(r_0, R_L))}{r_{ie} + R_P(R_E, R_P(r_0, R_L))} \qquad v_o = 0.901$$

This is the voltage gain.

$r_{out} := R_P(r_{ie}, R_P(r_0, R_E))$ $\qquad r_{out} = 55.168$

$r_{ib} := r_x + (1+\beta)\cdot\left(r_e + R_P(R_E, R_P(r_0, R_L))\right)$ $\qquad r_{ib} = 3.359 \cdot 10^5$

$r_{in} := R_P(r_{ib}, R_P(R_1, R_2))$ $\qquad r_{in} = 4.693 \cdot 10^4$

Note the low output resistance of the CC amplifier. It is much lower than the output resistance in the CE amplifier example. To obtain a high voltage gain and a low output resistance, a CE/CC amp can be used in cascade. We will look at such an example.