Common-Emitter Amplifier Example - Summer 2000

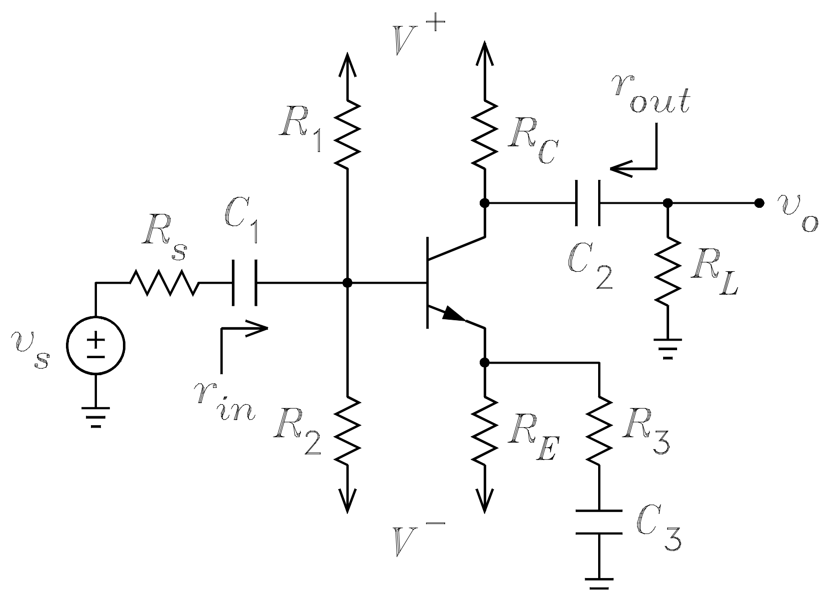
$R_P(x,y) := \frac{x \cdot y}{x+y}$ Function for calculating parallel resistors.

$R_1 := 100000$ $R_2 := 120000$ $R_C := 4300$ $R_E := 5600$ $R_S := 5000$ $R_L := 10000$

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

$r_x := 20$ $r_0 := 50000$ $R_3 := 100$

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



DC Bias Solution

$V_{BB} := \frac{V_p \cdot R_2 + V_m \cdot R_1}{R_1 + R_2}$ $V_{BB} = 1.3636$

$R_{BB} := R_P(R_1, R_2)$ $R_{BB} = 5.4545 \bullet 10^4$

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

$V_C := V_p - \alpha \cdot I_E \cdot R_C \qquad V_C = 4.1151$

$r_e := \frac{V_T}{I_E} \qquad r_e = 9.7773$

AC Solution

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

$R_{tb} := R_P(R_S, R_P(R_1, R_2)) \qquad R_{tb} = 4.5802 \cdot 10^3$

$R_{te} := R_P(R_E, R_3) \qquad R_{te} = 98.2456$

$r_{ie} := \frac{R_{tb} + r_x}{1 + \beta} + r_e \qquad r_{ie} = 55.7788$

$R_{tc} := R_P(R_C, R_L) \qquad R_{tc} = 3.007 \cdot 10^3$

$r_{ic} := \frac{r_0 + R_P(r_{ie}, R_{te})}{1 - \frac{\alpha \cdot R_{te}}{r_{ie} + R_{te}}} \qquad r_{ic} = 1.3577 \cdot 10^5$

$i_{csc} := \frac{v_{tb}}{r_{ie} + R_P(R_{te}, r_0)} \cdot \left(\alpha - \frac{R_{te}}{R_{te} + r_0}\right) \qquad i_{csc} = 5.8835 \cdot 10^{-3}$

$v_o := -i_{csc} \cdot R_P(R_C, R_P(r_{ic}, R_L)) \qquad v_o = -17.3084$ This is the voltage gain.

$r_{out} := R_P(R_C, r_{ic}) \qquad r_{out} = 4.168 \cdot 10^3$

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

$r_{ib} = 1.0253\bullet 10^4$

$r_{in} := R_P\left(r_{ib}, R_P\left(R_1, R_2\right)\right)$ $\quad r_{in} = 8.6309\bullet 10^3$

The following solution is based on the r_0 approximations.

$i_{csc} := v_{tb}\cdot\dfrac{\alpha}{r_{ie} + R_{te}}$ $\quad i_{csc} = 5.8878\bullet 10^{-3}$

$v_c := -i_{csc}\cdot R_P\left(R_C, R_P\left(r_{ic}, R_L\right)\right)$ $\quad v_c = -17.3211$ This is the voltage gain. It is 0.075% lower than the exact solution.

$r_{out} := R_P\left(r_{ic}, R_C\right)$ $\quad r_{out} = 4.168\bullet 10^3$

$r_{ib} := r_x + (1+\beta)\cdot\left(r_e + R_{te}\right)$ $\quad r_{ib} = 1.0822\bullet 10^4$

$r_{in} := R_P\left(r_{ib}, R_P\left(R_1, R_2\right)\right)$ $\quad r_{in} = 9.0305\bullet 10^3$