Common-Base Amplifier Example - Spring 2002

$$R_P(x,y) := \frac{x \cdot y}{x+y}$$

Function for calculating parallel resistors.
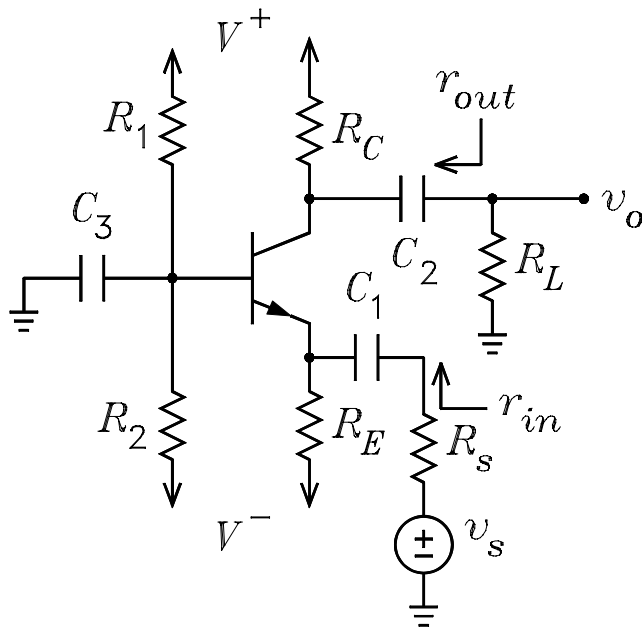
$R_1 := 100000$ $R_2 := 120000$ $R_C := 4300$ $R_E := 5600$ $R_S := 100$ $R_L := 10000$

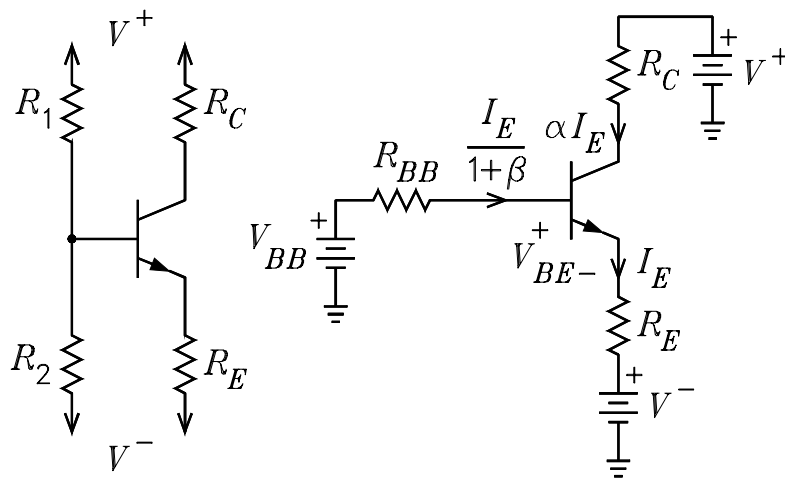$V_{plus} := 15$ $V_{minus} := -15$ $V_{BE} := 0.65$ $V_T := 0.025$ $\beta := 99$ $\alpha := 0.99$

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

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

DC Bias Circuit

$$V_{BB} := \frac{V_{plus} \cdot R_2 + V_{minus} \cdot R_1}{R_1 + R_2} \qquad V_{BB} = 1.364$$

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

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

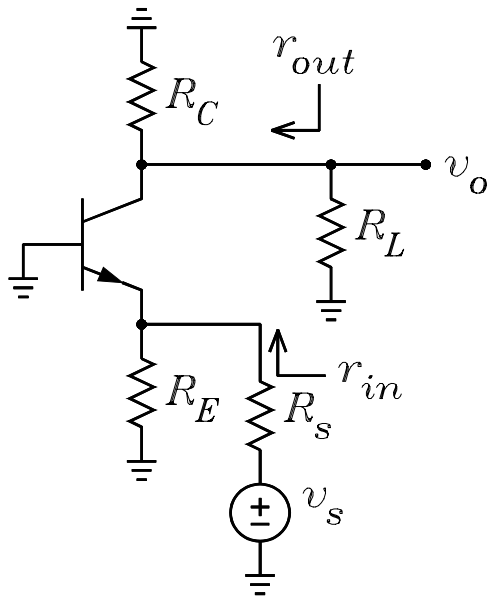$$r_e := \frac{V_T}{I_E} \qquad r_e = 9.777$$

Test for Active Mode

$$V_C := V_{plus} - \alpha \cdot I_E \cdot R_C \qquad V_C = 4.115$$

$$V_B := V_{minus} + I_E \cdot R_E + V_{BE} \qquad V_B = {}^-0.031$$

$$V_{CB} := V_C - V_B \qquad V_{CB} = 4.146 \qquad \text{Thus active mode.}$$
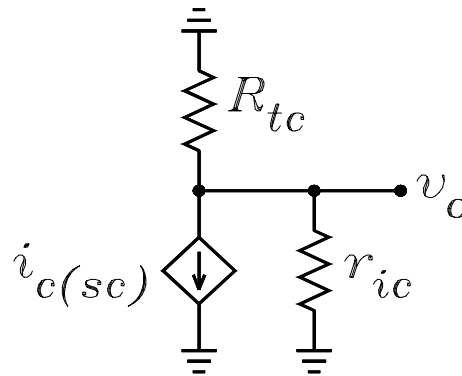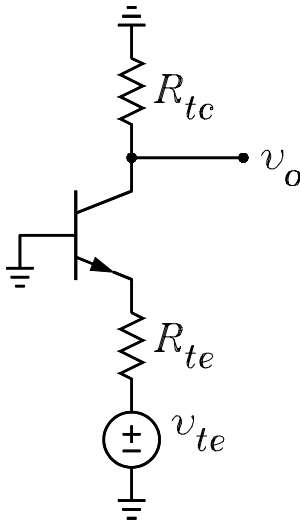
AC Signal Circuit

$$v_{te} := v_s \cdot \frac{R_E}{R_S + R_E} \qquad\qquad v_{te} = 0.982$$

$$R_{te} := R_P(R_E, R_S) \qquad\qquad R_{te} = 98.246$$

$$R_{tb} := 0$$

$$r'_e := \frac{R_{tb} + r_x}{1 + \beta} + r_e \qquad r'_e = 9.977$$
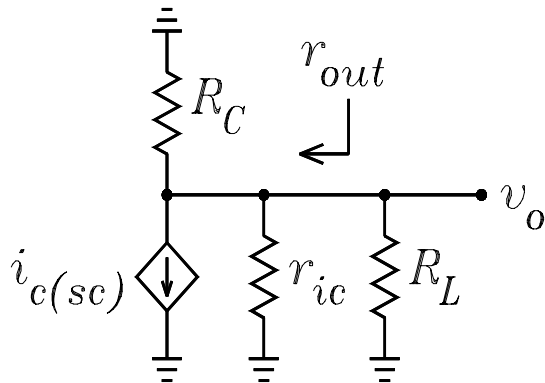
Circuit for v_o

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

$$r_{ic} := \frac{r_0 + R_P(r'_e, R_{te})}{1 - \dfrac{\alpha \cdot R_{te}}{r'_e + R_{te}}} \qquad r_{ic} = 4.938 \cdot 10^5$$

$$i_{csc} := \frac{-v_{te}}{R_{te} + R_P(r'_e, r_0)} \cdot \frac{\alpha \cdot r_0 + r'_e}{r_0 + r'_e} \qquad i_{csc} = -8.987 \cdot 10^{-3}$$

$$v_o := -i_{csc} \cdot R_P(R_{tc}, r_{ic}) \qquad v_o = 26.862 \qquad \text{This is the voltage gain.}$$
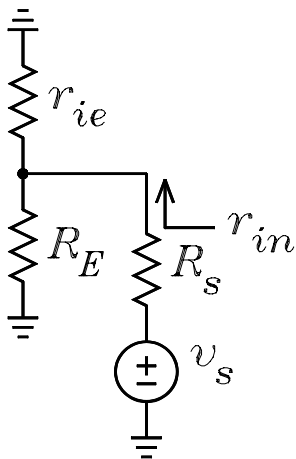
Circuit for r_{out}

$$r_{out} := R_P(R_C, r_{ic})$$

$$r_{out} = 4.263 \cdot 10^3$$

Circuit for r_{in}

$$r_{ie} := r'_e \cdot \frac{r_0 + R_{tc}}{r'_e + r_0 + \dfrac{R_{tc}}{1 + \beta}}$$

$$r_{ie} = 10.569$$

$r_{in} := R_P(r_{ie}, R_E)$ $r_{in} = 10.549$

The following solution is based on the r_0 approximations.

$i_{csc} := -v_{te} \cdot \dfrac{\alpha}{r'_e + R_{te}}$ $i_{csc} = -8.987 \bullet 10^{-3}$

$v_c := -i_{csc} \cdot R_P(R_{tc}, r_{ic})$ $v_c = 26.861$ This is the voltage gain.

$\text{Percent} := \dfrac{v_c - 26.862}{26.862} \cdot 100$ $\text{Percent} = -3.028 \bullet 10^{-3}$ This is the percent change from the exact value.

$r_{out} := R_P(r_{ic}, R_C)$ $r_{out} = 4.263 \bullet 10^{3}$

$r_{in} := R_P(r_{ie}, R_E)$ $r_{in} = 10.549$