TO: Li Yan

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Preliminary Report II: Last Stage Amplifier

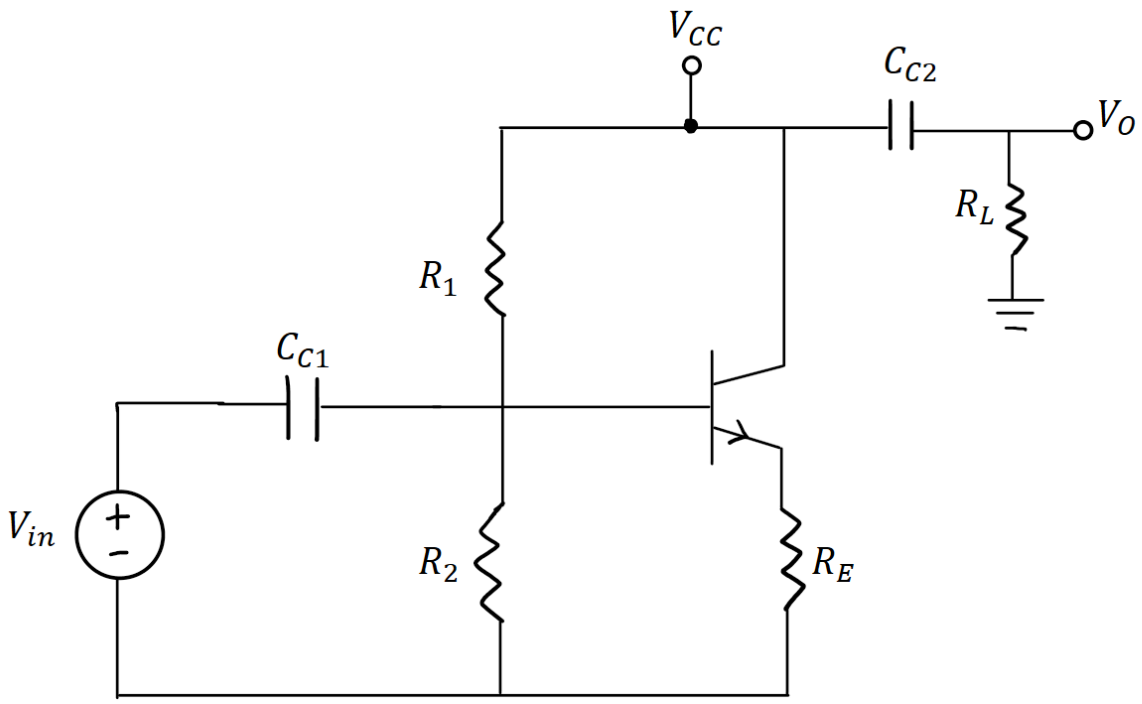


Figure 1: DC Circuit for Emitter Follower Stage

Our theoretically calculated DC circuit parameters are as follows:

$$V_{CC} = 9\,V$$

$$V_{CEQ} = \frac{V_{CC}}{2} = 4.5\,V$$

$$R_L = 10\,\Omega,\ V_{L,max} > 200\,mV,\ I_{L,max} \approx 20\,mA$$

$$I_{CQ} \approx 2I_{L,max} \approx 40\,mA$$

$$I_{BQ} = 0.4\,mA,\ I_{EQ} = 40.4\,mA$$

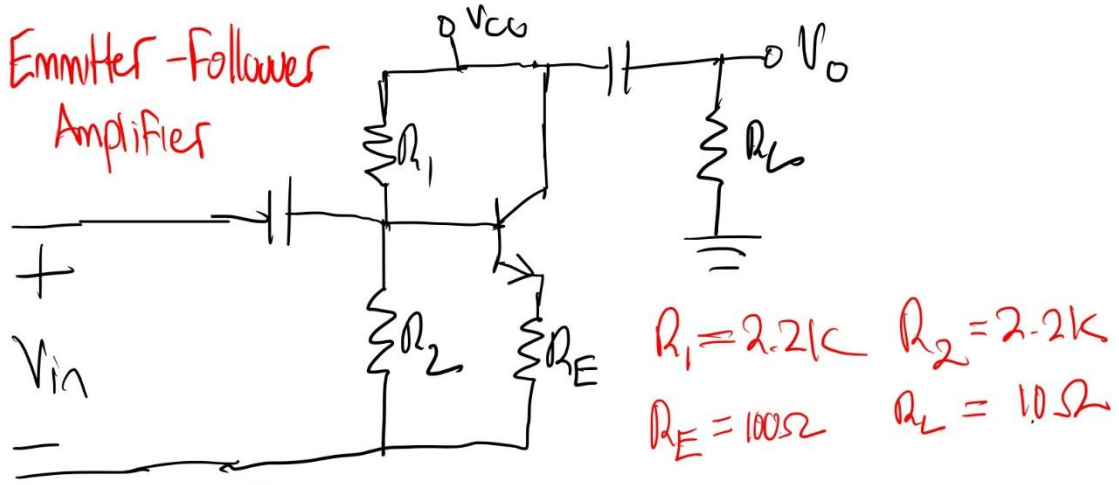
$$R_E = \frac{(V_{CC} - V_{CE})}{I_{EQ}} \approx 100\,\Omega$$

$$R_{TH} \approx 0.1(1+\beta)R_E \approx 1010\,\Omega$$

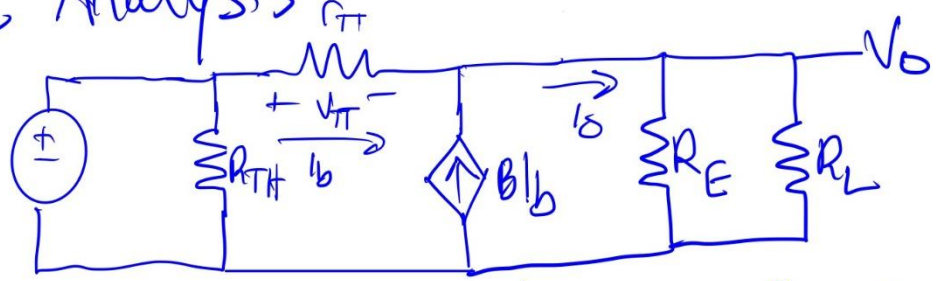
$$V_{TH} = R_{TH}I_{BQ} + V_{BE}(on) + R_E I_{EQ} = 5.144\,V$$

$$R_1 = R_2 = 2.2\,k\Omega$$

Our goal is to design an emitter follower amplifier to have sufficient current flowing through the load resistor (> 10 mA).



AC Analysis



$r_\pi = \frac{V_T}{I_{bQ}} = \frac{.026}{0.4mA} = 65$, $g_m = \frac{I_{CQ}}{V_T} = 1.538$, $r_o = \infty$

$R_{ib} = \frac{V_{in}}{i_b} = \frac{V_{TH}}{i_b} = 11.25K\Omega$ $A_V = \frac{V_o}{V_s} = \frac{(1+\beta)(R_E \| R_L)}{r_\pi + (1+\beta)(R_E \| R_L)} = 0.933$

$R_o = \frac{V_x}{I_x}$ $I_x = \frac{V_x}{R_E} + \frac{V_x}{R_L} + \frac{V_x}{r_\pi + R_{TH}} - g_m V_\pi$ $V_\pi = -\frac{r_\pi}{r_\pi + R_{TH}} V_x$ (Constraint)

$\frac{I_x}{V_x} = \frac{1}{R_E} + \frac{1}{R_L} + \frac{1 + g_m V_\pi}{r_\pi + R_{TH}} = \frac{1}{R_o}$ $R_o = \left(\frac{r_\pi + R_{TH}}{1+\beta}\right)(R_L \| R_E) = 104.8\Omega$

To find the small signal current gain, the process is as follows:

$$I_o = \frac{R_E}{R_L + R_E} i_e \, , \, i_e = (1+\beta) i_b$$

$$-V_{in} + i_b r_\pi + (1+\beta) i_b (R_E | | R_L) = 0$$

$$R_{ib} = \frac{V_{in}}{i_b} = r_\pi + (1+\beta)(R_E | | R_L)$$

$$i_b = \frac{R_{TH}}{R_{TH} + R_{ib}} I_i$$

$$A_i = (1+\beta) \frac{R_{TH}}{R_{TH} + R_{ib}} \frac{R_E}{R_L + R_E}$$

$$= \frac{(101)(10101)}{(1010 + 983)} \frac{(100)}{(110)}$$

$$A_i = 46.53$$