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ECEn 340 LAB 4 Notes

$A = 5 = \frac{R_c}{\frac{V_T}{I_c} + R_E}$

R_c Calculation

Choose $R_E = 100\,\Omega$

$5 = \frac{R_c}{(26\text{ mV})\frac{R_c}{4.5\text{ V}} + 100\,\Omega}$

$0.02889\,R_c + 500\,\Omega = R_c$

$500\,\Omega = 0.9711\,R_c$

$\boxed{R_c = 514.87\,\Omega}$

$V_{out,DC} = 4.5 = R_c I_c$

I_c calculation

$I_c = \frac{4.5}{R_c}$

$I_c = \frac{4.5\text{ V}}{514.87\,\Omega}$

$\boxed{I_c = 8.74\text{ mA}}$

R_1, R_2 Calculation (See note on voltage divider)

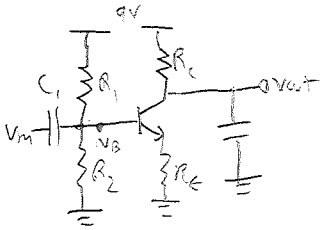
$I_C = \frac{V_E}{R_E} = \frac{V_B - V_{BE}}{R_E} = \frac{1}{R_E}\left(V_{CC}\frac{R_2}{R_1+R_2} - V_{BE}\right) \approx I_C$

$V_{CC}\frac{R_2}{R_1+R_2} >> V_{BE} \;\therefore\; I_C \approx \frac{1}{R_E} V_{CC}\frac{R_2}{R_1+R_2}$

$I_c = \frac{1}{R_E} V_{CC}\frac{R_2}{R_1+R_2}$

$\frac{R_E I_C}{V_{CC}} = \frac{R_2}{R_1+R_2}$

$\frac{R_2}{R_1+R_2} = \frac{(100\,\Omega)(8.74\text{ mA})}{9\text{ V}} = 0.09711$



The voltage divider used in the derivation of I_C in terms of R_1, R_2, R_E, and V_{CC} should actually replace R_2 with $R_2 \| R_{in}$ (with R_{in} being the input resistance of the BJT as seen from V_B). If we let $R_{in} >> R_2$, then we can use the simplification $R_2 \| R_{in} \approx R_2$

$\frac{R_2}{R_1+R_2} \approx 0.0971$

$R_2 = 0.097(R_1+R_2)$

$R_2 \approx 0.097R_1 + 0.097R_2$

$0.90R_2 \approx 0.097R_1$

$9.29\,R_2 \approx R_1$

Impedance of BJT

$\beta R_E + r_\pi$

$\beta R_E + r_\pi \approx 10{,}000\,\Omega$

If $R_{in} \to R_2$, then

$R_2 \| R_{in} \approx R_2$

Let $R_2 \approx 100\,\Omega$

$R_2 = 100\,\Omega$ → Actual resistor values that we have → $R_2 = 100\,\Omega$, $R_1 = 1\text{ k}\Omega$

$R_1 = (100\,\Omega)(9.20) = 929\,\Omega$

Input impedance

$R_{in} = (r_\pi + (\beta+1)R_E) \| R_1 \| R_2$

$R_{in} = \left(r_\pi + (\beta+1)(100\,\Omega)\right) \| (1\text{ k}\Omega) \| (200\,\Omega)$

$(1\text{ k}\Omega) \| (100\,\Omega) = 90.91\,\Omega$

$R_{in} = \left(r_\pi + (\beta+1)(100\,\Omega)\right) \| 90.91\,\Omega$

$r_\pi + (\beta+1)(100\,\Omega) \approx \beta(100\,\Omega) >> 90.91\,\Omega$

$\therefore\; \beta(100\,\Omega) \| 90.91\,\Omega \approx 90.91\,\Omega$

$\boxed{R_{in} = 90.91\,\Omega}$

Output impedance

$R_{out} \approx R_c$

$\boxed{R_{out} = 514.87\,\Omega}$