ECE 363 QUIZ 2 (F18) NAME: Solutions

1 problem for 20 pts

Differential amplifier design

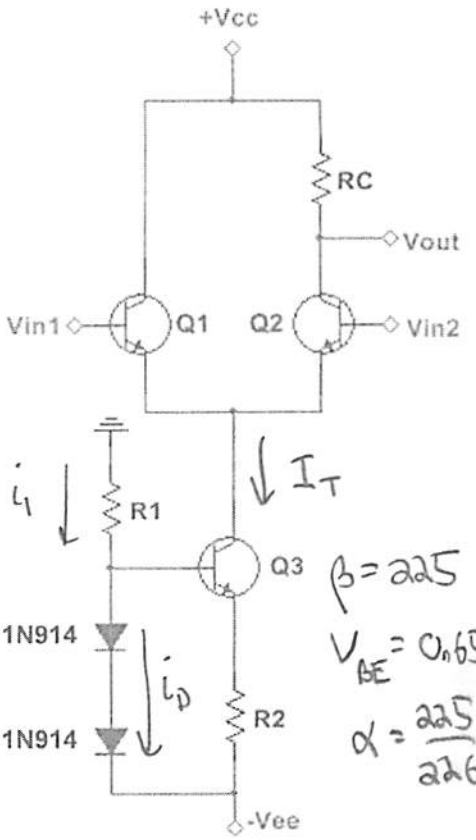
Design a differential amplifier with Ad = 100 (slightly higher is OK) and $Z_{IN} \geq 10$ kohm. The power supplies are +/-15V, and the current source uses two forward-biased 1N914 diodes. Assume all transistors have the same properties as the 2N3904. Use standard 5% resistors.

a) Compute the maximum tail current I_T, assuming Q1 and Q2 have minimum $\beta = 70$.

b) Choose appropriate values for R1 and R2, assuming **typical** Q3 parameters. Assume the 1N914 diodes have $V_F = 0.62V$ @ 1 mA.

c) Based on your chosen values for R1 and R2, compute your actual tail current I_T.

d) Based on your actual I_T, choose the appropriate value for R_C, assuming **typical** Q2 parameters.



$\beta = 225$

$V_{BE} = 0.65V$

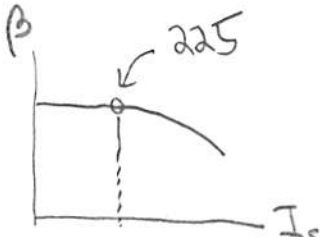
$\alpha = \frac{225}{226} = .996$

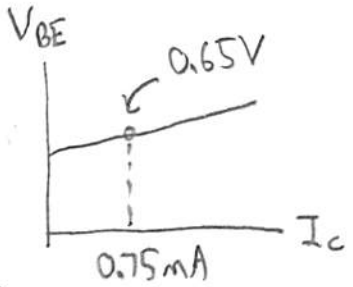
(a) $Z_{IN} = 2(\beta_{min}+1)\, r_e' \geq 10K$

$2(71)\frac{.026}{.5\, I_T} \geq 10K$

$\rightarrow I_T \leq \boxed{0.74mA}$ +4

(b) 2N3904 data sheet:





$I_T = \alpha I_E$

$= .996\ \frac{2*.62-.65}{R_2} \leq .74mA$

$R_2 \geq 0.79K$ Choose $\boxed{R_2 = 820\Omega}$ +4

$I_E = \frac{2*.62-.65}{.82K} = 0.72mA$

$i_D = i_1 - i_{B3} = 1mA \rightarrow \frac{0-(-15+2*.62)}{R_1} - \frac{.72mA}{225+1} = 1mA$

$R_1 = 13.7K \rightarrow$ choose $\boxed{R_1 = 13K}$ +4

(extra sheet for work)

+4

(c) $I_T = .996\,\frac{2(.62)-.65}{.82K} = \boxed{0.72mA}$ ✓

(d) At $I_c \cong \frac{1}{2}(.72mA) = .36mA$

$\beta_{Typical} = 225 \longrightarrow \alpha = .996$

$A_1 = \frac{\alpha R_c}{2r_e'}$ $\qquad r_e' = \frac{.026V}{\frac{1}{2}(.72mA)} = .072K$

$A_1 = .996\,\frac{R_c}{2(.072K)} \geq 100$

$R_c \geq 14.46K$

Choose $\boxed{R_c = 15K}$ +4