BIPOLAR TRANSISTOR BIASING AND BETA DEPENDENCE

- BETA CAN VARY A **LOT**
  - DEVICE TO DEVICE
  - VS. I_C
  - VS. V_{CE}
  - VS: TEMPERATURE

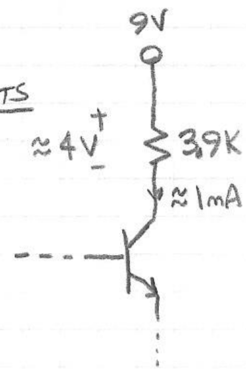
BETA : 3 TRANSISTORS

NOMINAL :	180
LOW :	115
HIGH :	275

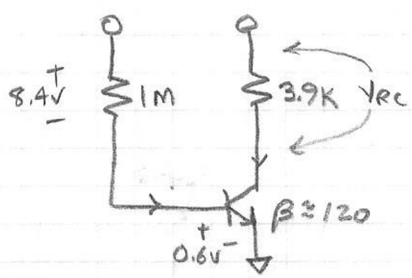
EXAMPLE REQUIREMENTS

OPERATING POINT
QUIESCENT POINT
Q - POINT
BIAS POINT

$V_{CC} = 9V$
$R_L = 3.9 K\Omega$
$V_{RL} \approx 4V$
$I_C \approx 1mA$



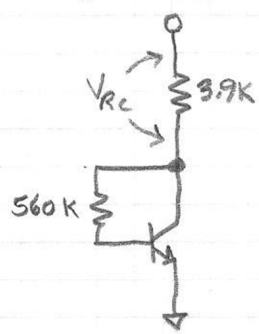
FIXED BASE BIAS



RELIES ON BETA

	V_{RC}
NOMINAL:	4.02
LOW :	2.98
HIGH :	8.69

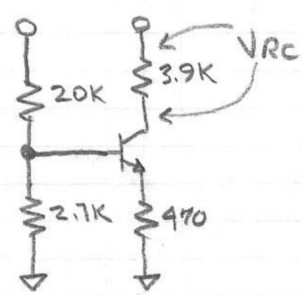
COLLECTOR FEEDBACK BIAS



	V_{RC}
NOMINAL:	3.86
LOW:	3.28
HIGH:	5.50

FEEDBACK HELPS STABLIZE Q-POINT

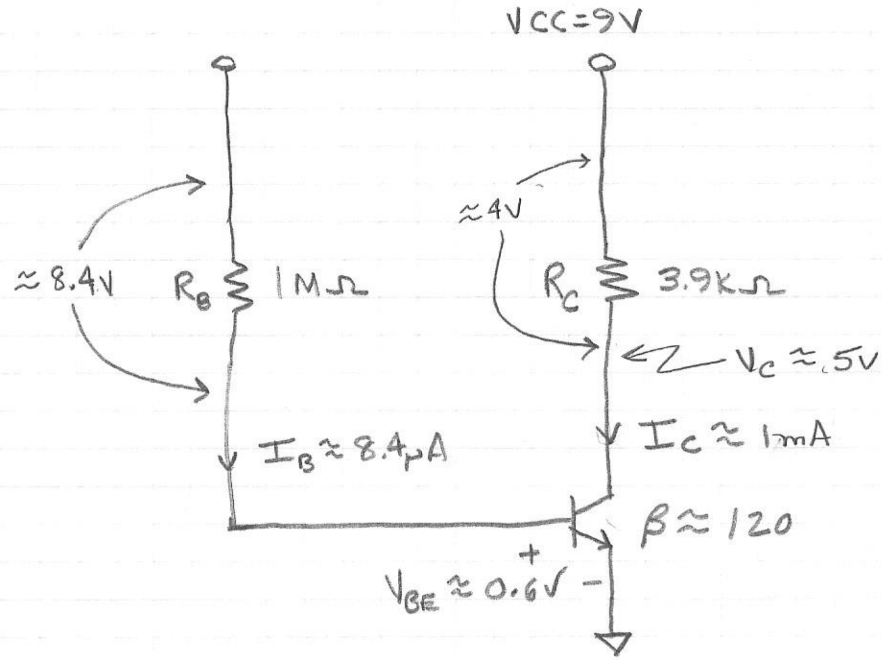
VOLTAGE DIVIDER BIAS



	V_{RC}
NOMINAL:	3.79
LOW :	3.67
HIGH :	3.98V

- USE RESISTORS TO SETUP BIAS VOLTAGES
- MAKE I_B INSIGNIFICANT

BASE BIAS



$$I_B = \frac{V_{CC} - V_{BE}}{R_B} \qquad I_C = \beta \cdot I_B$$

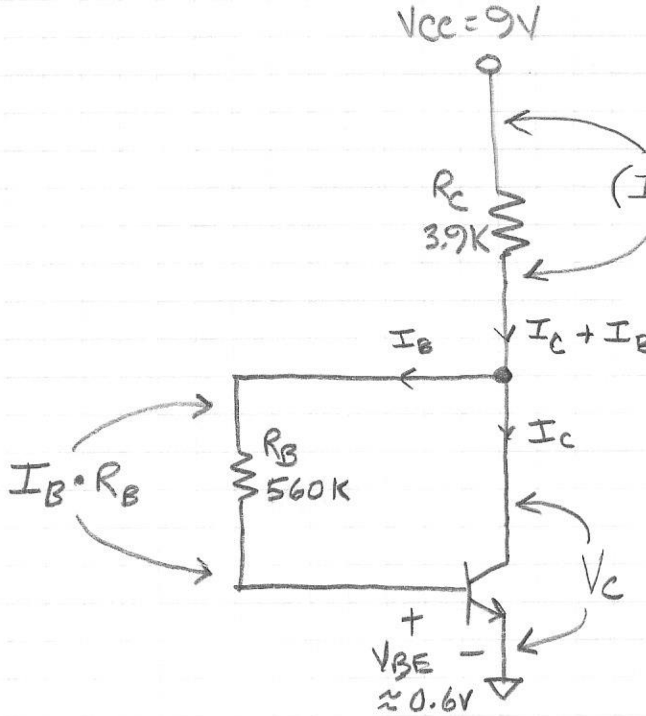
$$V_{RC} = \beta \cdot I_B \cdot R_C$$

$$V_C = V_{CC} - I_C \cdot R_C$$

$$V_C = V_{CC} - \beta \cdot I_B \cdot R_C$$

DIRECT DEPENDENCE ON β

Collector Feedback Bias



$$(I_C + I_B) \cdot R_C = (\beta + 1) \cdot I_B \cdot R_C$$

$$V_{CC} = V_{BE} + I_B \cdot R_B + (\beta+1) \cdot I_B \cdot R_C$$

$$I_B = \frac{V_{CC} - V_{BE}}{R_B + (\beta+1)R_C} \qquad I_C = \frac{\beta \cdot (V_{CC} - V_{BE})}{R_B + (\beta+1)R_C}$$

$$V_{RC} = R_C \cdot (\beta+1) \cdot I_B$$

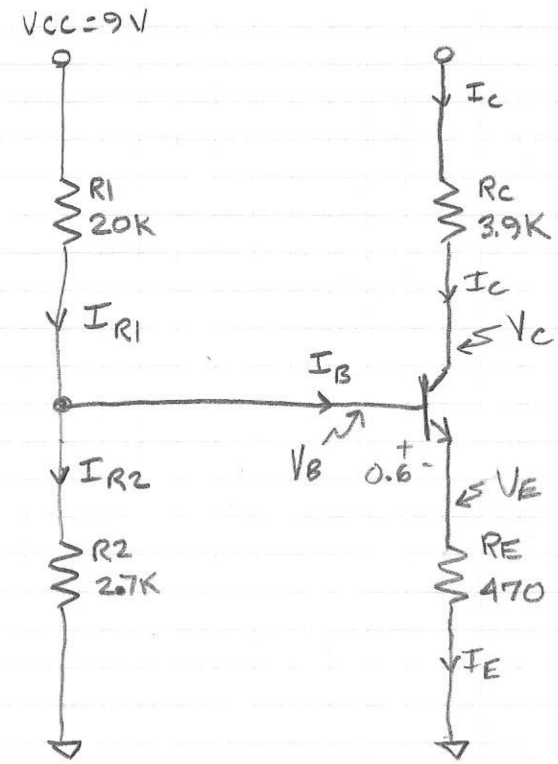
$$V_{RC} = R_C \cdot \frac{(\beta+1) \cdot (V_{CC} - V_{BE})}{R_B + (\beta+1)R_C}$$

$$V_C = V_{CC} - V_{RC}$$

β DEPENDENCE IS REDUCED AS $(\beta+1)R_C$ IS MADE LARGE WITH RESPECT TO R_B

VOLTAGE DIVIDER BIAS

(TAKES I_B OUT OF EQUATION)



- MAKE $I_{R1} >> I_B$ ($\approx 50x$)

- QUICK APPROXIMATIONS:

  $I_C \approx I_E \quad I_{R1} \approx I_{R2}$ ($\beta > 100$)

- SET UP BIAS USING V_E / R_E

  - PICK $V_E \approx 500mV$

  - FOR $I_E \approx 1mA$, $R_E \approx 500\Omega$

    (470 IS CLOSEST VALUE I HAD IN MY STASH)

$\therefore V_B \approx V_{BE} + V_E = 1.1V$

- PICK $I_{R1} \approx 50x \cdot I_B$ $\left[\dfrac{VCC}{R_1 + R_2}\right]$

  - CHOOSE R1 + R2 TO RESULT IN $V_B \approx 1.1V$