Exercise (5)

Base bias :

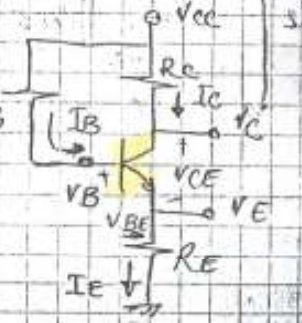
(1) For the circuit shown
$R_C = 2.2K$, $R_B = 240k\Omega$, $\beta = 50$
and $V_{CC} = 12$ Find :
a) I_{BQ} and I_{CQ} b) V_{CEQ} c) V_B and V_C
d) V_{BC} e) $I_{C\,sat}$

(2) $R_C = 2.7K$, $R_B = 470K$, $\beta = 90$ and $V_{CC} = 16$, Find:
a) I_{BQ} and I_{CQ} b) V_{CEQ} c) V_C , V_B, and V_E

(3) $I_B = 40\,\mu A$, $V_C = 6\,V$, $\beta = 80$ and $V_{CC} = 12\,V$
Find : a) I_C b) R_C c) R_B and d) V_{CE}

(4) $I_B = 20\,\mu A$, $R_C = 2.2K$, $I_E = 4\,mA$ and $V_{CE} = 7.2V$
Find : a) I_C b) V_{CC} c) β d) R_B

(5) For the circuit shown :



$R_B = 430\,k\Omega$, $R_C = 2k$, $R_E = 1K$
$\beta = 50$ and $V_{CC} = 20\,V$ Find :
a) I_B and I_C b) V_{CE} c) V_C , V_B , V_E
d) V_{BC} e) $I_{CE(sat)}$

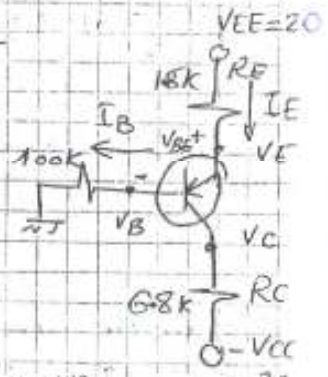
(6) $R_B = 510\,K$, $R_C = 2.4K$, $R_E = 1.5K$, $\beta = 100$
$V_{CC} = 20$ Find : a) I_B and I_C b) V_{CE}
c) V_C , V_B , V_E d) V_{BC} e) $I_{CE\,sat}$ $I_{C\,sat}$

(7) $V_{CC} = 12V$, $I_C = 2\,mA$, $V_C = 7.6\,V$, $V_E = 2.4V$
$\beta = 80$ Find : a) R_C b) R_E c) R_B d) V_{CE}

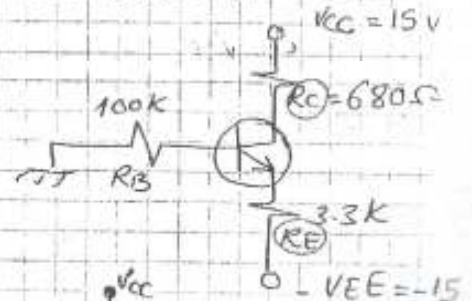
Emitter Bias:

(1) Find V_C, V_E and V_{CE} for the circuit shown, for $\beta = 100$ and $V_{BE} = 0.7\,V$

PnP

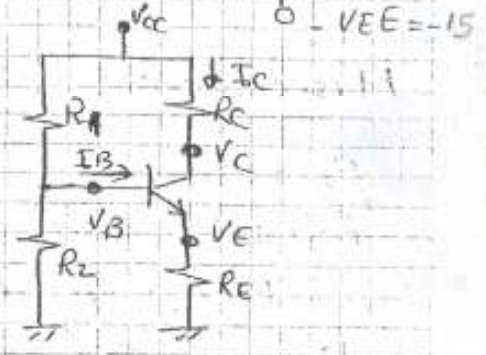


(2) Find I_B, I_C and V_{CE} for the circuit shown.
$\beta = 150$



Voltage Divider bias:

(1) $V_{cc} = 16$ & $R_C = 5.9K$ & $R_E = 0.68K$
$R_1 = 6.2K$ & $R_2 = 9.1K$ and $\beta = 80$
Find a) I_{BQ} & I_{CQ} and V_{CEQ}
b) V_C & V_E and V_B
c) $I_{C(sat)}$

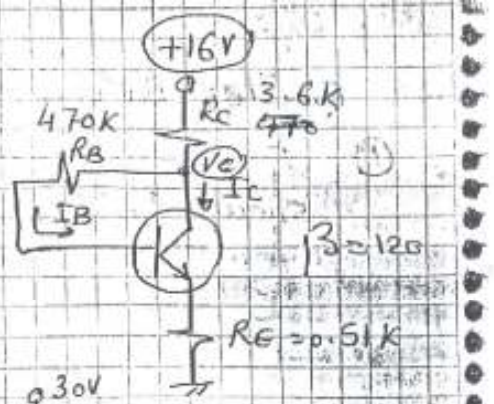


(2) $V_{cc} = 18V$ & $V_C = 12V$ & $R_C = 4.7k$ and $R_E = 1.2k$ & $R_2 = 5.6k$
Find a) I_C b) V_E and V_B c) R_1

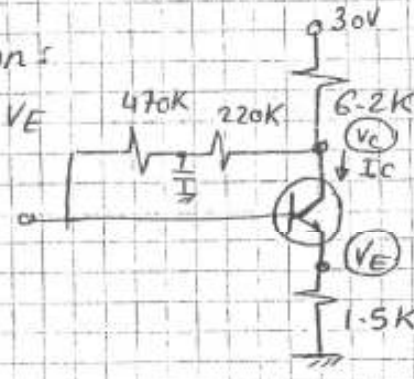
(3) Given $R_C = 2.7K$ and $R_E = 1.2K$ & $\beta = 100$ & $I_B = 20\mu A$
and $R_2 = 8.2$ kΩ (and $V_C = 10.6V$) Find a) I_C b) V_{CC} and V_{CE} and V_B
c) R_1

Collector feed back bias

1) Find a) I_B b) I_C d) V_C

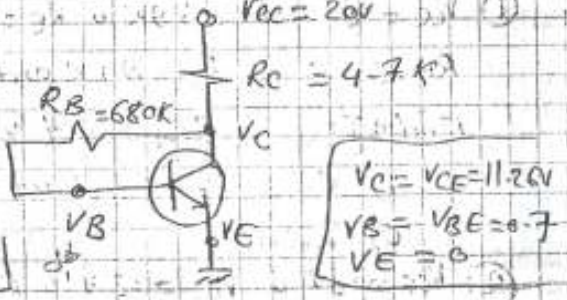


2) For the circuit shown:
Find a) I_C b) V_C c) V_E
d) V_{CE}



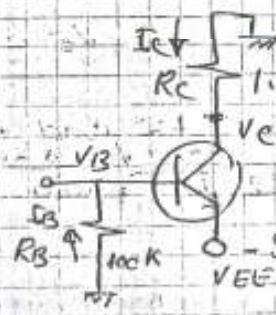
Miscellaneous Bias

1) $\beta = 120$
Find a) I_{CQ} and V_{CEQ}
b) V_B, V_C, V_E and V_{BC}



$I_{CQ} = 1.86$ mA & $V_{CEQ} = 11.26$V

2) Find V_C and V_B



Solution:

$$I_B R_B + V_{BE} - V_{EE} = 0$$

$$\therefore I_B = \frac{V_{EE} - V_{BE}}{R_B} = \frac{8.3}{100K\Omega}$$

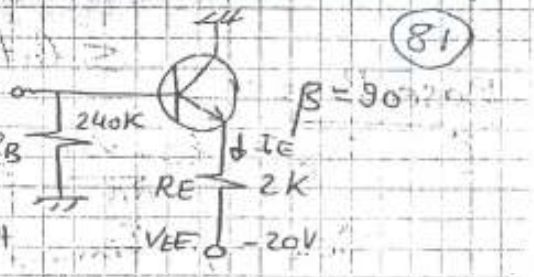
$$= 83\ \mu A$$

$$I_C = \beta I_B = 3.735\ mA$$

$$V_C = -I_C R_C = -4.48V$$

$$V_B = -I_B R_B = -8.3\ V$$

③ Find V_{CEQ} and I_E



solution

$I_B R_B + V_{BE} + I_E R_E - V_{EE} = 0$

but $I_E \simeq (\beta+1) I_B = 4.16\ mA$

$I_B = \frac{V_{EE} - V_{BE}}{R_B + (\beta+1) R_E} = 45.73\ \mu A$

$I_C = \beta I_B = 4.12\ mA$

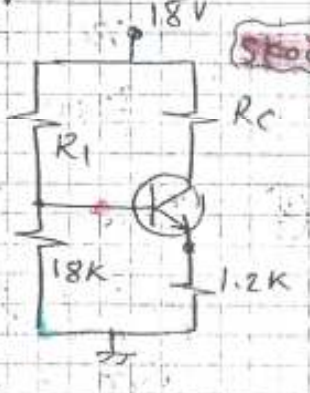
$V_{CE} + I_E R_E - V_{EE} = 0 \Rightarrow V_{CE} = V_{EE} - I_E R_E$

$V_{CE} = V_{EE} - (\beta+1) I_B R_E \simeq 11.68\ V$

④ For the circuit shown

$I_{CQ} = 2\ mA$ & $V_{CEQ} = 10\ V$

Find R_1 and R_C



solution

$V_E = I_E R_E \simeq I_C R_E$

$= 2 \times 10^{-3} \times 1.2k = 2.4\ V$

$V_B = V_{BE} + V_E = 3.1\ V$

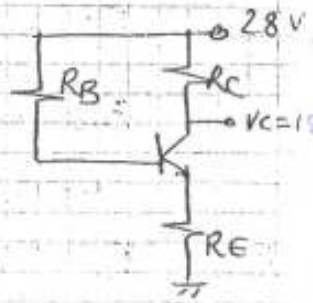
$V_{B} = V_{CC} \frac{R_2}{R_1 + R_2} = 3.1 \Rightarrow R_1 = 86.52\ K\Omega$

$R_C = \frac{V_{CC} - V_C}{I_C} \Rightarrow$

$V_C = V_{CE} + V_E = 10 + 2.4 = 12.4\ V$

$R_C = \frac{18 - 12.4}{2 \times 10^{-3}} = \frac{5.6}{2 \times 10^{-3}} = 2.8\ K\Omega$

⑤ For the circuit shown $\beta = 110$



$I_{CQ} = \frac{1}{2} I_{Csat}$ & $I_{Csat} = 8\ mA$

solution

$I_{CQ} = \frac{1}{2} I_{Csat} = 4\ mA$

$R_C = \frac{V_{CC} - V_C}{I_{CQ}} = \frac{28 - 18}{4} = 2.5\ K\Omega$

$I_{C(sat)} = \frac{V_{CC}}{R_C + R_E} \Rightarrow R_E = 1\ K$

$I_{BQ} = \frac{I_{CQ}}{\beta} = \frac{4\ mA}{110} = 36.36\ \mu A = \frac{V_{CC} - V_{BE}}{R_B + (B+1) R_E}$

$R_B = 639.8\ K$

Base Bias — Solution for the Exercise

(1) $I_{BQ} = \frac{V_{CC} - V_{BE}}{R_B} = \frac{12 - 0.7}{240 \times 10^3} = 47\ \mu A$

$I_{CQ} = \beta I_{BQ} = 50 \times 47 = 2350\ \mu A = 2.35\ mA$

$V_{CEQ} = V_{CC} - I_C R_C = 12 - 2.35 \times 2.2 = 6.83\ V$

$V_B = V_{BE} = 0.7\ V$

$V_C = V_{CE} = 6.83\ V$

$V_{BC} = V_B - V_C = -6.13\ V$

$I_{C\,sat} = \frac{V_{CC}}{R_C} = \frac{12}{2.2 \times 10^3} = 5.455\ mA$

(2) $I_{BQ} = \frac{V_{CC} - V_{BE}}{R_B} = \frac{16 - 0.7}{470 \times 10^3} = 32.55\ \mu A$

$I_{CQ} = \beta I_{BQ} = 90 \times 32.55 = 2.93\ mA$

$V_{CEQ} = V_{CC} - I_{CQ} R_C = 16 - 2.93 \times 2.7 = 8.1\ V$

$V_C = V_{CEQ} = 8.1\ V$

$V_B = V_{BE} = 0.7\ V$ — $V_E = 0$

(3) $I_C = \beta I_B = 80 \times 40 = 3200\ \mu A = 3.2\ mA$

$R_C = \frac{V_{CC} - V_C}{I_C} = \frac{12 - 6}{3.2 \times 10^{-3}} = 1.875\ k\Omega$

$R_B = \frac{V_{CC} - V_{BE}}{I_B} = \frac{12 - 0.7}{40 \times 10^{-6}} = 282.5\ k\Omega$

$V_{CE} = V_C = 6\ V$

(4) $I_C \approx I_E = 4\ mA$

$\beta = \frac{I_C}{I_B} = \frac{4 \times 10^{-3}}{20 \times 10^{-6}} = 200$

$V_{CE} = V_{CC} - I_C R_C$ $\therefore V_{CC} = V_{CE} + I_C R_C =$

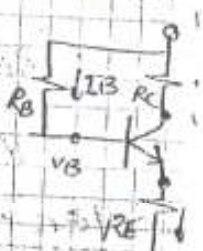
$V_{CC} = 7.2 + 4 \times 2.2 = 7.2 + 8.8 = 16\ V$

$R_B = \frac{V_{CC} - V_{BE}}{I_B} = \frac{16 - 0.7}{20 \times 10^{-6}} = 765\ k\Omega$

(5)

$$I_B = \frac{V_{CC} - V_B}{R_B}$$

$$V_B = V_{BE} + I_C R_E$$



$$R_B I_B = V_{CC} - V_{BE} + \beta I_B R_E$$

$$I_B (R_B + \beta R_E) = V_{CC} - V_{BE}$$

$$\therefore I_{BQ} = \frac{V_{CC} - V_{BE}}{R_B + \beta R_E} = \frac{20 - 0.7}{(430 + 50) \times 10^3} = 40.2\ \mu A$$

$$I_{CQ} = \beta I_{BQ} = 50 \times 40.2 = 2010.0\ \mu A = 2.01\ mA$$

$$V_{CEQ} = V_{CC} - I_C (R_C + R_E) = 20 - 2.01(2+1) = 13.97$$

$$V_C = I_C R_E + V_{CEQ} = V_{CC} - I_C R_C = 20 - 2.01 \times 2 = 15$$

$$V_E = I_C R_E = 2.01 \times 1 = 2.01\ V$$

$$V_B = V_{BE} + V_E = 0.7 + 2.01 = 2.71\ V$$

$$I_{CE\,sat} = \frac{V_{CC}}{R_C + R_E} = \frac{20}{3 \times 10^3} = 6.667\ mA$$

(6)

$$I_{BQ} = \frac{V_{CC} - V_{BE}}{R_B + \beta R_E} = \frac{20 - 0.7}{(510 + 150) \times 10^3} = 29.2\ \mu A$$

$$I_{CQ} = \beta I_{BQ} = 2.92\ mA$$

$$V_{CEQ} = V_{CC} - I_C (R_C + R_E) = 20 - 2.92 \times 3.9 = 8.61$$

$$V_E = I_C R_E = 2.92 \times 10^{-3} \times 1.5 \times 10^3 = 4.38\ V$$

$$V_C = V_{CE} + V_E = 12.992\ V$$

$$V_B = V_{BE} + V_E = 0.7 + 4.38 = 5.08\ V$$

$$V_{BC} = V_B - V_C = -7.912\ V$$

$$I_{CE\,sat} = \frac{V_{CC}}{R_C + R_E} = \frac{20}{3.9k} = 5.13\ mA$$

(7)

$$R_C = \frac{V_{CC} - V_C}{I_C} = \frac{12 - 7.6}{2 \times 10^{-3}} = 2.2\ k\Omega$$

$$R_E = \frac{V_E}{I_C} = \frac{2.4}{2 \times 10^{-3}} = 1.2\ k\Omega$$

$$R_B = \frac{V_{CC} - V_B}{I_B} \quad ; \quad V_B = V_{BE} + V_E = 0.7 + 2.4 = 3.$$

$$I_B = \frac{I_C}{\beta} = \frac{2 \times 10^{-3}}{80} = 25\ \mu A$$

$$\therefore R_B = \frac{12 - 3.1}{25\times10^{-6}} = 356\ K\Omega$$

$$V_{CE} = V_C - V_E = 7.6 - 2.4 = 5.2\ V$$

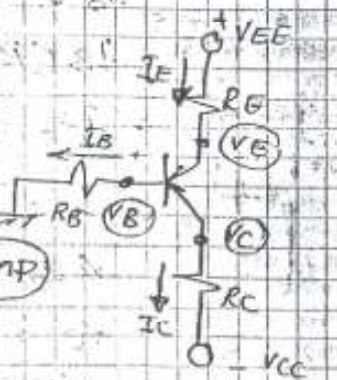
Other Bias

$$V_B = +V_{BE} - I_E R_E + V_{EE}$$

$$I_B R_B + \beta I_B R_E = V_{EE} + V_{BE}$$

$$I_{B_Q} = \frac{V_{EE} + V_{BE}}{R_B + \beta R_E}$$

$$= \frac{20 - 0.7}{(100 + 180)\times10^3} = 68.9\ \mu A$$



$$I_{C_Q} = \beta I_{B_Q} = 6.89\ mA$$

$$V_E = V_{EE} - I_E R_E = 20 - 6.89\times1.8 = 7.6\ V$$

$$V_C = I_C R_C - V_{CC} = 6.89\times6.8 - 20 = 26.85\ V$$

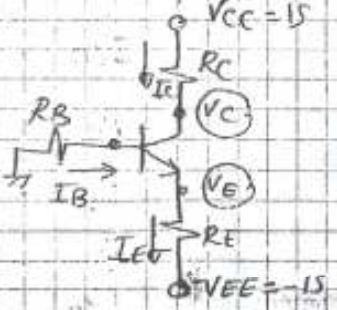
$$V_{CE} = V_C - V_E = 26.85 - 7.6 = 19.25\ V$$

$$I_B R_B + V_{BE} + I_E R_E - V_{EE} = 0$$

$$I_B (R_B + \beta R_E) = V_{EE} - V_{BE}$$

$$I_{B_Q} = \frac{V_{EE} - V_{BE}}{R_B + \beta R_E} = \frac{15 - 0.7}{(100 + 180\times3.3)10^3}$$

$$= \frac{14.3}{595\times10^3} = 24\ \mu A$$



$$I_{C_Q} = \beta I_{B_Q} = 3.6\ mA$$

$$V_{CC} = I_C R_C + V_{CE} + I_E R_E - V_{EE}$$

$$V_{CE} = (V_{CC} + V_{EE}) - I_C (R_C + R_E) = 30 - 3.6\times10^{-3}\times8.98k$$

$$= 30 - 3.6\times10^{-3}(3.3 + 0.68)\times10^3 = 15.672\ V$$