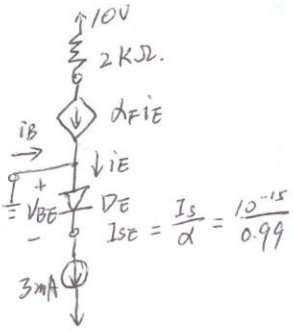
EE 20242 HW6

6.13. $i_C = I_S e^{v_{BE}/V_T} = (5\times10^{-15})\, e^{0.650/0.025} = 977\,\mu A$

$i_B = \frac{i_C}{\beta}$ from $\frac{i_C}{\beta} = \frac{977\times10^{-6}}{50} = 19.6\,\mu A$ to $\frac{i_C}{\beta} = \frac{977\times10^{-6}}{200} = 4.89\,\mu A$

$i_E = \frac{\beta+1}{\beta} i_C$ from $\frac{\beta+1}{\beta} i_C = \frac{51}{50}\times977\times10^{-6} = 998\,\mu A$ to $\frac{\beta+1}{\beta} i_C = \frac{201}{200}\times977\times10^{-6} = 983\,\mu$

6.17.



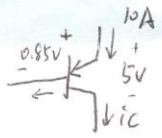
$\beta = 100$. $I_S = 10^{-15} \Rightarrow \alpha = \frac{100}{101} = 0.99$

$I_E = I_{SE} e^{V_{BE}/V_T} \Rightarrow 3\times10^{-3} = \frac{10^{-15}}{0.99} e^{V_{BE}/0.025} \Rightarrow V_{BE} = 0.718$

$V_E = 0 - 0.718 = -0.718V$

$i_C = \alpha i_E = 0.99\times3mA$ $V_C = 10 - 2 i_C = 10 - 2\times0.99\times3 = 4.06V$

6.25.



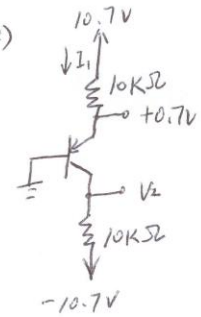
$i_E = (\beta+1) i_B \Rightarrow 10A = (15+1) i_B \Rightarrow i_B = 0.625A$

$i_C = \frac{\beta}{\beta+1} i_E = I_{S1} e^{V_{EB}/V_T} \Rightarrow \frac{15}{16}\times10 = I_{S1} e^{0.85/0.025} \Rightarrow I_{S1} = 1.6\times$

$I_{S2} = i_C e^{-V_{EB}/V_T} = 10^{-3} e^{-0.7/0.025} = 6.9\times10^{-16}$

$\frac{\text{Area1}}{\text{Area2}} = \frac{I_{S1}}{I_{S2}} = \frac{1.6\times10^{-14}A}{6.9\times10^{-16}A} = 23.3$

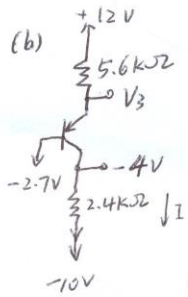
6.28 (a)



$I_1 = \frac{10.7-0.7V}{10K\Omega} = 1mA$

$V_2 = -0.7V$

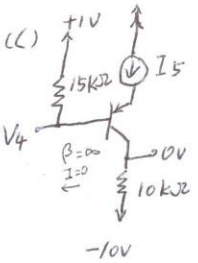
(b)



$I = \frac{-4+10}{2.4} = 2.5mA$

$V_3 = 12 - 5.6\times2.5 = -2V$

(c)

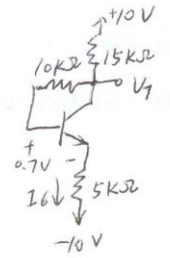


$I_5 = \frac{0-(-10)V}{10\,k\Omega} = 1mA$

$V_4 = 1V - 0V = 1V$

P1

(d)



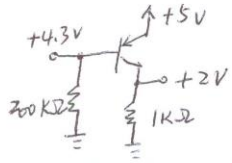
$I_E = I_C \quad V_B = 0$

$$\frac{V_B - 0.7V + 10V}{5K\Omega} = \frac{10 - V_E}{15K\Omega}$$

$$\Rightarrow V_1 = V_E = -4.475V$$

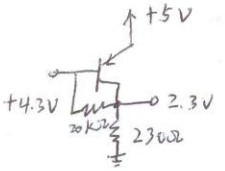
$$I_6 = \frac{V_1 - 0.7V + 10V}{5K\Omega} = 0.965mA$$

6.29



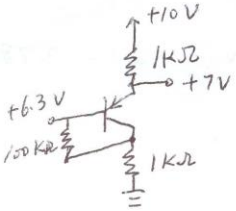
(a)

$$\beta = \frac{I_C}{I_B} = \frac{\frac{2V}{1K\Omega}}{\frac{4.3V}{200K\Omega}} = \frac{2mA}{0.0251mA} = 93$$



(b)

$$\left.\begin{aligned}(I_C + I_B) \times 230\Omega = 2.3V \\ I_B = \frac{4.3V - 2.3V}{20K\Omega} = 0.1mA\end{aligned}\right\} \Rightarrow \beta = \frac{I_C}{I_B} = \frac{10mA - 0.1mA}{0.1mA} = 99$$



(c)

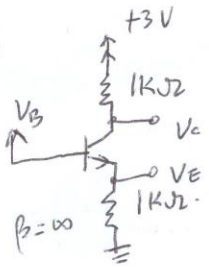
$$I_E = I_B + I_C = \frac{10V - 7V}{1K\Omega} = 3mA$$

$$V_C = 3mA \times 1K\Omega = 3V$$

$$I_B = \frac{6.3V - 3V}{100K\Omega} = 33\mu A$$

$$1 + \beta = \frac{I_E}{I_B} = \frac{3mA}{33\mu A} = 90.9 \Rightarrow \beta = 89.9$$

6.53



maximum $V_B = V_C$, assume $V_{BE}=0.8V$ or $V_{BE}=0.7V$

$V_E = V_B - V_{BE} = V_B - 0.8\,V$ $\quad V_B = V_E + 0.8\,V$

$V_E = I_E \times (1K\Omega)$

for high $\beta \Rightarrow I_E = I_C$

$3 - I_C \times (1K) = V_C$

$I_C \times (1K) + 0.8V = V_B$ $\Rightarrow I_C = 1.1\,mA$

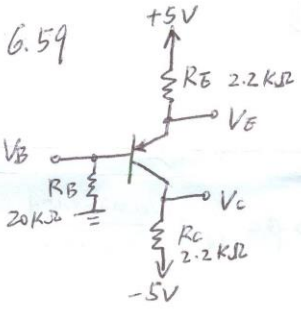
$V_C = V_B$ $\quad V_C = V_B = 3 - 1.1m\,(1K) = 1.9\,V$

With $\beta = 1$ $\quad I_C = I_B \Rightarrow I_E = I_C + I_B = 2I_C$ $\quad 2\left(\frac{-V_C+3}{1K\Omega}\right) = \frac{V_E}{1K}$ $\Rightarrow V_E = 1.9V$

$V_{CE} = 0.2$

$V_B = 1.9\,V + 0.8\,V = 2.7\,V$ or $V_B = 1.9\,V + 0.7\,V = 2.6\,V$

6.59



for $R_B = 20K\Omega$.

$I_E = \frac{5-0.7}{2.2+20/51} = 1.66\,mA$

$I_C = I_E \frac{50}{51} = 1.63\,mA$

$V_C = -5 + 2.2 \times 1.63 = -1.42\,V$

$V_E = +5 - 2.2 \times 1.66 = +1.35\,V$

$V_B = V_E - 0.7 = -0.65\,V$

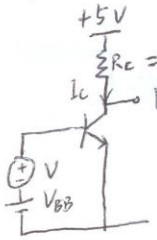
for $R_B = 100K\Omega$

$I_E = \frac{5-0.7}{2.2+100/51} = 1.03\,mA$, $\quad V_E = 5 - 1.03 \times 2.2 = +2.73\,V$

$V_B = 0 + \frac{1.03}{51} \times 100 = +2.03\,V$, $\quad V_C = -5 + 1.03 \times \frac{50}{51} \times 2.2 = -2.78\,V$

for same I_B: $\beta = 51 \times \frac{100}{20} - 1 = 255$

6.72



For $I_C \approx 0.5\,mA$

$A_V = \frac{I_C R_C}{V_T} = \frac{0.5}{0.025} = 20\ V/V$

$V_{CE} = V_{CC} - I_C R_C = 5 - 0.5 = 4.5\,V$

max $+\Delta V_o = 5 - 4.5 = 0.5\,V$

min $-\Delta V_o = 0.3 - 4.5 = -4.2\,V$

I_C(mA)	A_v(V/V)	$+\Delta V_o$	$-\Delta V_o$
0.5	-20	0.5	4.2
1.0	-40	1.0	3.7
2.5	-100	2.5	2.2
4.0	-160	4.0	0.7
4.5	-180	4.5	0.2