Chapter 5:Part 1 – Assignment Problems from S&S with Solutions

Question 5.3

$$i_c = I_s e^{v_{BE}/V_T}$$

For Device #1

$$0.2\times10^{-3} = I_{S1} e^{0.72/0.025}$$

$$I_{S1} = \underline{\underline{6.214\times10^{-17} A}}$$

For Device #2

$$12\times10^{-3} = I_{S2} e^{0.72/0.025}$$

$$I_{S2} = \underline{\underline{3.728\times10^{-15} A}}$$

Since $I_s \propto A$, the relative junction areas is:

$$\frac{A_2}{A_1} = \frac{I_{S2}}{I_{S1}} = \frac{i_{c2}}{i_{c1}} = \frac{12}{0.2} = \underline{\underline{60}}$$

Question 5.4

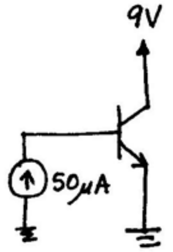
$$i_c = \beta i_B$$

$$400 = \beta\times7.5$$

$$\beta = \frac{400}{7.5} = \underline{\underline{53.3}}$$

$$\alpha = \frac{\beta}{\beta+1} = \frac{53.3}{54.3} = \underline{\underline{0.982}}$$

Question 5.10



$\beta = 60$ to 300

$I_C = \beta I_B$ ranges from

$= 60 \times 50\mu A$ to $300 \times 50\mu A$

$= \underline{\underline{3mA \text{ to } 15mA}}$

$I_E = I_C + I_B$ ranges from

$= \underline{\underline{3.05mA \text{ to } 15.05mA}}$

Max Power $= 9 \times I_{C max} = 9 \times 15$

$= \underline{135mW}$

Question 5.17

$\therefore i_C = I_S e^{v_{EB}/V_T}$

Use $\dfrac{i_C}{1A} = e^{\frac{v_{EB} - 0.8}{0.025}}$

to calculate v_{EB} for a particular i_C

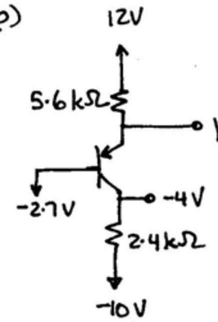
for $i_C = 10mA$ $\quad v_{EB} = 0.685V$

$i_C = 5A$ $\quad v_{EB} = 0.840V$

Question 5.20

(a) $I_1 = \frac{10.7 - 0.7}{10} = \underline{\underline{1mA}}$

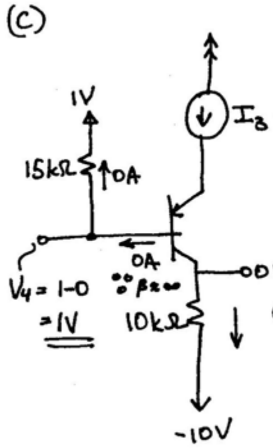
(b)



$V_2 = 12 - 5.6 \times 2.5 = \underline{\underline{-2V}}$

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

(c)

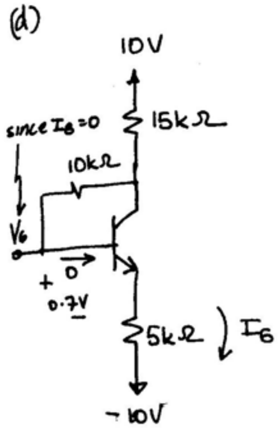


$I_3 = \underline{\underline{1mA}}$ ∵ $\alpha \approx 1$

$V_4 = 1 - 0 = \underline{\underline{1V}}$ ∵ $\beta \approx \infty$

$\frac{0-(-10)}{10} = 1mA$

(d)



$I_E = I_C$

$\frac{V_6 - 0.7 + 10}{5} = \frac{10 - V_6}{15}$

$15V_6 + 139.5 = 50 - 5V_6$

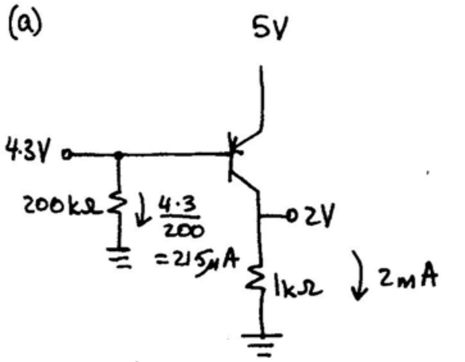
$V_6 = \underline{\underline{-4.475V}}$

$I_6 = \frac{V_6 - 0.7 + 10}{5}$

$= \frac{-4.475 - 0.7 + 10}{5} = \underline{\underline{0.965mA}}$

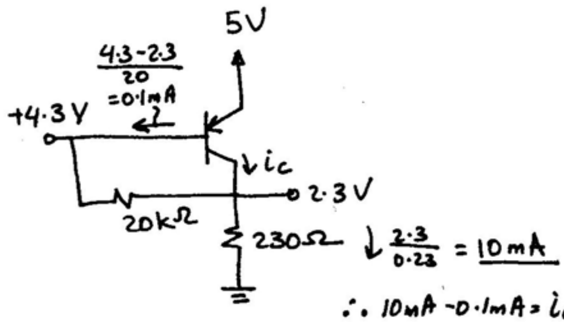
Question 5.21

(a)



$$\frac{i_C}{i_B} = \beta = \frac{2}{0.0215} = \underline{\underline{93.0}}$$

(b)



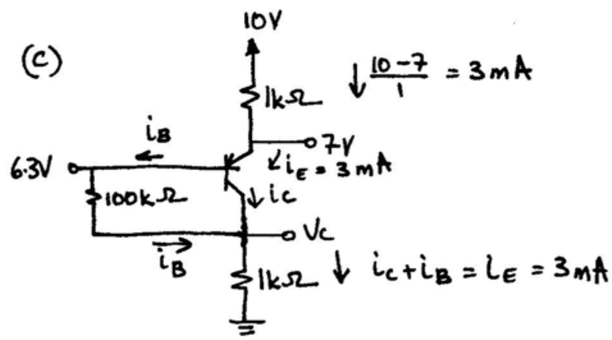
$\therefore$ 10mA − 0.1mA = i_C

9.9mA = i_C

$$\frac{i_C}{i_B} = \frac{9.9}{0.1} = \beta$$

$$\beta = \underline{99}$$

(c)



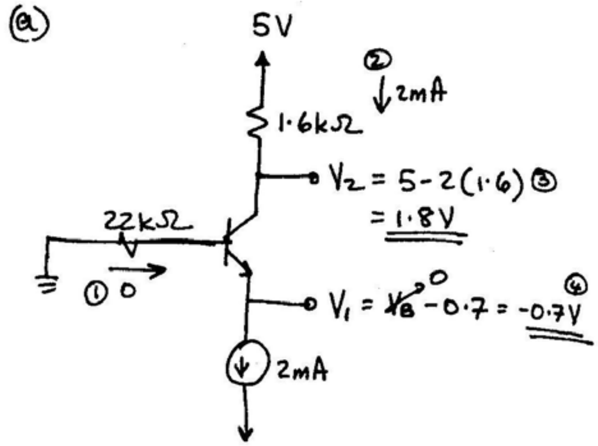
$$V_C = 3 \times 1 = 3\,V$$

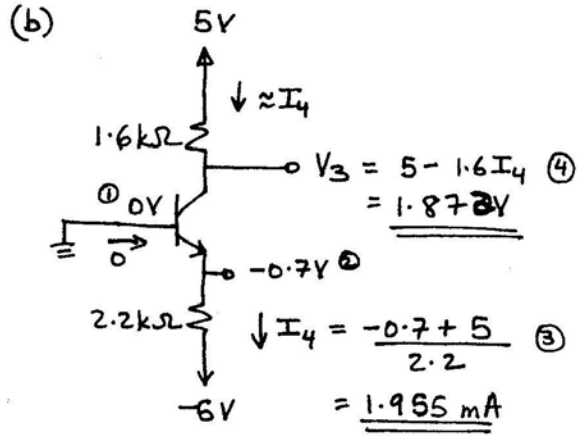
$$i_B = \frac{6.3-3}{100} = \frac{3.3}{100}$$

$$\beta + 1 = \frac{i_E}{i_B} = \frac{3 \times 100}{3.3}$$

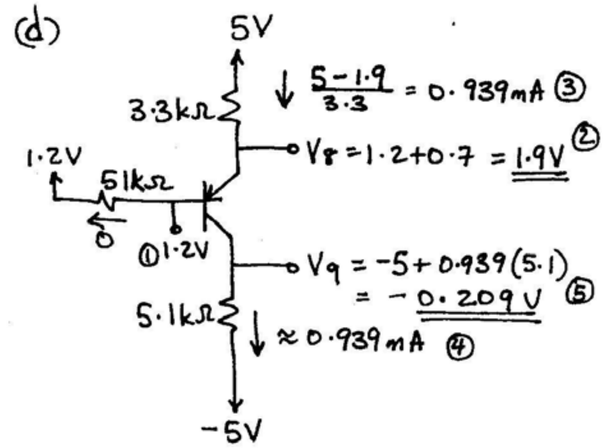
$$\beta = \frac{300}{3.3} - 1 = \underline{\underline{89.9}}$$

Question 5.79

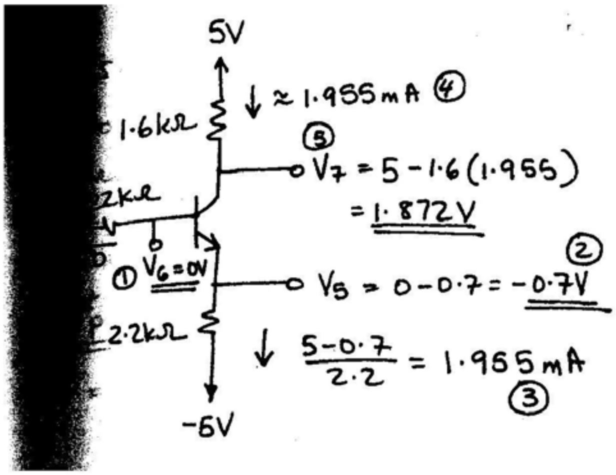




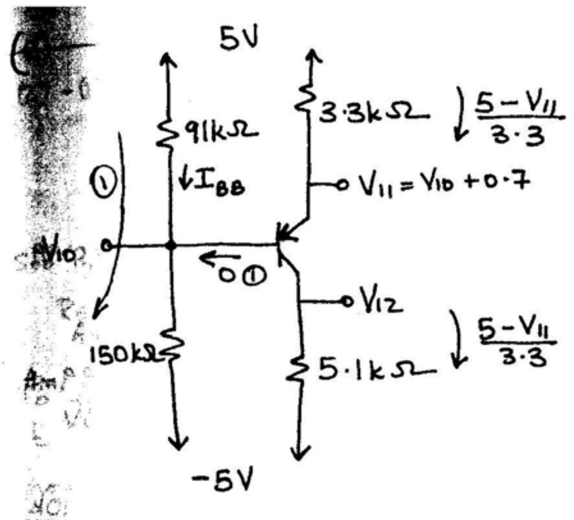
see below for part (c)



(C)



(D)



Loop ①

$$5 - 91 I_{BB} - 150 I_{BB} + 5 = 0$$

$$I_{BB} = \frac{10}{91 + 150}$$

$$V_{10} = -5 + 150 I_{BB}$$

$$= -5 + \frac{150}{91 + 150} \times 10$$

$$= \underline{\underline{1.224V}}$$

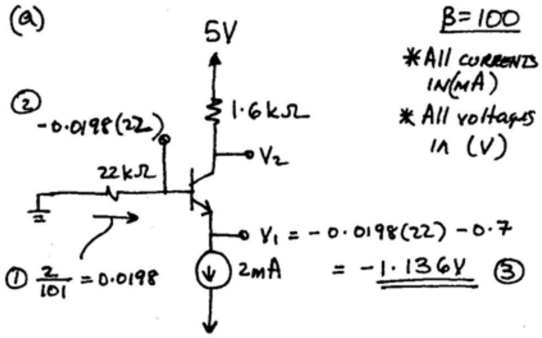
$$V_{11} = V_{10} + 0.7 = \underline{\underline{1.924V}}$$

$$\therefore I_C \approx I_E = \frac{5 - V_{11}}{3.3}$$

$$V_{12} = -5 + \left(\frac{5 - V_{11}}{3.3}\right) 5.1 = \underline{\underline{-0.246V}}$$

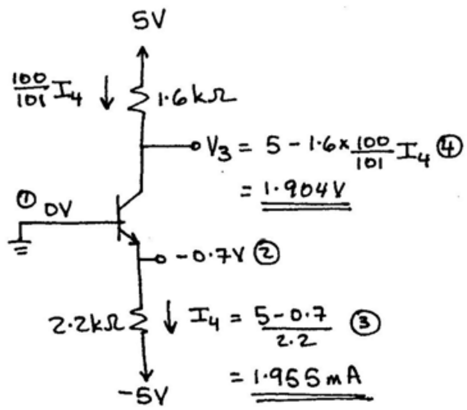
Question 5.80

(a)

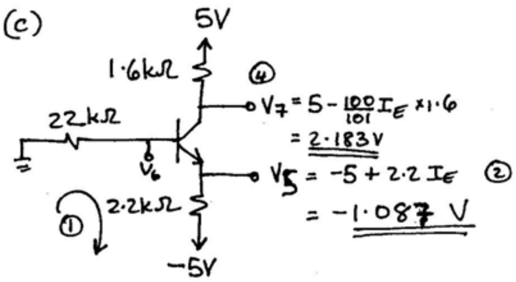


④ $V_2 = 5 - 2\left(\frac{100}{101}\right)1.6 = 1.832V$

(b)



(c)

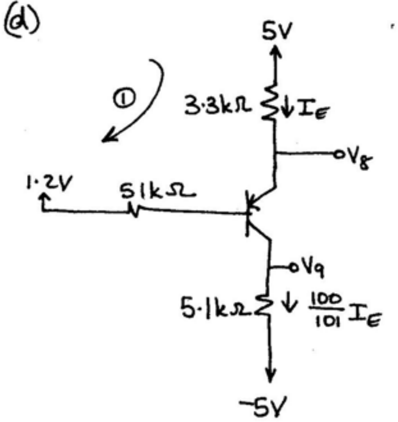


Loop ① $0 - \frac{I_E}{101} 22 - 0.7 - 2.2 I_E + 5 = 0$

$I_E = 1.778 mA$

③ $V_6 = V_5 + 0.7 = -0.387 V$

(d)



Loop ①

$$5 - 3.3 I_E - 0.7 - \frac{I_E}{101} 51 - 1.2 = 0$$

$$I_E = 0.8147 \, mA$$

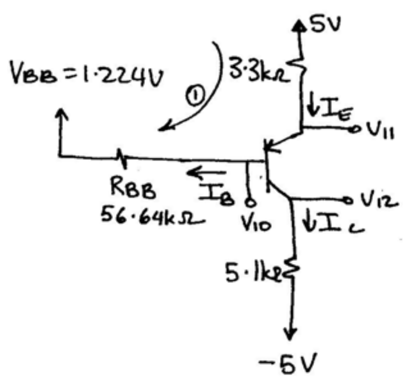
$$V_8 = 5 - 3.3 I_E = \underline{\underline{2.3114 \, V}}$$

$$V_9 = -5 + 5.1 \times \frac{100}{101} I_E = \underline{\underline{-0.8862 V}}$$

(e) *Use Thévenin's theorem to simplify the bias network:*

$$V_{BB} = -5 + \frac{150}{150+91} \times 10 = 1.224 \, V$$

$$R_{BB} = 150 \| 91 = 56.64 \, k\Omega$$



Loop ①

$$5 - 3.3 I_E - 0.7 - \frac{I_E}{101} R_{BB} - 1.224 = 0$$

$$I_E = 0.7967 \, mA$$

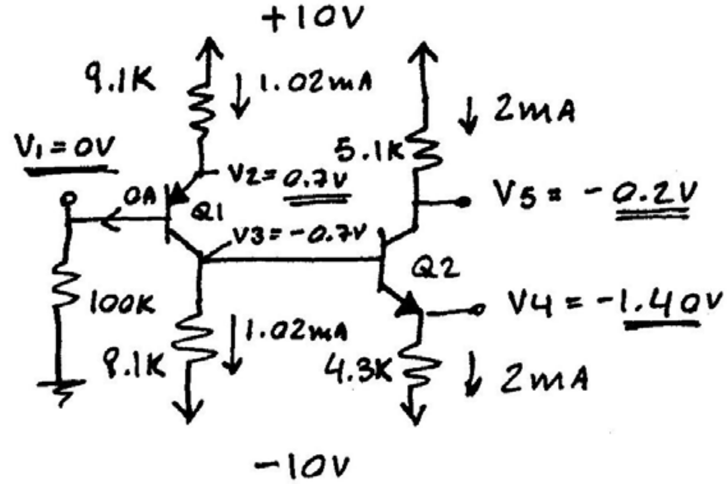
$$V_{11} = 5 - 3.3 I_E = \underline{\underline{2.371 V}}$$

$$V_{12} = \frac{100}{101} I_E \times 5.1 - 5 = \underline{\underline{-0.977 V}}$$

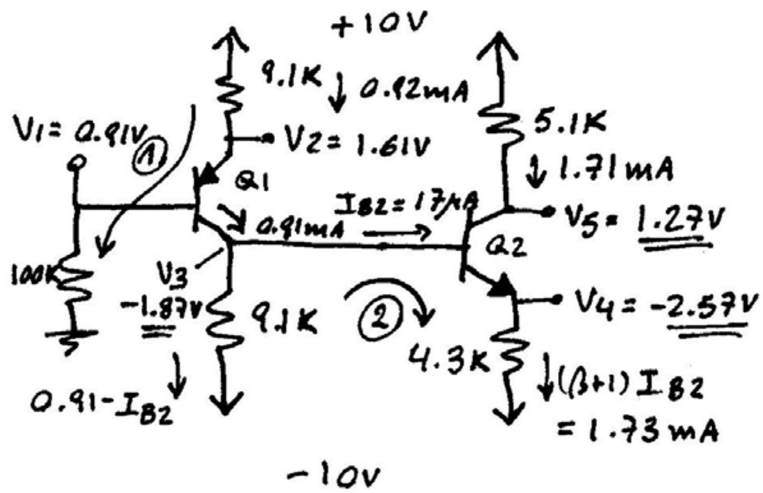
$$V_{10} = V_{11} - 0.7 = \underline{\underline{1.67 V}}$$

Question 5.84

(a) $\beta = \infty$



(b) $\beta = 100$



① $10 - 9.1(\beta+1)I_{B1} - 0.7 - 100 I_{B1}$

$= 0$

$\rightarrow I_{B1} = 0.009\ mA$

② $(0.91 - I_{B2}) \times 9.1 =$

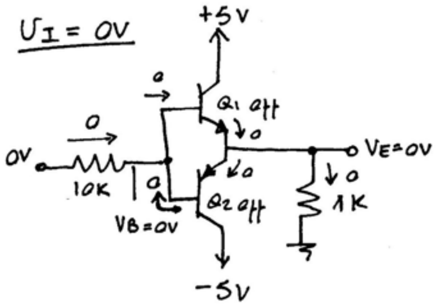
$0.7 + (\beta+1) I_{B2} \times 4.3$

$\rightarrow I_{B2} = 0.017\ mA$

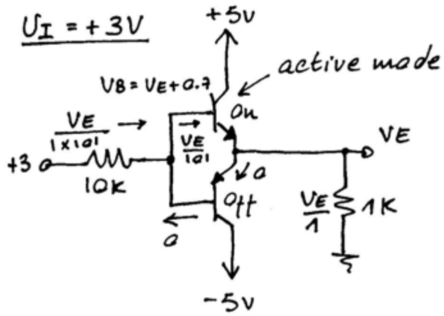
$\rightarrow I_{E2} = 1.73\ mA$

Question 5.86

$v_I = 0V$



$v_I = +3V$

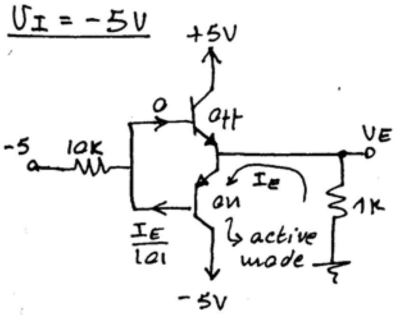


$$3 = \frac{V_E}{101} \times 10 + 0.7 + V_E$$

$$\Rightarrow V_E = \underline{\underline{2.09V}}$$

$$V_B = \underline{\underline{2.79V}}$$

$v_I = -5V$

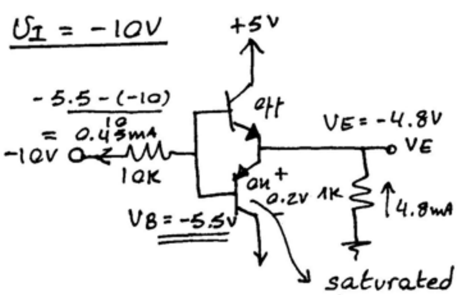


$$I_E = \frac{5-0.7}{1+10/101} = 3.91mA$$

$$V_E = -3.91V$$

$$V_B = \underline{\underline{-4.61V}}$$

$v_I = -10V$



$$\frac{I_C}{I_B} = \frac{4.35}{0.45} = 9.7 < 100$$

thus, Q_2 is saturated as assumed

$V_E = \underline{\underline{-4.8V}}$ $V_B = \underline{\underline{-5.5V}}$