Ex: 6.13

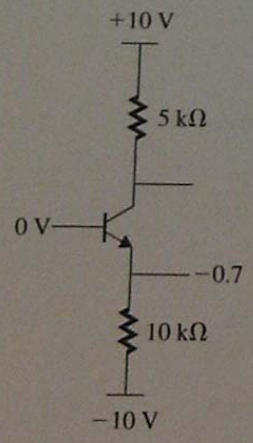


Fig 6.13

$\beta = 50$, $V_{BE} = 0.7$ V

$V_E = V_B - 0.7$ V

$= 0 - 0.7 = -0.7$ V

$$I_E = \frac{-0.7 + 10}{10\ \text{K}}$$

$= 0.93$ mA

$$I_C = \frac{50}{51} I_E = 0.91 \text{ mA}$$

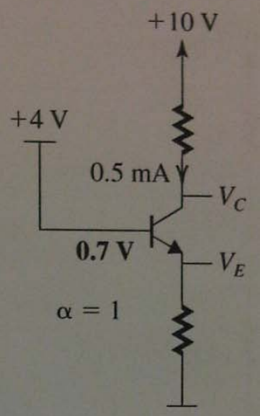
$V_C = 10 - 0.91 \times 5$

$= 5.45$ V

$$I_B = \frac{I_C}{\beta} = \frac{0.91}{50}$$

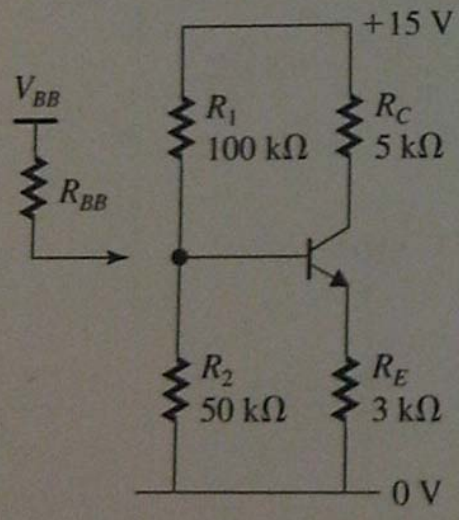
$= 0.0182\ \mu$A

Ex: 6.23



$$V_E = V_B - 0.7$$
$$= 4 - 0.7 = 3.3 \text{ V}$$
$$R_E = \frac{3.3 \text{ V}}{0.5 \text{ mA}} = 6.6 \text{ k}\Omega$$
$$V_C = V_B + 2 \text{ V}$$
$$= 4 + 2 = +6 \text{ V}$$
$$R_C = \frac{V_{CC} - V_C}{I}$$
$$= \frac{10 - 6}{0.5} = 8 \text{ k}\Omega$$

Ex 6.28



$\beta = 50$

$$V_{BB} = \frac{15 \times 50}{150} = 5 \text{ V}$$

$$R_{BB} = 50 \parallel 100$$
$$= 100/3 \text{ k}\Omega$$

$$I_E = \frac{V_{BB} - V_{BE}}{R_E + [R_{BB}/(\beta + 1)]}$$

$$= \frac{4.3}{3 + \frac{100}{3} \cdot \frac{1}{51}}$$

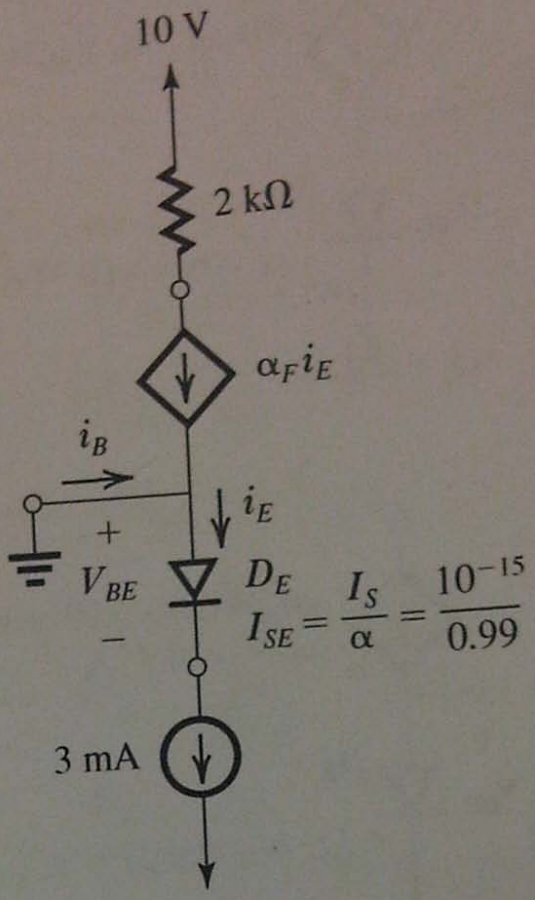
$$= 1.18 \text{ mA}$$

$$I_C = I_E \frac{50}{51} = 1.15 \text{ mA}$$

$$\% \text{ change} = \frac{1.28 - 1.15}{1.28}$$

$$\Rightarrow -9.8\%$$

6.17



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

$$i_E = I_{SE} e^{v_{BE}/V_T}$$

$$3 \times 10^{-3} = \frac{10^{-15}}{0.99} e^{v_{BE}/0.025}$$

$$V_{BE} = 0.718 \text{ V}$$

$$V_E = 0 - 0.718 = -0.718 \text{ V}$$

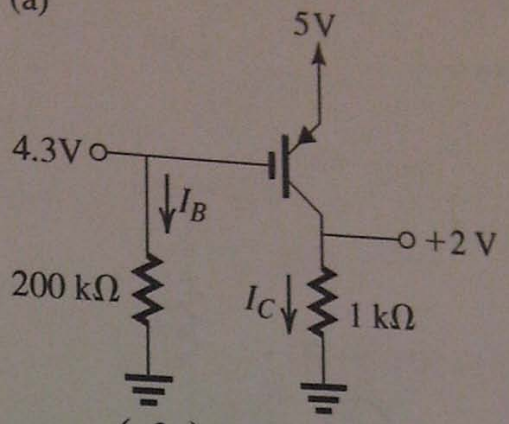
$$i_C = \alpha i_E = 0.99 \times 3 \text{ mA}$$

$$V_C = 10 - 2i_C = 10 - 2 \times 0.99 \times 3$$

$$= 4.06 \text{ V}$$

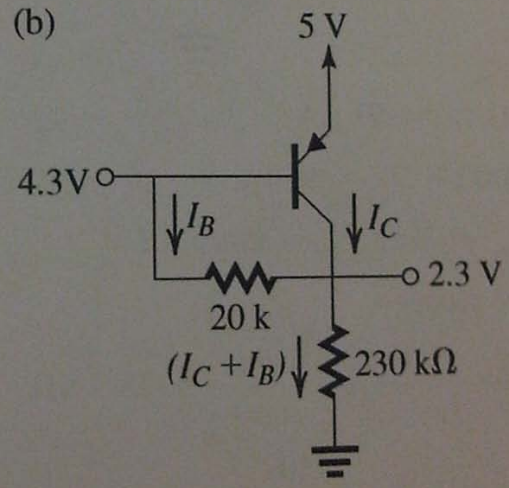
6.29

(a)



$$\frac{I_c}{I_B} = \beta = \frac{\left(\frac{2}{1\text{ K}}\right)}{\left(\frac{4.3}{200\text{ K}}\right)} = \frac{2\text{ m}}{0.0215\text{ m}} = 93$$

(b)

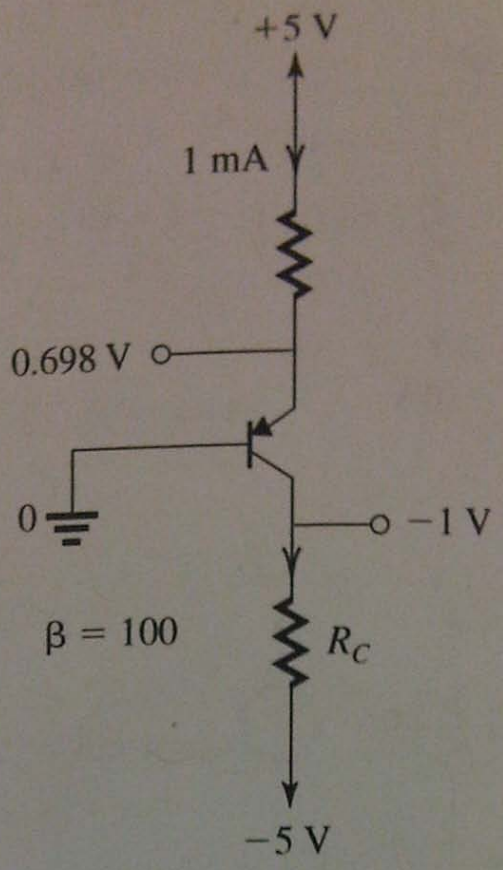


$$(I_c + I_B) = \frac{2.3}{230} = 10\text{ mA}$$

$$I_B = \left(\frac{4.3 - 2.3}{20\text{ K}}\right) = 0.1\text{ mA}$$

$$\frac{I_c}{I_B} = \left(\frac{10\text{ m} - 0.1\text{ m}}{0.1\text{ m}}\right) = \beta = 99$$

6.32



$$V_{BE(1mA)} - V_{BE(0.1mA)} = 25 \ln\left[\frac{1}{0.1}\right]$$

$$\therefore \; V_{BE(1mA)} = 640 \text{ mV} + 57.9 \text{ mV} = 698 \text{ mV}$$

$$I_C = \frac{100}{101} I_E = 0.99 \text{ mA}$$

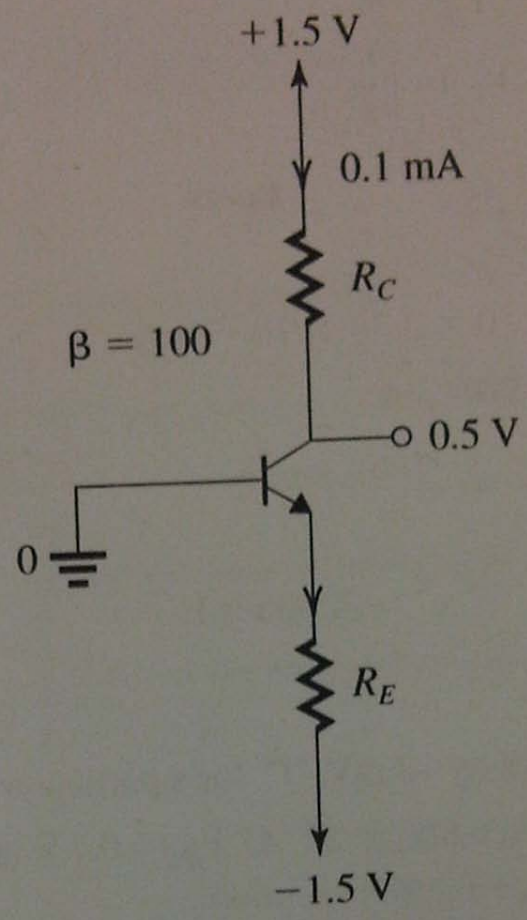
$$R_C = \frac{-1-(-5)}{0.99} = 4.04 \text{ k}\Omega$$

$$R_E = \frac{5 - 0.698}{1} = 4.3 \text{ k}\Omega$$

V_C can be raised untill $\approx +0.4$ V

$$R_C = \frac{5 + 0.4}{0.99} = 5.45 \text{ k}\Omega$$

6.34



$$\Delta V_{BE} = V_T \ln\left[\frac{I_{C7}}{I_{C1}}\right]$$

$$= 25 \ln [0.1] = -57.6 \text{ mA}$$

$$V_{BE(0.1)} = 742 \text{ mV}$$

$$R_C = \frac{1.5 - 0.5}{0.1} = 10 \text{ k}\Omega$$

$$V_E = -0.742 \text{ V}$$

$$R_E = \frac{-0.742 + 1.5}{\frac{\beta + 1}{\beta} I_C}$$

$$= \frac{100}{101} \cdot \frac{0.758}{0.1} = 7.5 \text{ k}\Omega$$

6.35 (B & D)

(b) $V_B = 0\,V$

$V_E = V_B + 0.8 = 0.8\,V$

$I_E = \frac{|0.8 - 1.5|}{1\,K} = 0.7\,mA$

$I_c = \alpha I_E = \frac{50}{51}(0.7\,m) = 0.69\,mA$

$V_c = I_c(1\,K) - 1.5 = -0.81\,V$

$I_B = \frac{I_c}{\beta} = 0.69\,m / 50 = 14\,\mu A$ and

$V_C < V_B < V_E$ so Active

(c) $V_B = 1\,V$

$V_E = V_B + 0.8 = 1.8\,V$

$I_E = \frac{3 - 1.8}{1.1\,K} = 1\,mA$

$I_c = \alpha I_E = \frac{50}{51} \times 1\,m = 0.98\,mA$

$V_c = I_c(560) = 0.55\,V$

$I_B = \frac{I_c}{\beta} = \frac{0.98\,m}{50} = 20\,\mu A$ and

$V_C < V_B < V_E$ so Active

(d) $V_B = 1.5\,V$

$V_E = 1.5 - 0.8 = 0.7\,V$

$I_E = \frac{0.7}{470} = 1.5\,mA$

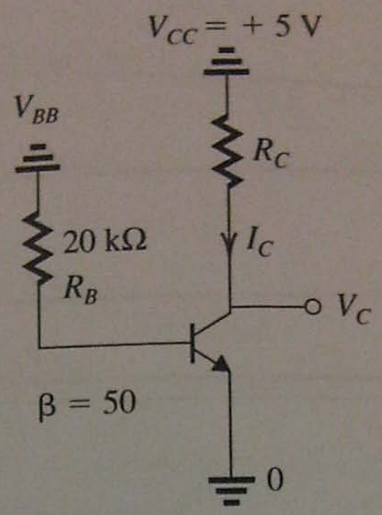
$I_c = \alpha I_E = \frac{50}{51}(1.5\,m) = 1.47\,mA$

$V_c = 3 - (1.47\,m)(1\,K) = 1.52\,V$

$I_B = \frac{I_c}{\beta} = \frac{1.47\,m}{50} = 29\,\mu A$ and

$V_C > V_B > V_E$ so Active

6.49



(a) active region

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

$$= \frac{5 - 1}{1\text{ K}} = 4\text{ mA}$$

$$I_B = \frac{I_C}{\beta} = \frac{4}{50} = 0.08\text{ mA}$$

$$V_{BB} = 0.7 + \frac{20 \times 4}{50}$$

$$= +2.3\text{ V}$$

(b) edge of saturation $v_C = 0.3$ V

$$I_C = \frac{5 - 0.3}{1} = 4.7\text{ mA}$$

$$I_B = I_C/\beta = 4.7/50 = 0.094\text{ mA}$$

$$V_{BB} = 0.094 \times 20 + 0.7 = 2.58\text{ V}$$

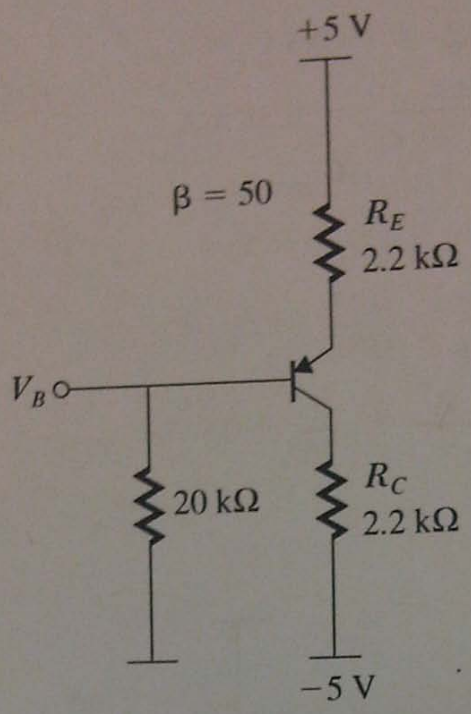
(c) deep saturation $v_C = 0.2$ V $\beta_F = 10$

$$I_C = (5 - 0.2)/1 = 4.8\text{ mA}$$

$$I_B = I_C/\beta_{\text{forced}} = 4.8/10 = 0.48\text{ mA}$$

$$V_{BB} = 0.48 \times 20 + 0.7 = +10.3\text{ V}$$

6.59



For $R_B = 20\ \text{k}\Omega$

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

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

$$V_C = -5 + 2.2 \times 1.63 = -1.42\ \text{V}$$

$$V_E = +5 - 2.2 \times 1.66 = +1.35\ \text{V}$$

$$V_B = V_E - 0.7 = -0.65\ \text{V}$$

For $R_B = 100\ \text{k}\Omega$

$$I_E = \frac{5 - 0.7}{2.2 + 100/51} = 1.03\ \text{mA}$$

$$V_E = 5 - 1.03 \times 2.2 = +2.73\ \text{V}$$

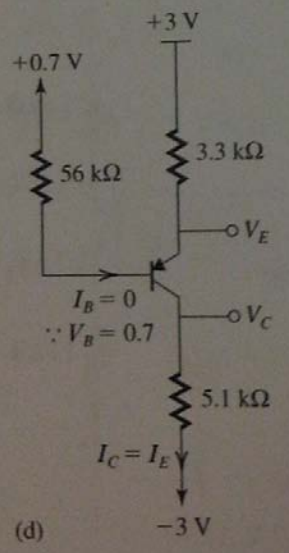
$$V_B = 0 + \frac{1.03}{51} \times 100 = +2.03\ \text{V}$$

$$V_C = -5 + 1.03 \times \frac{50}{51} \times 2.2 = -2.78\ \text{V}$$

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

6.62(d)(e)

(d)



(d)

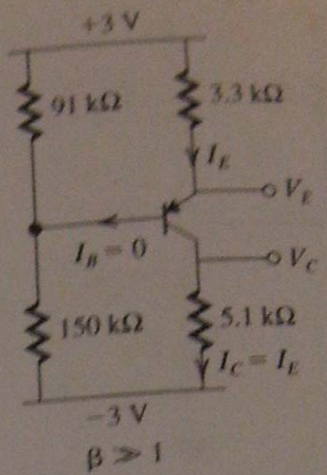
$$I_E = \frac{3 - 0.7 - 0.7}{3.3} = 0.48 \text{ mA}$$

$$V_E = 0.7 + 0.7 = 1.4 \text{ V}$$

$$V_C = -3 + 0.48 \times 5.1 = -0.55 \text{ V}$$

$$V_B = 0.7 \text{ V}$$

(e)



$\beta \gg 1$

since $I_B = 0$

$$V_B = -3 + \frac{150 \times 6}{150 + 91} = 0.73 \text{ V}$$

$$V_E = V_B + 0.7 \text{ V} = +1.43 \text{ V}$$

$$I_E = \frac{3 - 1.43}{3.3} = 0.48 \text{ mA}$$

$$V_C = -3 + 0.48 \times 5.1 = -0.55 \text{ V}$$