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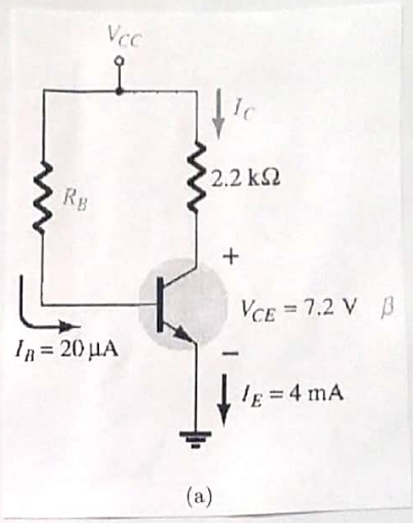
CSE 231

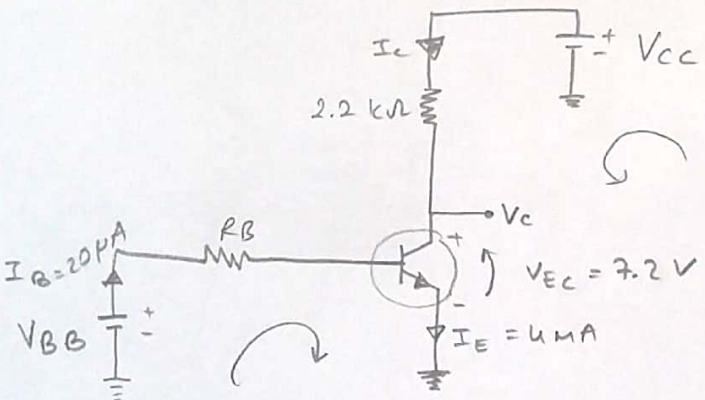
- Homework 4 -

20.01.2021

(1) Given the information appearing in figure 1a, determine:

a) I_c b) V_{cc} c) β d) R_B





a) Using KCL : $I_E = I_B + I_C$

$I_C = I_E - I_B \simeq 4$ mA

b) Using KVL : $V_{CC} = I_C R_C + V_C$ $\quad V_C = V_{CE} = 7.2$ V

$V_{CC} = (4)\cdot(2.2) + 7.2$

$= 16$ V

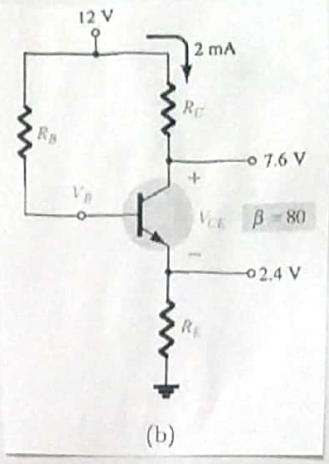
c) $I_C = \beta I_B \rightarrow \beta = \frac{I_C}{I_B} = \frac{4\text{ mA}}{20\,\mu A} = 200$

d) $V_{BB} = I_B R_B + V_{BE} \rightarrow R_B = \frac{V_{BB} - V_{BE}}{I_B}$ ($V_{BB} = V_{CC}$)

$R_B = \frac{16 - 0.7}{20\,\mu A} = 765$ kΩ

(2) Given the information provided in figure 1b, determine:

a) R_C b) R_E c) R_B d) V_{CE} e) V_B



a) $R_C = \dfrac{V_{CC} - V_C}{I_C} = \dfrac{12 - 7.6}{2 \cdot 10^{-3}} = 2.2\ k\Omega$

b) $R_E = \dfrac{V_E}{I_E} \approx \dfrac{V_E}{I_C} = \dfrac{2.4}{2 \cdot 10^{-3}} = 1.2\ k\Omega$

c) $R_B = \dfrac{V_{R_B}}{I_B} = \dfrac{V_{CC} - V_{BE} - V_E}{I_B}$ ⟶ $I_B = \dfrac{I_C}{\beta} = \dfrac{2 \cdot 10^{-3}}{80} = 25\ \mu A$

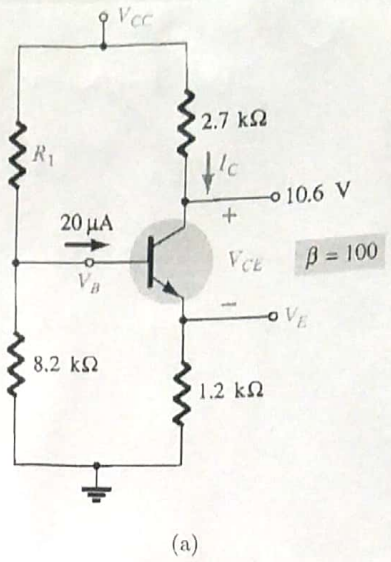
$= \dfrac{12 - 0.7 - 2.4}{25 \cdot 10^{-6}} = 356\ k\Omega$

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

e) $V_B = V_{BE} + V_E = 0.7 + 2.4 = 3.1\ V$

(3) Given the information appearing in figure 2a, determine:

a) I_c b) V_E c) V_{cc} d) V_{CE} e) V_B f) R_1



(a)

Figure 2

a) $I_c = \beta I_B$

$= 100 \cdot (20 \cdot 10^{-6}) = \underline{2\ mA}$

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b) $V_E = I_E R_E$

$= ((2.02) \cdot 10^{-3}) \cdot ((1.2 \cdot 10^{3}))$

$= \underline{2.42\ V}$

$I_E = I_c + I_B$

$= 2 \cdot 10^{-3} + 20 \cdot 10^{-6}$

$= 2.02\ mA$

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c) $V_{cc} = V_c + I_c R_c$

$= 10.6 + (2 \cdot 10^{-3}) \cdot (2.7 \cdot 10^{3}) = \underline{16\ V}$

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d) $V_{CE} = V_c - V_E = 10.6 - 2.42 = \underline{8.18\ V}$

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e) $V_B = V_E + V_{BE} = 2.42 + 0.7 = \underline{3.12\ V}$

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f) $R_1 = \dfrac{V_{cc} - V_B}{I_{R_1}} = \dfrac{16 - 3.12}{400.5 \cdot 10^{-6}}$

$= \underline{32.16\ k\Omega}$

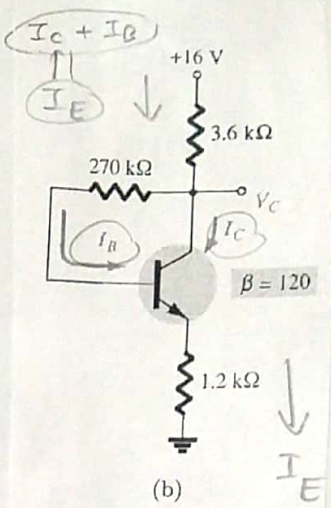
$I_{R_1} = I_{R_2} + I_B$

$= \dfrac{3.12}{8.2 \cdot 10^{3}} + 20 \cdot 10^{-6}$

$= 400.5\ \mu A$

(4) For the collector-feedback configuration of figure 2b, determine:

a) I_B b) I_C c) V_C



a) Using KVL

$$16 = 3.6 I_E + 270 I_B + V_{BE} + 1.2 I_E$$

$$I_E = (1+\beta) I_B$$

$$= 121 I_B$$

$$16 = (3.6) \cdot 121 I_B + 270 I_B + 0.7 + (1.2) \cdot 121 I_B$$

$$I_B = 17.98 \ \mu A$$

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b) $I_C = \beta I_B$

$= 120 \cdot (17.98 \ \mu A)$

$= 2.158 \ mA$

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c) $V_C = 16 - 3.6 I_C$

$= 16 - (3.6) \cdot (2.158)$

$= 8.23 \ V$

(5) For the voltage feedback network of figure 3a, determine:

a) I_C b) V_C c) V_E d) V_{CE}

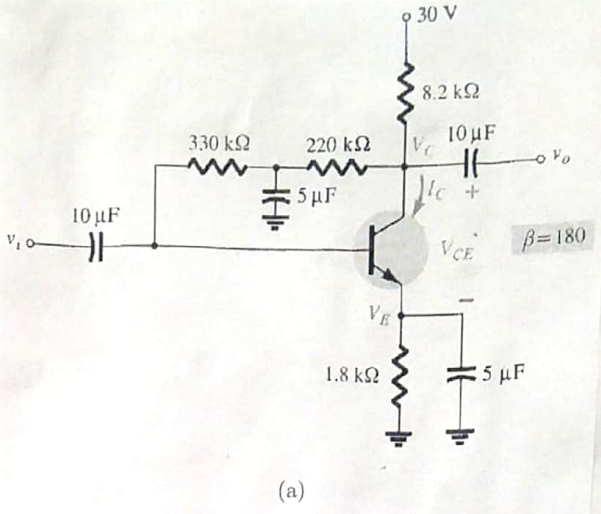


Figure 3

a) $I_C = \beta I_B$

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

$$= \frac{30 - 0.7}{(220.000 + 330,000) + 180 \cdot (8200 + 1800)}$$

$I_B = 12.47\ \mu A$

$I_C = 180 \cdot (12,47) \cdot 10^{-6} = \underline{2.24\ mA}$

b) $V_C = V_{CC} - I_C R_C$

$= 30 - (2.24 \cdot 10^{-3})(8200) = \underline{11.63\ V}$

c) $V_E = I_E R_E \approx I_C R_E$

$= (2,24) \cdot 10^{-3} \cdot 1800 = \underline{4.03\ V}$

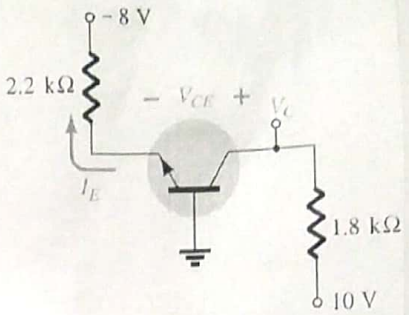
d) $V_{CE} = V_{CC} - I_C (R_C + R_E)$

$= 30 - (2.24 \cdot 10^{-3}) \cdot (8200 + 1800)$

$= \underline{7.6\ V}$

(6) For the network of 3b, determine:

a) I_E b) V_c c) V_{CE}



(b)

a) $I_E = \frac{V_{EE} - V_{BE}}{R_E} = \frac{8-(0.7)}{2200}$

$= 3.32 \text{ mA}$

b) $V_c = V_{cc} - I_c R_c \approx V_{cc} - I_E R_c$

$= 10 - ((3.32) \cdot 10^{-3})\ 1800$

$= 4.02 \text{ V}$

c) $V_{CE} = V_{cc} + V_{EE} - I_c (R_c + R_E)$

$= 10 + 8 - (3.32 \cdot 10^{-3}) \cdot (2200 + 1800)$

$= 4.72 \text{ V}$