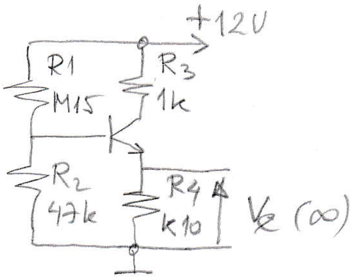
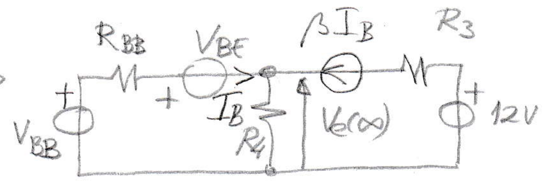
(1)



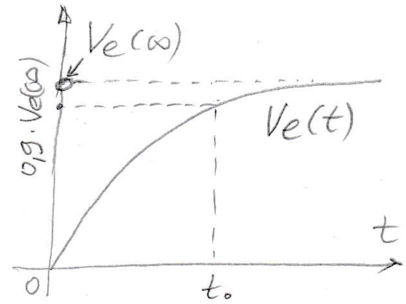
$\Rightarrow$



$$V_{BB} = \frac{R_2}{R_1+R_2}\cdot 12 = \frac{47}{150+47}\cdot 12 = 2{,}86\,V \; ; \quad R_{BB} = R_1 \| R_2 = \frac{150\cdot 47}{150+47} = 35{,}8\,k\Omega .$$

$$\left.\begin{aligned} I_B &= \frac{V_{BB}-V_{BE}-V_e(\infty)}{R_{BB}} \\ V_e(\infty) &= (1+\beta)\, I_B \cdot R_4 \end{aligned}\right\} \Rightarrow V_e(\infty) = (1+\beta)\,\frac{V_{BB}-V_{BE}-V_e(\infty)}{R_{BB}}\cdot R_4$$

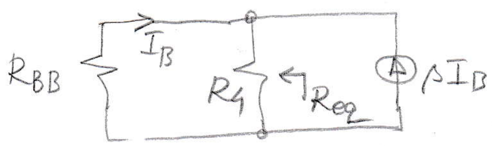
$$V_e(\infty)\cdot\left(1+\frac{(1+\beta)R_4}{R_{BB}}\right) = (1+\beta)\,\frac{R_4}{R_{BB}}\,(V_{BB}-V_{BE})$$



$$V_e(\infty)\left(1+101\cdot\frac{0{,}1}{35{,}8}\right) = 101\cdot\frac{0{,}1}{35{,}8}\,(2{,}86-0{,}6)$$

$\underline{V_e(\infty) = 497\,mV.}$

$$V_e(t) = V_e(\infty)\cdot\left(1-e^{-t/\tau}\right) \; ; \quad \tau = R_{eq}\cdot C1$$



$$R_{eq} = R_4 \,\|\, \frac{R_{BB}}{1+\beta} = 0{,}1 \,\|\, \frac{35{,}8}{101} = \frac{0{,}1\cdot 0{,}354}{0{,}1+0{,}354} = 78\,\Omega$$

$$V_e(t_0) = 0{,}9\cdot V_e(\infty) = V_e(\infty)\cdot\left(1-e^{-t_0/\tau}\right) \Rightarrow 0{,}9 = 1-e^{-\frac{t_0}{\tau}} \Rightarrow 0{,}1 = e^{-\frac{t_0}{\tau}} \; ;$$

$$t_0 = \tau\cdot \ln 10 = R_{eq}\cdot C_1\cdot \ln 10 = 78\cdot 100\cdot 10^{-6}\cdot \ln 10 = \underline{18\,ms}.$$

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(2) $0 < V_{BB} < V_{BE} \Rightarrow I_B = 0,\; I_C = 0 \Rightarrow V_{CE} = 0$

$$V_{BB}(t_1) = V_{BE} \Rightarrow 10\cdot\sin\frac{2\pi}{4\cdot 10^{-3}}\cdot t_1 = V_{BE} \Rightarrow t_1 = \frac{4\cdot 10^{-3}}{2\pi}\arcsin\frac{0{,}7}{10} = 44{,}6\,\mu s;$$

$$I_{Cmax} = \frac{12-V_{CEsat}}{R_2} = \frac{12-0{,}2}{10^3} = 11{,}8\,mA\,;$$

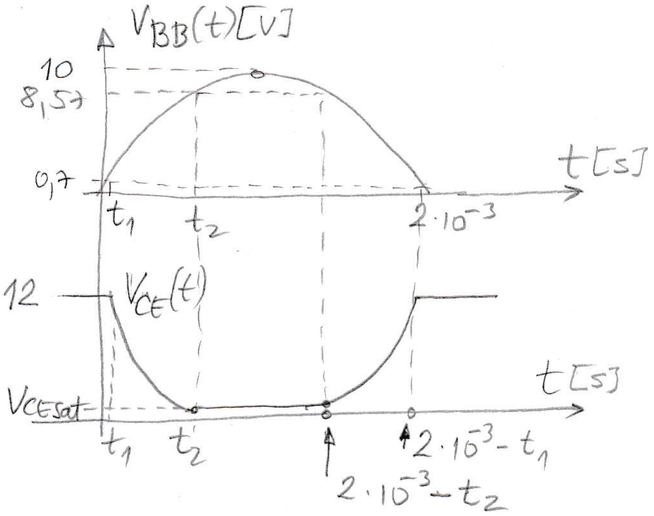
$$I_{Bmax} = (V_{BBmax}-V_{BE})/R_1 = (10-0{,}7)/10^5 = \underline{93\,\mu A}\,; \quad \beta\cdot I_{Bmax} = \underline{13{,}95\,mA}$$

$\beta\cdot I_{Bmax} > I_{Cmax}$ (saturation!)

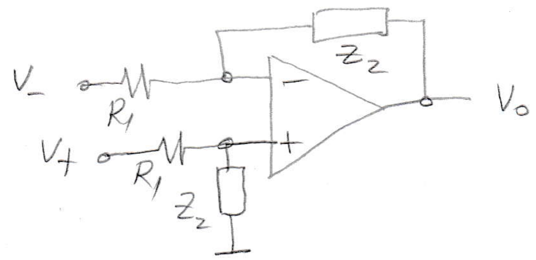
$$\beta I_{Bsat} = 11{,}8\,mA \Rightarrow I_{Bsat} = \frac{11{,}8\cdot 10^{-3}}{150} = 78{,}7\,\mu A$$

$$I_{Bsat} = (V_{BBsat}-V_{BE})/R_1 \Rightarrow V_{BBsat} = R_1\cdot I_{Bsat}+V_{BE} = 10^5\cdot 78{,}7\cdot 10^{-6}+0{,}7 = \underline{8{,}57\,V}$$

$$V_{BBmax}\cdot\sin\frac{2\pi}{2\cdot 10^{-3}}\,t_2 = V_{BBsat} \Rightarrow t_2 = \frac{4\cdot 10^{-3}}{2\pi}\arcsin\frac{V_{BBsat}}{V_{BBmax}} = \underline{655\,\mu s}$$



③ $V_o = -\frac{Z_2}{R_1}V_- + \frac{Z_2}{R_1+Z_2}\cdot\left(1+\frac{Z_2}{R_1}\right)\cdot V_+$



$$\Rightarrow V_o = (V_+ - V_-)\,\frac{Z_2}{R_1}$$

$$Z_2 = R_2 \,||\, C_2 = \frac{R_2\cdot\frac{1}{j\omega C_2}}{R_2+\frac{1}{j\omega C_2}} = \frac{R_2}{1+j\omega C_2R_2}$$

$$V_o = (V_+ - V_-)\,\frac{R_2}{R_1}\cdot\frac{1}{1+j\omega C_2R_2} = (V_+ - V_-)\cdot A_o\,\frac{1}{1+j\frac{\omega}{\omega_p}}$$

$$A_o = 10 = \frac{R_2}{R_1} \Rightarrow R_2 = 10R_1 = \underline{100\,k\Omega}$$

$$\omega_p = \frac{1}{R_2C_2} \Rightarrow f_p = \frac{\omega_p}{2\pi} = \frac{1}{2\pi R_2C_2} = 10^3$$

$$2\pi R_2C_2 = 10^{-3} \Rightarrow C_2 = \frac{10^{-3}}{2\pi R_2} = \frac{10^{-3}}{2\pi\cdot10^5}$$

$\underline{C_2 = 1{,}59\ nF}$