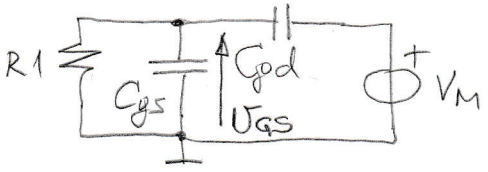
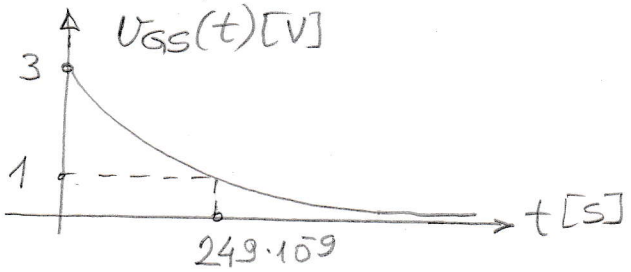
① $t > 0_+$





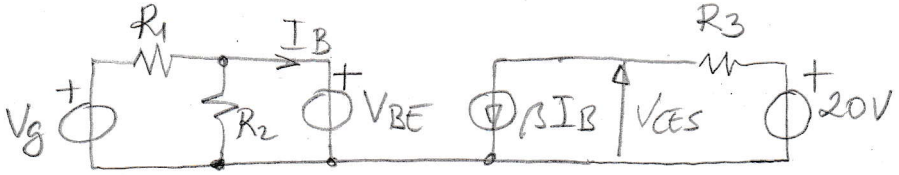
$$U_{GS}(t) = U_{GS}(0) \cdot e^{-\frac{t}{\tau}}$$

$$U_{GS}(0) = \frac{C_{gd}}{C_{gs}+C_{gd}} \cdot V_M = V_T = 3\,V.$$

$$V_M = V_T \cdot \frac{C_{gs}+C_{gd}}{C_{gd}} = 3 \cdot \frac{1000+30}{30} = \underline{103\,V.}$$

$$\tau = R_1 \cdot (C_{gs} \| C_{gd}) = R_1 \cdot (C_{gs}+C_{gd}) = 220 \cdot 1030 \cdot 10^{-12} = \underline{227\,ns}$$

$$U_{GS}(t_1) = 1 = 3 \cdot e^{-\frac{t_1}{\tau}}\ ;\ e^{t_1/\tau} = 3\ ;\ t_1 = \tau \cdot \ln 3 = \underline{249\,ns}$$

② 

$$I_B = \frac{V_g - V_{BE}}{R_1} - \frac{V_{BE}}{R_2}$$

$$V_{CES} = 20 - R_3 \cdot \beta I_B \quad \Rightarrow \quad \beta I_B = \frac{20 - V_{CES}}{R_3} = \frac{20-0{,}5}{68} = \underline{287\,mA}.$$

$$I_B = \frac{287 \cdot 10^{-3}}{120} = \underline{2{,}39\,mA}.$$

$$\frac{V_g - V_{BE}}{R_1} = I_B + \frac{V_{BE}}{R_2} \Rightarrow \frac{V_g}{R_1} = I_B + \frac{V_{BE}}{R_1} + \frac{V_{BE}}{R_2} = 2{,}39 \cdot 10^{-3} + \frac{0{,}7}{1000} + \frac{0{,}7}{470} = \underline{4{,}158\,mA}$$

$$V_g = R_1 \cdot 4{,}158 \cdot 10^{-3} = \underline{4{,}158\,V}$$

③ $V_o = -V_- \cdot A(j\omega)$

$$V_-\left(\frac{1}{R_1}+\frac{1}{R_2}\right) - V_i\frac{1}{R_1} - V_o\frac{1}{R_2} = 0 \quad \Rightarrow \quad V_-(R_2+R_1) = V_i R_2 + V_o R_1$$

$$V_- = V_i \cdot \frac{R_2}{R_1+R_2} + V_o \frac{R_1}{R_1+R_2}$$

$$V_o = -\left[V_i \frac{R_2}{R_1+R_2} + V_o \frac{R_1}{R_1+R_2}\right] \cdot A(j\omega) \Rightarrow A_r(j\omega) = \frac{V_o}{V_i} = \underline{-\frac{R_2\,A(j\omega)}{R_1+R_2+R_1 \cdot A(j\omega)}}$$

$$A_r = -\frac{R_2 A_0 \frac{1}{1+j\omega/\omega_0}}{R_1+R_2+R_1 A_0 \frac{1}{1+j\omega/\omega_0}} = -\frac{R_2 A_0}{(R_1+R_2)(1+j\omega/\omega_0)+R_1 A_0}$$

$$A_r = -\frac{R_2 A_0}{R_1+R_2+R_1 A_0} \cdot \frac{1}{1+j\frac{\omega}{\omega_0}\cdot\frac{R_1+R_2}{R_1+R_2+R_1A_0}} = K \cdot \frac{1}{1+j\frac{\omega}{\omega_{or}}} \qquad \omega_{or}$$

$$\omega_{or} = \omega_0 \cdot \frac{R_1+R_2+R_1A_0}{R_1+R_2} = 2\pi \cdot 10 \cdot \frac{10^3+10^5+10^3\cdot 10^5}{10^3+10^5} \approx 2\pi \cdot 10^4\ rad/s$$

$$f_{or} = 10^4\,Hz = 10\,kHz.$$