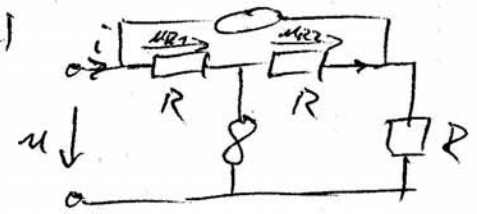
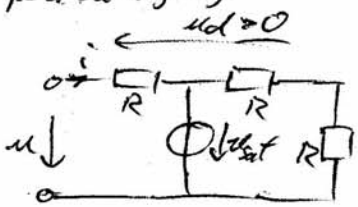
Aufgabe 5:

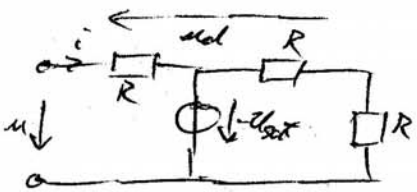
a)



pos. Sättigung:



neg. Sättigung



$u_{R1} = Ri \quad u_{R2} = -Ri$

$i_{R2} = -i$

$\Rightarrow u = -Ri$

$u = Ri + U_{sat}$

$u_d > 0$

$-Ri - \frac{U_{sat}}{2} > 0$

$-u + \frac{U_{sat}}{2} > 0$

$u < \frac{U_{sat}}{2}$

$u = Ri - U_{sat}$

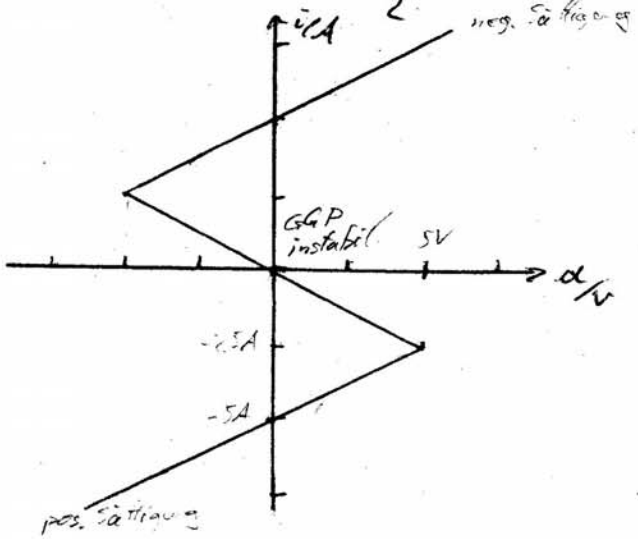
$u_d = -Ri + \frac{U_{sat}}{2} < 0$

$-u - \frac{U_{sat}}{2} < 0$

$u > \frac{U_{sat}}{2}$

$\frac{u - U_{sat}}{R} = \frac{u - 10V}{2.7}$

b)



$-i = C\dot{u} \qquad i > 0 \Rightarrow u$ fällt

$i < 0 \Rightarrow u$ steigt

c) $u_0 = -Ri_0 = 2.5V$

- $-i = C\dot{u} \Rightarrow C\dot{u} = \frac{u}{R} \Rightarrow \dot{u} = -\frac{u}{-RC}$

$\Rightarrow u(t) = 2.5V\, e^{\frac{t}{RC}} = 2.5V\, e^{\frac{t}{2s}}$

$i = -C \cdot \frac{2.5V}{RC} e^{\frac{t}{RC}} = -\frac{2.5V}{R} e^{\frac{t}{RC}} = -1.25A\, e^{\frac{t}{2s}}$

$u(t) = 2.5V\, e^{\frac{t}{2s}} \stackrel{!}{=} 5V$

$t = 2s \ln 2$

- $-i = C\dot{u}$ mit $i = \frac{u + U_{sat}}{R}$

$\Rightarrow \dot{u} = -\frac{u}{RC} + \frac{-U_{sat}}{RC}$

$\Rightarrow u(t) = -U_{sat} + [5V + U_{sat}]\, e^{-\frac{t - 2s\ln 2}{RC}} = -10V + 15V\, e^{-\frac{t - 2s\ln 2}{RC}}$

$i(t) = -C \cdot \frac{15V}{-RC} e^{-\frac{t - 2s\ln 2}{RC}} = 7.5A\, e^{-\frac{t - 2s\ln 2}{RC}}$

$u(t) = -10V + 15V\, e^{-\frac{t - 2s\ln 2}{RC}} \stackrel{!}{=} -5V$

$e^{-\frac{t - 2s\ln 2}{RC}} \stackrel{!}{=} \frac{1}{3} \qquad t - 2s\ln 2 = RC \ln 3$

$t = 2s \ln 6$

- $-i = Ci \quad \text{mit } i = \frac{u - u_{sat}}{R}$

$\Rightarrow \dot{u} = -\frac{u}{RC} + \frac{u_{sat}}{RC}$

$\Rightarrow u(t) = u_{sat} + [-5V - u_{sat}]\, e^{-\frac{t - 2s\ln 6}{RC}} = 10V - 15V\, e^{-\frac{t - 2s\ln 6}{RC}}$

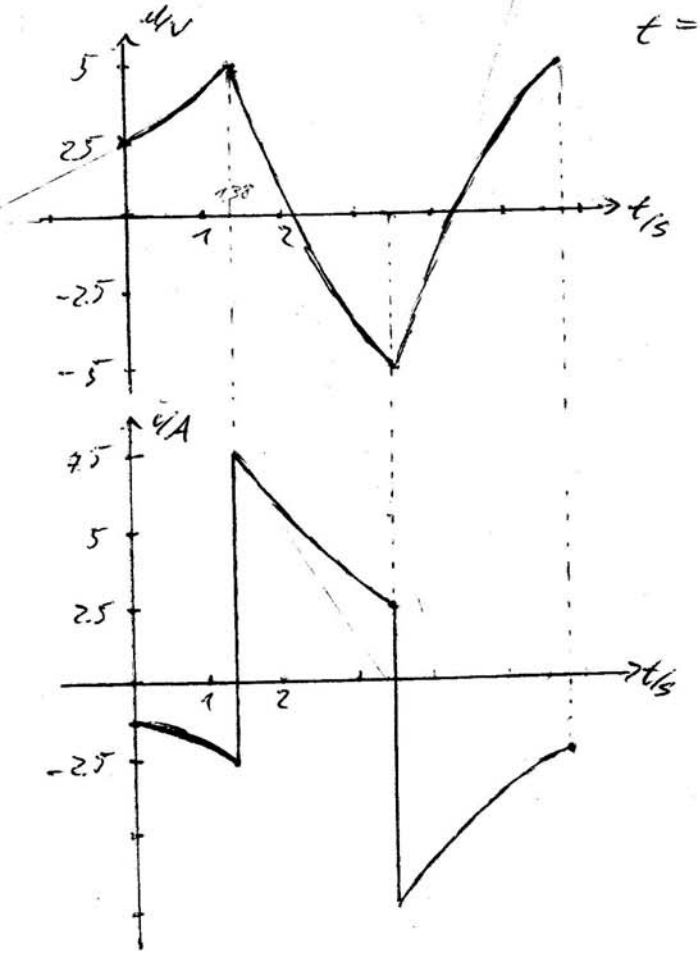
$i(t) = -C\, \frac{(-15V)}{-RC}\, e^{-\frac{t-2s\ln 6}{RC}} = -7{,}5A\, e^{-\frac{t-2s\ln 6}{RC}}$

$u(t) = 10V - 15V\, e^{-\frac{t-2s\ln 6}{RC}} \stackrel{!}{=} 5V$

$e^{-\frac{t-2s\ln 6}{RC}} \stackrel{!}{=} \frac{1}{3}$

$t - 2s\ln 6 = 2s\ln 3$

$t = 2s\ln 18$



Periodendauer $T_p = 2s\ln 18 - 2s\ln 2 =$

$= 2s\ln 9 \approx 4.4s$

$f = \frac{1}{T_p} = \frac{1}{2s\ln 9} \approx 0.23Hz$

Relaxationsoszillator

$\Rightarrow$ keine harmonische Schwingung

d) $\tau = RC$

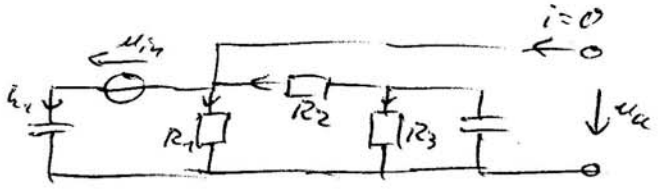
Frequenz kleiner $\Rightarrow$ Periodendauer größer

$\Rightarrow \tau = RC$ muss steigen

$\Rightarrow C$ erhöhen

$\Rightarrow C$ parallel $C_{ges} = C_1 + C_2$

Aufgabe 6:



a) u_{C1}, u_{C2}

b) $i_{R1} = \frac{u_{in} + u_{C1}}{R_1} \qquad i_{R2} = \frac{u_{C2} - u_{C1} - u_{in}}{R_2}$

$i_{R3} = \frac{u_{C2}}{R_3}$

$\Rightarrow i_{C1} = i_{R2} - i_{R1} = \frac{u_{C2}}{R_2} - \frac{u_{C1}}{R_2} - \frac{u_{in}}{R_2} - \frac{u_{in}}{R_1} - \frac{u_{C1}}{R_1}$

$C_1 \dot{u}_{C1} = i_{C1} = u_{C1}\left(-\frac{1}{R_1} - \frac{1}{R_2}\right) + \frac{u_{C2}}{R_2} + u_{in}\left(-\frac{1}{R_1} - \frac{1}{R_2}\right)$

$C_2 \dot{u}_{C2} = -i_{R2} - i_{R3} = u_{C2}\left(-\frac{1}{R_2} - \frac{1}{R_3}\right) + \frac{u_{C1}}{R_2} + \frac{u_{in}}{R_2}$

$\Rightarrow \begin{bmatrix} \dot{u}_{C1} \\ \dot{u}_{C2} \end{bmatrix} = \begin{bmatrix} -\frac{1}{C}\left(\frac{1}{R_1} + \frac{1}{R_2}\right) & \frac{1}{R_2 C} \\ \frac{1}{R_2 C} & -\frac{1}{C}\left(\frac{1}{R_2} + \frac{1}{R_3}\right) \end{bmatrix} \begin{bmatrix} u_{C1} \\ u_{C2} \end{bmatrix} + \begin{bmatrix} \frac{1}{C}\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \\ \frac{1}{C R_2} \end{bmatrix} u_{in}$

c) $u_a = R_2 i_{R2} = -\frac{R_2}{R_2} u_{C1} - \frac{R_2}{R_2} u_{C2} - \frac{R_2}{R_2} u_{in} = u_{in} + u_{C1}$

$\Rightarrow u_a = \underbrace{\begin{bmatrix} -\frac{R_2}{R_2} & \frac{R_2}{R_2} \end{bmatrix}}_{\text{Auskoppelvektor}} \begin{bmatrix} u_{C1} \\ u_{C2} \end{bmatrix} - \underbrace{\frac{R_2}{R_2}}_{\text{Durchgriff}} u_{in}$ (Erregung)