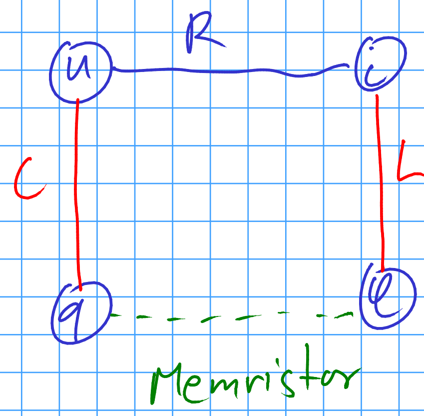
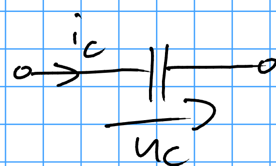
ST 2 - Tutorium, Blatt 1, 4.05.2010

$\Rightarrow$ Einführung reaktive Bauelemente



• Kapazität

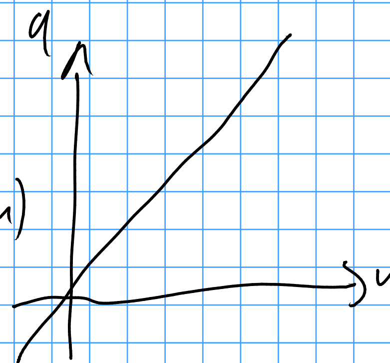


$$q = Cu$$

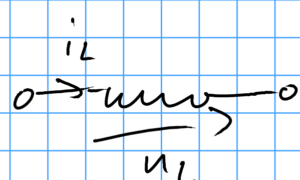
$$\frac{d}{dt} q = \frac{d}{dt}(Cu)$$

$$\dot{q} = C\dot{u}$$

$$\boxed{i = C\dot{u}}$$



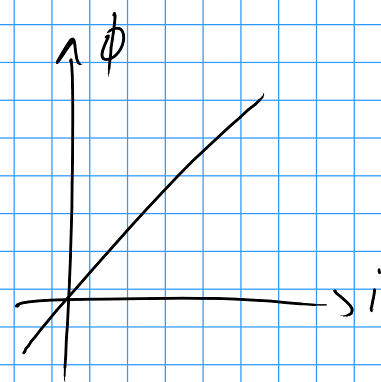
• Induktivität



$$\phi = L \cdot i$$

$$\frac{d}{dt}\phi = L\frac{di}{dt}$$

$$\boxed{u = L\dot{i}}$$



Lineare Schaltung 1. Grades

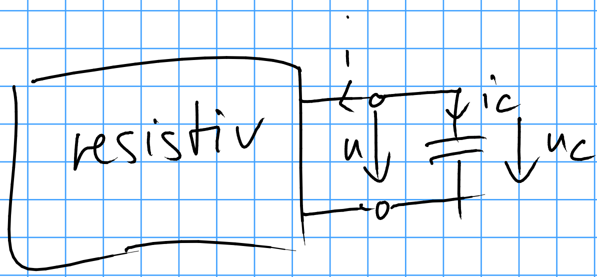
(1) Zustandsgröße festlegen

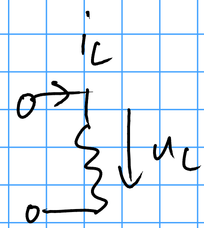
$C \rightarrow u$

$L \rightarrow i$

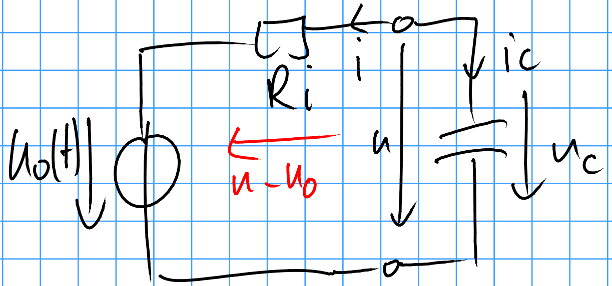
↳ stetig

② alle übrigen resistiven Bauelemente werden zusammengefasst

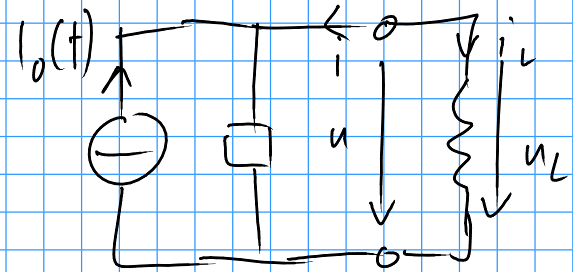




Helmholtz/Thévenin



Mayer/Norton



C → LL

L → KS

→ Parameter (U_0, R_i) bzw. (I_0, G) berechnen

③ Zustandsgleichung aufstellen

Bsp: $i_C = C\dot{u}_C \Leftrightarrow \dot{u}_C = \frac{i_C}{C}$ Ziel $\boxed{\dot{u}_C = f(u_C)}$

$$= -\frac{i}{C} = -\frac{u - U_0}{RC} = -\frac{u_C - U_0}{RC}$$

$$\dot{u}_C = -\frac{u_C}{RC} + \frac{U_0}{RC}$$

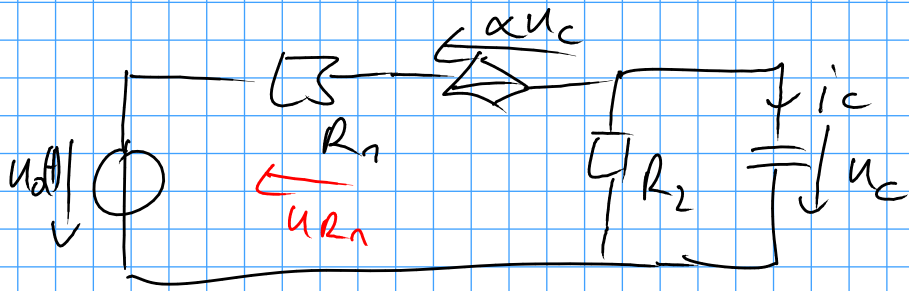
$\tau = RC$

$\tau = GL$

$$\dot{x}(t) = -x(t)\frac{1}{\tau} + x(t_\infty)\cdot\frac{1}{\tau}$$

$$\Rightarrow x(t) = x(t_\infty) + [x(t_0) - x(t_\infty)]\, e^{-\frac{t-t_0}{\tau}}$$

ST 2 – Blatt 1



2. $\overset{\circ}{u}_C = \frac{1}{C} i_C$ mit $i_C + \frac{u_C}{R_2} + \frac{u_{R1}}{R_1} = 0$

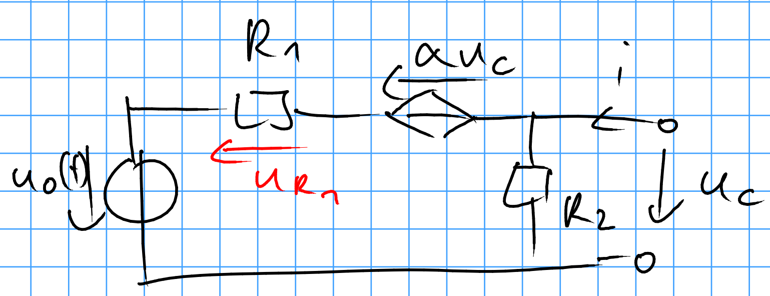
$u_{R1} = -\alpha u_C + u_C - u_0(t)$

$$i_C = -\frac{u_C}{R_2} - \frac{u_{R1}}{R_1} = -\frac{u_C}{R_2} - \frac{-\alpha u_C + u_C - u_0(t)}{R_1}$$

$$= -u_C\left(\frac{1}{R_2} + \frac{1}{R_1}(1-\alpha)\right) + \frac{u_0(t)}{R_1}$$

$$\Rightarrow \overset{\circ}{u}_C = -\frac{1}{C} u_C \left(\frac{1}{R_2} + \frac{1}{R_1}(\alpha - 1)\right) + \frac{u_0(t)}{R_1 C}$$

Alternative über ESB: Betrachtung des Falls $\overset{\circ}{u}_C = 0 = i_C$



$$R = \frac{u_C}{i}\Big|_{u_0(t)=0}$$

$$i = \frac{u_C}{R_2} + \frac{u_{R1}}{R_1} = \frac{u_C}{R_2} + \frac{u_C(1-\alpha)}{R_1}$$

$u_{R1} = -\alpha u_C + u_C =$

$= u_C(1-\alpha)$

$$R = \frac{u_C}{u_C\left(\frac{1}{R_2} + \frac{1-\alpha}{R_1}\right)} = \frac{1}{\frac{1}{R_2} + \frac{1-\alpha}{R_1}}$$

$$\tilde{u}_0(t) = u_C\Big|_{i=0}$$

$$u_C = \alpha u_C - \frac{u_C}{R_2}\cdot R_1 + u_0(t)$$

$$u_C\left(1 - \alpha + \frac{R_1}{R_2}\right) = u_0(t)$$

$$= \frac{u_0(t)}{1 - \alpha + \frac{R_1}{R_2}}$$

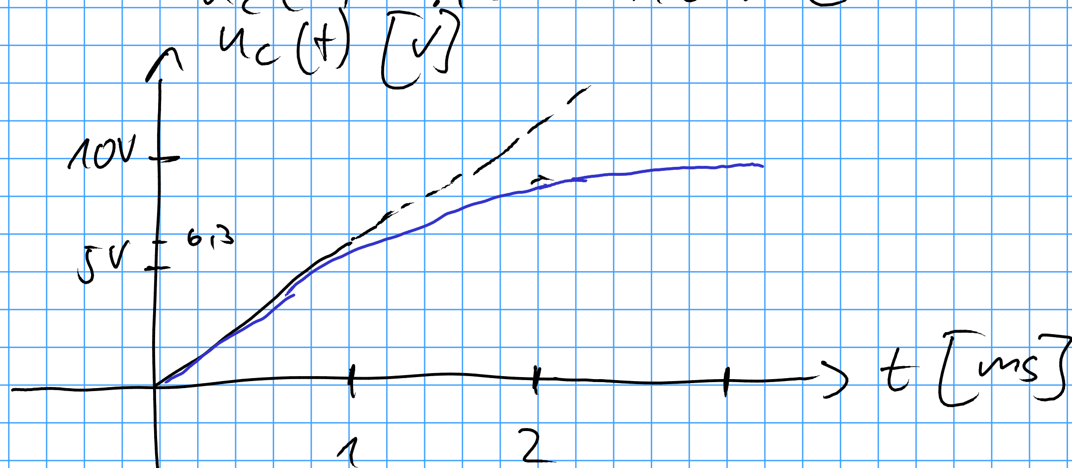
3. $\alpha = 1 \quad \Rightarrow \quad \tilde{u}_0(t) = \frac{10V}{1} = 10V$

$$R = 1k\Omega$$

$$\tau = RC = 1k\Omega \cdot 1\mu F = 1ms$$

allg. Lösung: $x(t) = x(t\infty) + [x(t_0) - x(t\infty)]\, e^{-\frac{t-t_0}{\tau}}$

ALSO: $u_C(t) = 10V - 10V\, e^{-\frac{t}{1ms}}$



$$u_C(2ms) = 10V - 10V\, e^{-2} = 10V - 1{,}4V = 8{,}6$$

4. $\alpha = 3$

$$\tilde{u}_0(t) = \frac{-10V}{1-3+1} = 10V \qquad R = \frac{1}{\frac{1}{1k\Omega} - \frac{2}{1k\Omega}} = -1k\Omega$$

$$\tau = -1ms$$

$$u_C(t) = 10V + [8{,}6V - 10V]\, e^{\frac{t-2ms}{1ms}}$$

$$= 10V - 1{,}4V\, e^{\frac{t-2ms}{1ms}}$$

↳ instabil

$$u_C(t) \overset{!}{=} 0 \iff 10V - 1{,}4V\, e^{\frac{t-2ms}{1ms}} = 0$$

$$e^{\frac{t-2ms}{1ms}} = \frac{10}{1{,}4} = 7{,}14$$

ln

$$\frac{t-2ms}{1ms} = 2$$

$$t = 4ms$$