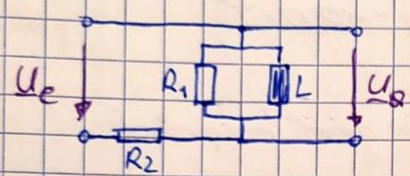
Dies sind Beispiele aus dem Jahre 2021 (11.02.2021).

Es sind keine Angaben dabei, aber die sind 1:1 die gleichen, wie bei den anderen Klausuren.

Also trotzdem eine gute Übung für die 2. Teilklausur.

① Frequenzlinienverfahren:



$R_1 = 1\,\Omega \quad R_2 = 9\,\Omega \quad L = 900\,\mu H = 900 \cdot 10^{-6}$

$$\underline{Z}_{R_1L} = \frac{R_1 \cdot j\omega L}{R_1 + j\omega L}$$

$$\underline{U}_a = \underline{U}_e \cdot \frac{\frac{R_1 \cdot j\omega L}{R_1 + j\omega L}}{R_2 + \frac{R_1 \cdot j\omega L}{R_1 + j\omega L}} \quad | : \underline{U}_e$$

$$\Rightarrow \underline{F}(j\omega) = \frac{\underline{U}_a}{\underline{U}_e} = \frac{\frac{R_1 \cdot j\omega L}{R_1 + j\omega L}}{R_2 + \frac{R_1 \cdot j\omega L}{R_1 + j\omega L}} = \frac{\frac{R_1 \cdot j\omega L}{\cancel{R_1 + j\omega L}}}{\frac{R_1R_2 + R_2 j\omega L + R_1 \cdot j\omega L}{\cancel{R_1 + j\omega L}}} = \frac{R_1 \cdot j\omega L}{R_2 \cdot (R_1 + j\omega L) + R_1 j\omega L} \quad \begin{matrix} | : (R_1R_2) \\ | : (R_1R_2) \end{matrix}$$

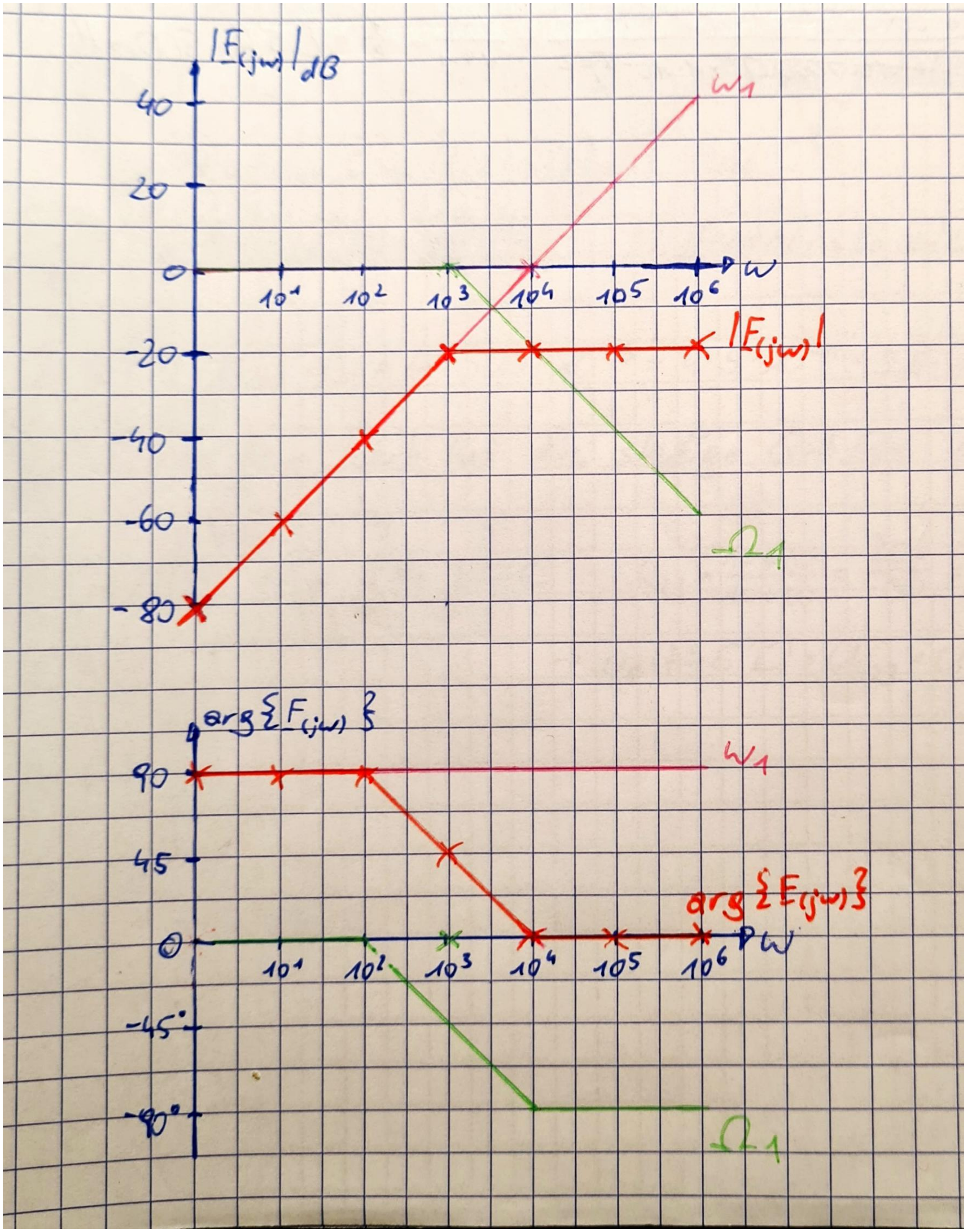
$$\left(= \frac{j\omega \frac{L}{R_2}}{1 + j\omega \frac{L}{R_1} \frac{R_2}{R_2} + j\omega \frac{L R_1}{R_2}} \right) = \frac{j\omega \frac{L}{R_2}}{1 + j\omega \boxed{\frac{L(R_1 + R_2)}{R_1 \cdot R_2}}}$$

ω_1

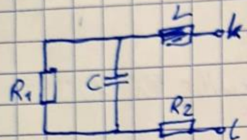
Ω_1

$$\omega_1 = \frac{R_2}{L} = \frac{\cancel{9}\,1}{\cancel{900}_{1} \cdot 10^{-6}} = 1 \cdot 10^4 = 10^4\,s^{-1}$$

$$\Omega_1 = \frac{R_1 \cdot R_2}{L \cdot (R_1 + R_2)} = \frac{1 \cdot 9}{900 \cdot 10^{-6} (1 + 9)} = \frac{\cancel{9}\,1}{\cancel{9}_{1} \cdot 10^{-4} \cdot 10} = 1 \cdot 10^3 = 10^3\,s^{-1}$$


|F(jω)|dB
40
20
0
-20
-40
-60
-80
10¹
10²
10³
10⁴
10⁵
10⁶
ω
ω1
|F(jω)|
Ω1
arg{F(jω)}
90
45
0
-45°
-90°
10¹
10²
10³
10⁴
10⁵
10⁶
ω
ω1
arg{F(jω)}
Ω1

② Komplexes Netzwerk:



$R_1 = 1k\Omega = 1000\,\Omega \qquad R_2 = 200\,\Omega$

$C = 1\mu F = 1\cdot 10^{-6} F \qquad \omega = 1000\,s^{-1}$

a) allg. Impedanz an den Klemmen k und l. + Real- und Imaginärteil.

$$\underline{Z} = \frac{R_1 \frac{1}{j\omega C}}{R_1 + \frac{1}{j\omega C}} = \frac{\frac{R_1}{\cancel{j\omega C}}}{\frac{R_1 j\omega C + 1}{\cancel{j\omega C}}} = \frac{R_1}{1+R_1 j\omega C} \cdot \frac{1-R_1 C j\omega}{1-R_1 C j\omega} = \frac{R_1 - R_1^2 C j\omega}{1+\omega^2 R_1^2 C^2} = \frac{R_1}{1+\omega^2 R_1^2 C^2} - j\frac{R_1^2 C\omega}{1+\omega^2 R_1^2 C^2}$$

$$\underline{Z}_{kl} = \frac{R_1 - R_1^2 C j\omega}{1+\omega^2 R_1^2 C^2} + j\omega L + R_2 = \frac{R_1}{1+\omega^2 R_1^2 C^2} - j\frac{R_1^2 C\omega}{1+\omega^2 R_1^2 C^2} + j\omega L + \frac{R_2 + R_2 R_1^2 \omega^2 C^2}{1+\omega^2 R_1^2 C^2} =$$

$$= \underbrace{\frac{R_1 + R_2 + R_2 R_1^2 C^2 \omega^2}{1+\omega^2 R_1^2 C^2}}_{\text{Realteil}} + \underbrace{j\left(\omega L - \frac{R_1^2 C\omega}{1+\omega^2 R_1^2 C^2}\right)}_{\text{Imaginärteil}}$$

b) Welchen Wert muss L annehmen

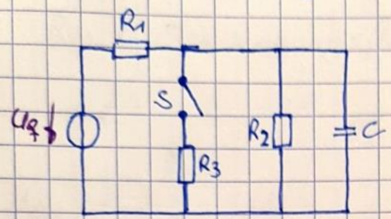
$$Im\{\underline{Z}_{kl}\} \overset{!}{=} 0$$

$$\omega L - \frac{R_1^2 C\omega}{1+\omega^2 R_1^2 C^2} \overset{!}{=} 0$$

$$\omega L = \frac{R_1^2 C\omega}{1+\omega^2 R_1^2 C^2} \qquad |:\omega$$

$$L = \frac{R_1^2 C}{1+\omega^2 R_1^2 C^2} = \frac{\cancel{1000\,000\,\Omega^2 \cdot 1\cdot 10^{-6} F}^{\,1}}{1+\cancel{1000\,000\,\frac{1}{s^2}\cdot 1000\,000\,\Omega^2 \cdot 1\cdot 10^{-12} F^2}_{\,1}} = \frac{1}{1+1} = \frac{1}{2} = 0{,}5H = 500mH$$

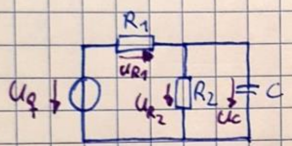
③ Schaltvorgang



$R_1 = 10\Omega = R_2$ $\quad R_3 = 20\Omega \quad C = 500\,\mu F = 500 \cdot 10^{-6} F$

$U_q = 50V$

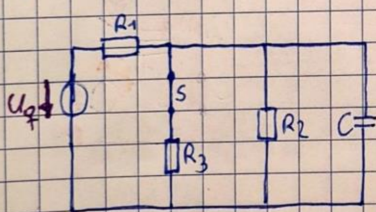
a) $t<0$ Schalter schon lange offen. ges: Anfangsbedingung der stetigen Größe



• stetige Größe bei einem Kondensator ist die Spannung $u_c(t)$. → Kondensator wird zu einem Leerlauf

$$u_c(t) = u_{R2} = U_q \frac{R_2}{R_1+R_2} = 50 \cdot \frac{10}{10+10} = \frac{500}{20} = 25V$$

b) $t=0$ schließt der Schalter. ges: Differentialgleichung



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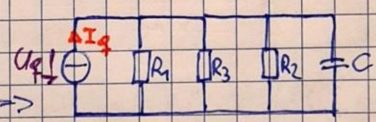


$$R_{12} = \frac{R_1 \cdot R_2}{R_1+R_2} = 5\Omega$$

$$I_q = \frac{U_q}{R_1} = \frac{50}{10} = 5A$$

$$R_{123} = \frac{R_{12} \cdot R_3}{R_{12}+R_3} = \frac{5 \cdot 20}{5+20} = 4\Omega$$

=>

=>

$I_q = i_c$

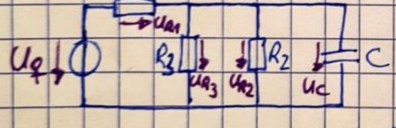
$M: u_{R123}(t) + u_c(t) - U_q = 0 \qquad u_{R123}(t) = R_{123} \cdot i_c(t) \qquad i_c(t) = C \cdot \frac{du_c(t)}{dt} = C \cdot u_c'(t)$

$U_q = R_{123} \cdot C \cdot u_c'(t) + u_c(t) \quad \Big| : (R_{123} \cdot C)$

$\frac{U_q}{R_{123} \cdot C} = u_c'(t) + \frac{u_c(t)}{R_{123} \cdot C}$ .... Differentialgleichung

c) $\tau = R_{123} \cdot C = 4 \cdot 500 \cdot 10^{-6} = 4 \cdot 5 \cdot 10^{-4} = 20 \cdot 10^{-4} = 0{,}002\,^1\!/_s = 2{,}00\,ms$

d) Welchen Wert hat die stetige Größe nach sehr langer Zeit?



$$R_{23} = \frac{10 \cdot 20}{10+20} = \frac{200}{30} = \frac{20}{3}\,\Omega$$

$$\rightarrow u_c(t > 5\tau) = U_{R23} = U_q \frac{R_{23}}{R_1 + R_{23}} = 50 \frac{\frac{20}{3}}{10+\frac{20}{3}} = 20V$$