1a) $\underline{Z}_{bd} = 2R \parallel 2R = R$ ①

Durch die Induktivität fließt kein Strom, weil die Schaltung symmetrisch ist.

b)

$$\underline{Z}_{ac} = 2R \parallel 2R \parallel j\omega L = R \parallel j\omega L = \frac{j\omega RL}{R + j\omega L}$$

$$= \frac{\omega^2 L^2 R}{R^2 + \omega^2 L^2} + j \frac{\omega L R^2}{R^2 + \omega^2 L^2}$$ ②

c) $Re\{\underline{Z}_{ac}\} = Im\{\underline{Z}_{ac}\}$

$$\omega^{\cancel{2}} L^{\cancel{2}} R = \cancel{\omega L} R^{\cancel{2}}$$

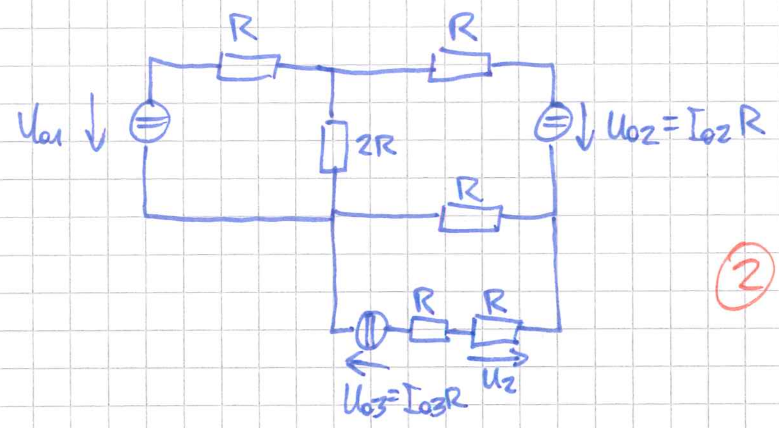
$$\omega L = R \Rightarrow L = \frac{R}{\omega} = \mu \frac{w^2 h}{2\pi} \ln\left(\frac{r_2}{r_1}\right)$$

$$w = \sqrt{\frac{R \cdot \cancel{2\pi}}{\cancel{2\pi} f \mu h \ln\left(\frac{r_2}{r_1}\right)}}$$

$$= \sqrt{\frac{10\,\Omega}{1\,kHz \cdot \mu \cdot 7{,}18\,cm \cdot \ln\left(\frac{10}{5}\right)}}$$

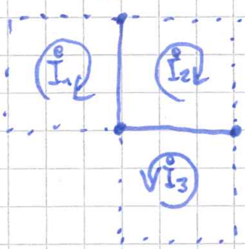
$$= 400$$ ③

2a)



2

b) 1



c) 1

$$m = z - k + 1$$
$$= 5 - 3 + 1$$
$$= 3$$

d)

$$\begin{pmatrix} 3R & -2R & 0 \\ -2R & 4R & R \\ 0 & R & 3R \end{pmatrix} \cdot \begin{pmatrix} \mathring{I}_1 \\ \mathring{I}_2 \\ \mathring{I}_3 \end{pmatrix} = \begin{pmatrix} U_{01} \\ -U_{02} \\ U_{03} \end{pmatrix}$$

2

e)

$$I_1 = -I_{02}$$

1

$$U_2 = \mathring{I}_3 R$$

f)

$$I_1 = -25\,mA$$

$$\mathring{I}_1 3R - \mathring{I}_2 2R = U_{01} \Rightarrow \mathring{I}_1 = \frac{U_{01} + \mathring{I}_2 2R}{3R}$$

$$-\frac{U_{01} + \mathring{I}_2 2R}{3\cancel{R}} 2\cancel{R} + \mathring{I}_2 4R + \mathring{I}_3 R = -U_{02}$$

$$\mathring{I}_2 R\left(4 - \frac{4}{3}\right) - \frac{2}{3} U_{01} + \mathring{I}_3 R = -U_{02}$$

$$\Rightarrow \mathring{I}_2 = \frac{\frac{2}{3} U_{01} - U_{02} - \mathring{I}_3 R}{\frac{8}{3} R} = \frac{U_{01}}{4R} - \frac{3}{8R} U_{02} - \frac{3}{8} \mathring{I}_3$$

$$\frac{U_{01} \cancel{R}}{4\cancel{R}} - \frac{3}{8\cancel{R}} U_{02} \cancel{R} - \frac{3}{8} \mathring{I}_3 R + \mathring{I}_3 3R = U_{03}$$

$$\frac{21}{8} \mathring{I}_3 R + \frac{U_{01}}{4} - \frac{3}{8} U_{02} = U_{03}$$

$$\mathring{I}_3 = \frac{U_{03} + \frac{3}{8} U_{02} - \frac{1}{4} U_{01}}{\frac{21}{8} R} = \frac{8 U_{03} + 3 U_{02} - 2 U_{01}}{21 R}$$

$$U_2 = \mathring{I}_3 R = \left(\frac{8}{21} I_{03} + \frac{1}{7} I_{02} - \frac{2}{21} \frac{U_{01}}{R}\right) R$$

$$= 20{,}\overline{3}\ V$$

3

3a)

$$\underline{H}(j\omega) = \frac{\underline{U}_2(j\omega)}{\underline{U}_1(j\omega)} = \frac{R_2 + \frac{1}{j\omega C}}{R_1 + R_2 + \frac{1}{j\omega C}} = \frac{1 + j\omega C R_2}{1 + j\omega C R_2 + j\omega C R_1}$$

$$= \frac{1 + j\omega C R_2}{1 + j\omega C (R_1 + R_2)}$$ 2

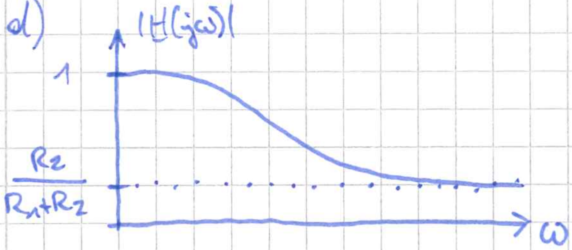
b) $$|\underline{H}(j\omega)| = \sqrt{\frac{1 + \omega^2 C^2 R_2^2}{1 + \omega^2 C^2 (R_1 + R_2)^2}}$$ 2

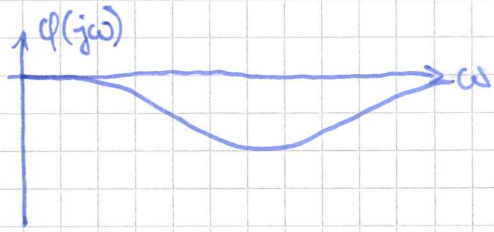
$$\varphi(j\omega) = \arctan(\omega C R_2) - \arctan(\omega C (R_1 + R_2))$$

c) $|\underline{H}(j\omega = 0)| = 1$ $\quad$ $\varphi(j\omega = 0) = 0$ 1

$|\underline{H}(j\omega \to \infty)| = \frac{R_2}{R_1 + R_2}$ $\quad$ $\varphi(j\omega \to \infty) = 0$

d)

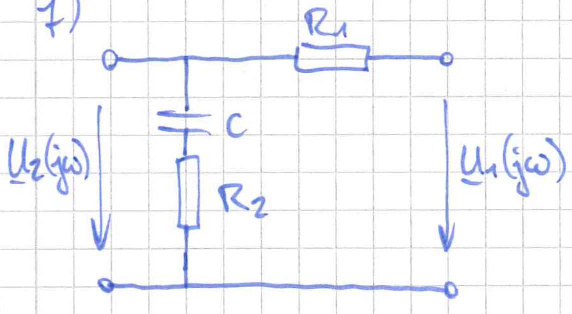




2

e) Tiefpass 1

f)



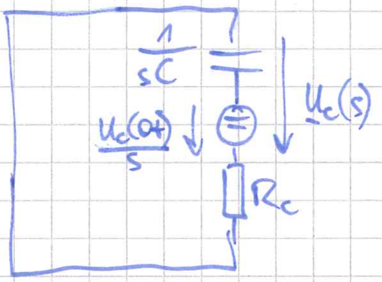
$$\underline{H}_{rück}(j\omega) = \frac{\underline{U}_1(j\omega)}{\underline{U}_2(j\omega)} = 1$$

1

4a) $u_c(0+) = U_0$ 1

b)

LAPLACE-ESB:



2

c) $$U_c(s) = \frac{u_c(0+)}{s} \frac{R_c}{R_c + \frac{1}{sC}} = \frac{U_c(0+)}{\cancel{s}} \frac{\cancel{s}}{s + \frac{1}{R_c C}} = u_c(0+) \frac{1}{s + \frac{1}{R_c C}}$$ 2

d) $$u_c(t) = u_c(0+) \cdot e^{-\frac{1}{R_c C} t} \quad ; t \geq 0$$
$$= U_0 \, e^{-\frac{1}{R_c C} t} \quad ; t \geq 0$$ 1

e) ~~$u_c(t=T) = ...$~~
$$u_c(T) = U_0 \, e^{-\frac{1}{R_c C} T}$$
$$\Rightarrow T = -R_c C \ln\left(\frac{u_c(T)}{U_0}\right)$$
$$= -600k\Omega \cdot 10\mu F \cdot \ln\left(\frac{4{,}415V}{12V}\right)$$ $\frac{V}{A} \cdot \frac{As}{V} = s$
$$= 6s$$ 2

f) Ladung bleibt konstant

Schalterstellung II: $Q = C\, u_c(T)$

Schalterstellung III: $Q = 2C \cdot u_c(t \to \infty)$

$$\cancel{C} \cdot u_c(T) = 2\cancel{C}\, u_c(t \to \infty)$$
$$\Rightarrow u_c(t \to \infty) = \frac{u_c(T)}{2} = \frac{4{,}415V}{2} = 2{,}2075V$$

Im eingeschwungenen Zustand fließt kein Strom 1