# Musterlösung

①

a) $R_{ab} = \frac{2/3 R \cdot 4/3 R}{2/3 R + 4/3 R} = 4/9\, R$

b) $R_{ad} = \frac{5/3 R \cdot 1/3 R}{5/3 R + 1/3 R} = 5/18\, R$

c) $R_{bd} = \frac{R \cdot R}{R + R} = 1/2\, R$

d) $R_{ac} = R + R_{ab} = \frac{13}{9} R$

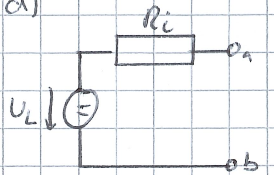
②

a) $R_i = R/3 + R/3 + R/3 = R = 300\,\Omega$

b) $U_L = R/3 \cdot I_{01} = 100\,\Omega \cdot 0{,}01\,A = 1\,V$

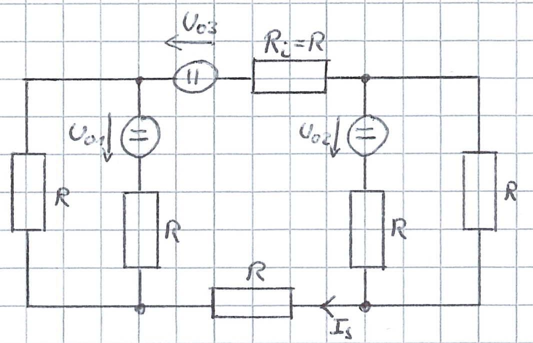
c) $I_K = I_{01} \cdot \frac{R_{ges}}{R/3 + R/3} = \frac{1}{3} I_{01} = 3{,}3\bar{3}\,mA$

d)



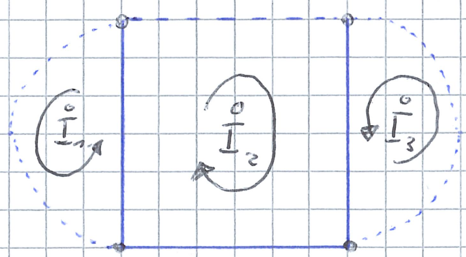

③

a)




$(U_{03} = R_i \cdot I_{03})$

b)




c)

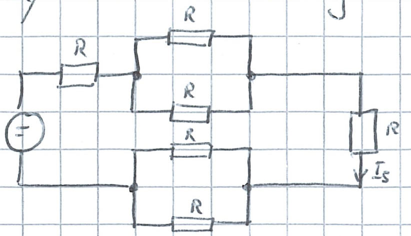
$m = z - k + 1 = 6 - 4 + 1 = 3$

d)

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

e)

Option 1:
Symmetrie durch Ignorieren von $U_{01}$ und $U_{02}$




$$\underline{I}_s = \frac{U_{03}}{3R} = \frac{5V}{300\Omega} = 16{,}\overline{6}\,mA$$

Option 2:
Determinante

$$\underline{\overset{\circ}{I}}_2 = \left(\frac{\det(A)}{\det(A_2)}\right)^{-1}$$

$$\det(A) = \begin{vmatrix} 2R & R & 0 \\ R & 4R & R \\ 0 & R & 2R \end{vmatrix} = 16R^3 - 2R^3 - 2R^3 = 12R^3$$

$$\det(A_2) = \begin{vmatrix} 2R & U_{01} & 0 \\ R & U_{03} & R \\ 0 & -U_{02} & 2R \end{vmatrix} = 4R^2U_{03} + 2R^2U_{02} - 2R^2U_{01} = 4R^2U_{03}$$

$$\Rightarrow \underline{\overset{\circ}{I}}_2 = \frac{4R^2U_{03}}{12R^3} = \frac{U_{03}}{3R} = 16{,}\overline{6}\,mA$$

4

a) $\underline{H}(j\omega) = \frac{\underline{U}_2(j\omega)}{\underline{U}_1(j\omega)} = \frac{1}{1 - j\frac{1}{\omega RC}}$

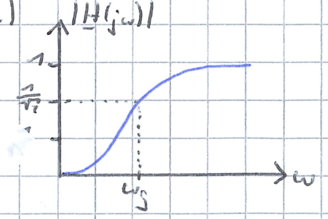
b) $|\underline{H}(j\omega)| = \frac{1}{\sqrt{1+\frac{1}{\omega^2R^2C^2}}}$ ; $\varphi(\omega) = -\arctan\left(\frac{-\frac{1}{\omega RC}}{1}\right) = \frac{\pi}{2} - \arctan(\omega RC)$

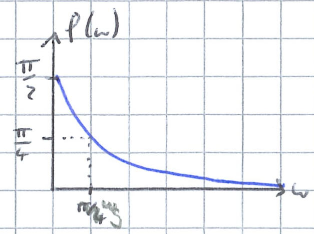
c)

| | $\lvert\underline{H}(j\omega)\rvert$ | $\varphi(\omega)$ |
|---|---|---|
| $\omega \to 0$ | 0 | $\pi/2$ |
| $\omega \to \infty$ | 1 | 0 |

$\frac{1}{\sqrt{2}} \overset{!}{=} |\underline{H}(j\omega_g)| \Leftrightarrow \omega_g = \frac{1}{RC}$

d)




e) Hochpass

f) $\underline{H}'(j\omega) = \frac{R'}{R' + \frac{1}{j\omega C}} \cdot \frac{R}{2R} = \frac{R}{2R + \frac{3}{j\omega C}} = \frac{1}{2} \cdot \frac{1}{1 + \frac{1}{j\omega R'C}}$ mit $R' = \frac{2}{3}R$

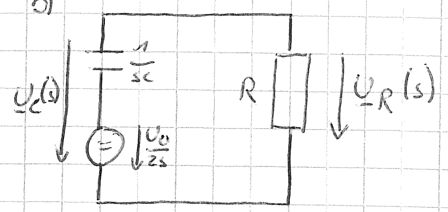
g) $\omega_g = \frac{1}{R'C} = \frac{3}{2}\omega_g$

→ Veränderter Hochpass mit nochmals halbierter Ausgangsspannung und höhere Grenzfrequenz.

⑤

a) $U_c(0-) = U_c(0+) = U_0/2$

b)




c) $\underline{U}_R(s) = \frac{U_0}{2s} \cdot \frac{R}{\frac{1}{sC}+R} = \frac{U_0}{2} \cdot \frac{1}{s+\frac{1}{RC}}$

d) $\underline{U}_R(s) = \frac{U_0}{2} \cdot \frac{1}{s+\frac{1}{RC}} \circ\!\!-\!\!\bullet \; \frac{U_0}{2} \cdot e^{-t/RC} = U_R(t)$

e)