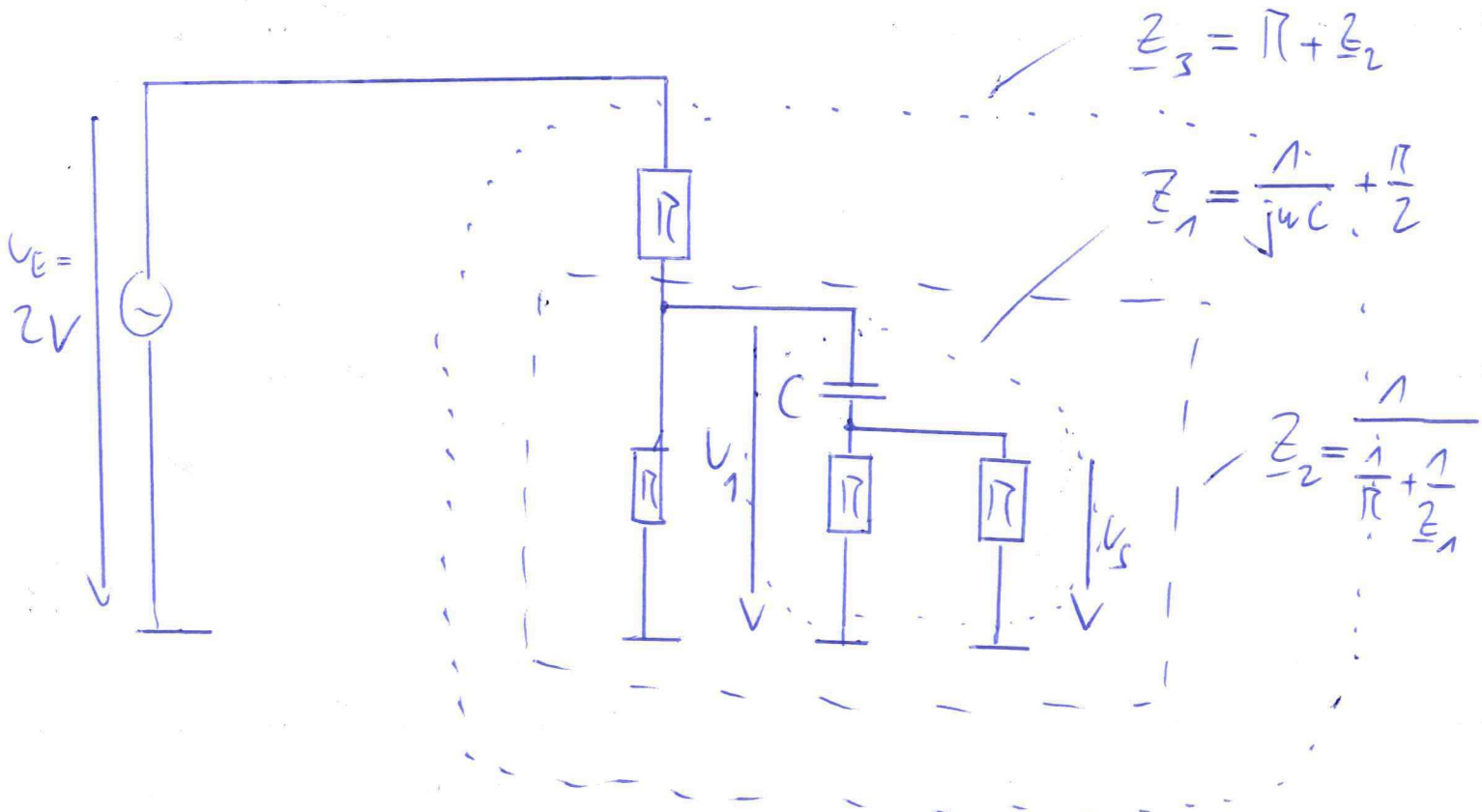


ges:  $U_s$  als Funktion von  $U_E$



$$Z_3 = R + Z_2$$

$$Z_1 = \frac{1}{j\omega C} + \frac{R}{2}$$

$$Z_2 = \frac{1}{\frac{1}{R} + \frac{1}{Z_1}}$$

$$\frac{U_s}{U_n} = \frac{R}{Z_1} = \frac{R}{\frac{R}{2} + \frac{1}{j\omega C}} = \frac{1}{\frac{1}{2} + \frac{1}{j\omega CR}} = \frac{2}{1 + \frac{2}{j\omega CR}}$$

(oder  $\frac{U_s}{U_n} = \frac{\frac{R}{2}}{Z_n}$  ...)

↙

$$\frac{U_1}{U_E} = \frac{Z_2}{Z_2 + R}$$

$$Z_2 = \frac{1}{\frac{1}{R} + \frac{1}{Z_1}} = \frac{1}{\frac{Z_1 + R}{R \cdot Z_1}} = \frac{Z_1 \cdot R}{Z_1 + R}$$

$$= \frac{\left(\frac{R}{2} + \frac{1}{j\omega C}\right) \cdot R}{\frac{R}{2} + \frac{1}{j\omega C} + R} = \frac{\frac{R}{2} + \frac{1}{j\omega C}}{\frac{1}{2} + 1 + \frac{1}{j\omega CR}}$$

$$= \frac{\frac{R}{2} + \frac{1}{j\omega C}}{\frac{3}{2} + \frac{1}{j\omega CR}} = \frac{1 + \frac{2}{j\omega CR}}{\frac{3}{R} + \frac{2}{j\omega CR^2}}$$

$$Z_3 = Z_2 + R = \frac{1 + \frac{2}{j\omega CR}}{\frac{3}{R} + \frac{2}{j\omega CR^2}} + R = \frac{1 + \frac{2}{j\omega CR} + R \left(\frac{3}{R} + \frac{2}{j\omega CR^2}\right)}{\frac{3}{R} + \frac{2}{j\omega CR^2}}$$

$$= \frac{1 + \frac{2}{j\omega CR} + 3 + \frac{2}{j\omega CR}}{\frac{3}{R} + \frac{2}{j\omega CR^2}} = \frac{4 + \frac{4}{j\omega CR}}{\frac{3}{R} + \frac{2}{j\omega CR^2}}$$

$$\frac{Z_2}{Z_3} = \frac{1 + \frac{2}{j\omega CR}}{\frac{3}{R} + \frac{2}{j\omega CR^2}} \cdot \frac{\frac{3}{R} + \frac{2}{j\omega CR^2}}{4 + \frac{4}{j\omega CR}}$$

$$= \frac{1 + \frac{2}{j\omega CR}}{4 + \frac{4}{j\omega CR}} = \frac{U_1}{U_E}$$

2

$$\frac{U_S}{U_n} \cdot \frac{U_n}{U_E} = \frac{2}{1 + \frac{2}{j\omega CR}} \cdot \frac{1 + \frac{2}{j\omega CR}}{4 + \frac{4}{j\omega CR}} = \frac{1}{2} \cdot \frac{1}{1 + \frac{1}{j\omega CR}}$$

$$\frac{U_S}{U_E} = \frac{1}{2} \cdot \frac{j\omega CR}{j\omega CR + 1} = \frac{1}{2} \cdot \frac{1}{1 + \frac{1}{j\omega CR}} = \frac{1}{2} \cdot \frac{1}{1 - j\frac{1}{\omega CR}}$$


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Amplitudengang  $\left| \frac{U_S}{U_E} \right| = \frac{1}{2} \cdot \frac{1}{\sqrt{1^2 + \frac{1}{(\omega CR)^2}}} = \frac{1}{2} \cdot \frac{\omega CR}{\sqrt{1 + \frac{1}{(\omega CR)^2}} \cdot \sqrt{(\omega CR)^2}}$

$$= \frac{1}{2} \frac{\omega CR}{\sqrt{(\omega CR)^2 + 1}}$$


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Real- und Imaginärkomponente:

$$\frac{U_S}{U_E} = \frac{j\omega CR}{(j2\omega CR + 2)} \cdot \frac{-j2\omega CR + 2}{(-j2\omega CR + 2)}$$

$$= \frac{2\omega^2 C^2 R^2 + j2\omega CR}{4\omega^2 C^2 R^2 + j4\omega CR - j4\omega CR + 4}$$

$$= \frac{2(\omega CR)^2}{4(\omega CR)^2 + 4} + j \frac{2\omega CR}{4(\omega CR)^2 + 4}$$


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Phasengang:

$$\varphi(\omega) = \arctan \left( \frac{\frac{2\omega CR}{4(\omega CR)^2 + 4}}{\frac{2(\omega CR)^2}{4(\omega CR)^2 + 4}} \right) = \underline{\underline{\arctan \left( \frac{1}{\omega CR} \right)}}$$