

A1

$$a) U_x(T_{amb}, U_1) = \left(\frac{1}{2} - \frac{e^{b(T_{amb} + a \cdot U_1^2 - T_0)}}{e^{b(T_{amb} + a \cdot U_1^2 - T_0)} + 1} \right) \cdot U_0$$

$$b) U_1 = \sqrt{\frac{T_0 - T_{amb}}{a}} = 6,32 V \quad U_0 = 2 \cdot U_1 = 12,64 V$$

$$c) f(U_1) = \frac{e^{b(T_{amb} + a \cdot U_1^2 - T_0)}}{e^{b(T_{amb} + a \cdot U_1^2 - T_0)} + 1} \cdot U_0 - U_1 \stackrel{!}{=} 0$$

$$f'(U_1) = \frac{U_0 \cdot 2 \cdot a \cdot b \cdot U_1 \cdot e^{b(T_{amb} + a \cdot U_1^2 - T_0)}}{(e^{b(T_{amb} + a \cdot U_1^2 - T_0)} + 1)^2} - 1$$

$$U_1^{n+1} = U_1^n - \frac{f(U_1)}{f'(U_1)}$$

$$d) U_{XL}(T_{amb}, T_{amb1}) = \sum_{v=0}^1 a_v (T_{amb} - T_{amb1})^v = a_0 + a_1 (T_{amb} - T_{amb1})$$

$$a_0 = -2,92 V$$

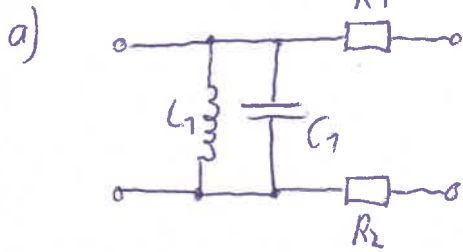
$$a_1 = -0,248$$

e) Knotenpotentialanalyse

$$\begin{bmatrix} \frac{3}{R_0} & -\frac{1}{R_0} \\ -\frac{1}{R_0} & \frac{1}{R_2} + \frac{2}{R_0} \end{bmatrix} \begin{pmatrix} \varphi_2 \\ \varphi_3 \end{pmatrix} = \begin{pmatrix} \frac{U_0}{R_0} \\ \frac{U_0}{R_0} \end{pmatrix}$$

$$U_x = \varphi_2 - \varphi_3 = U_0 \frac{\frac{1}{e} - 1}{\frac{3}{e} + 5} = -1,37 V$$

A2

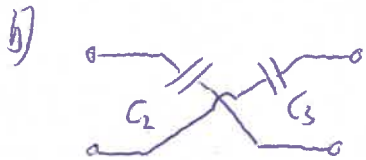


$$Y_{a11} = \frac{1}{j\omega L_1} + j\omega C_1 + \frac{1}{R_1 + R_2}$$

$$Y_{a12} = -\frac{1}{R_1 + R_2}$$

$$Y_{a21} = -\frac{1}{R_1 + R_2}$$

$$Y_{a22} = \frac{1}{R_1 + R_2}$$



$$[Y_b] = \frac{1}{\frac{1}{j\omega C_2} + \frac{1}{j\omega C_3}} \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$$

c)

$$[Y_{ges}] = [Y_a] + [Y_b] = \begin{bmatrix} \frac{1}{j\omega L} + j\omega \frac{3}{2}C + \frac{1}{2R} & -\frac{1}{2R} + j\omega \frac{C}{2} \\ -\frac{1}{2R} + j\omega \frac{C}{2} & \frac{1}{2R} + j\omega \frac{C}{2} \end{bmatrix}$$

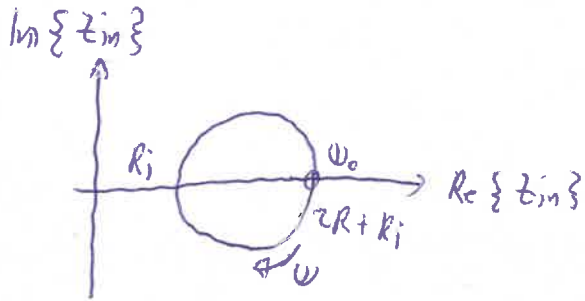
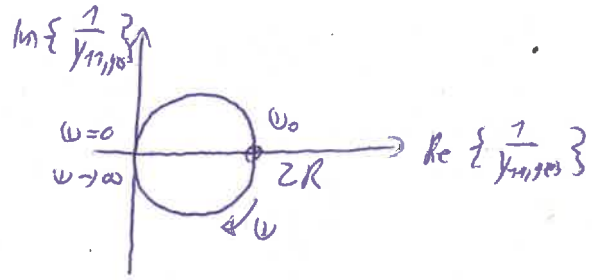
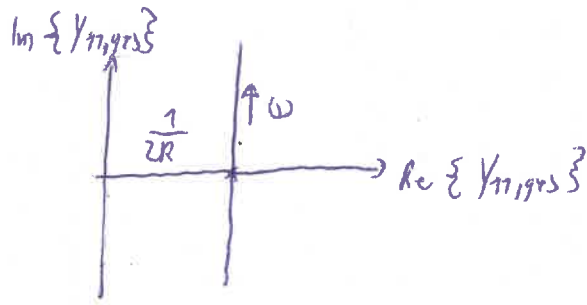
d)

$$\underline{F_A} = \frac{R_L}{-\frac{Y_{22,ges} \cdot R_L}{Y_{21,ges}} - \frac{1}{Y_{21,ges}}}$$

e)

$$\underline{F_G} = \frac{1}{-\frac{\det Y_{ges}}{Y_{21,ges}} R_i - \frac{Y_{11,ges}}{Y_{21,ges}} \cdot \frac{R_i}{R_L} - \frac{Y_{22,ges}}{Y_{21,ges}} - \frac{1}{Y_{21,ges}} \cdot \frac{1}{R_L}}$$

$$f) \underline{z}_{in} = R_i + \frac{1}{Y_{n,ges}} = R_i + \frac{1}{\frac{1}{2R} + j\omega \frac{1}{2}C + \frac{1}{j\omega L}}$$



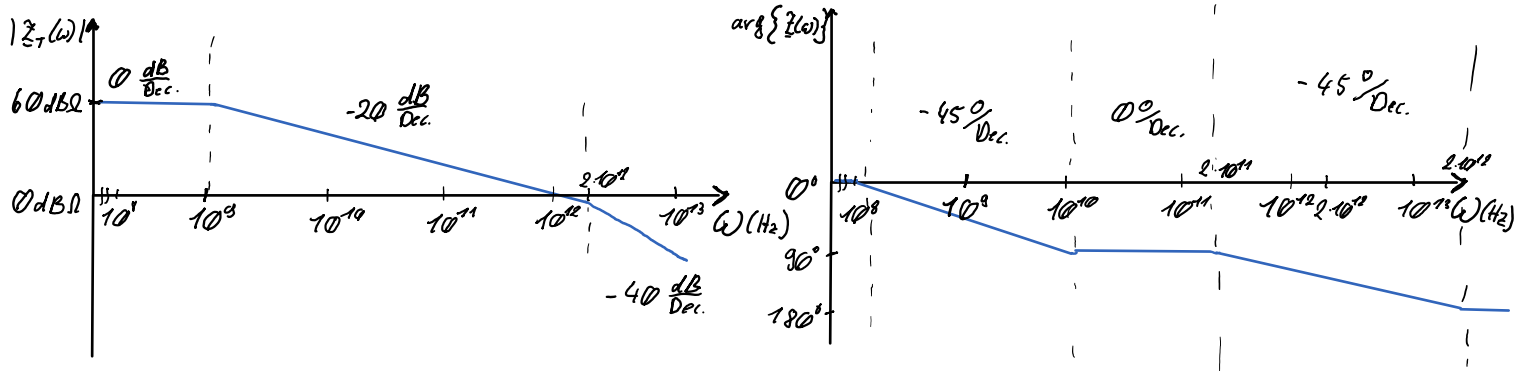
$$\omega_0 = \sqrt{\frac{2}{3} \frac{1}{LC}}$$

$$g) P = \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{|U_1|^2}{2R} = \frac{1}{8} \left(\frac{2R}{2R + R_i} \right)^2 \frac{|U_0|^2}{R}$$

Aufgabe 3

$$a) \underline{Z_T(\omega)} = \frac{U_a(\omega)}{I_p(\omega)} = \frac{R}{1 + j\omega CR + (j\omega)^2 CL}$$

$$b) \underline{Z_T(\omega)} \Big|_{j\omega=p} = \frac{R}{CL} \frac{1}{p^2 + p \frac{R}{L} + \frac{1}{CL}} \quad \begin{array}{l} p_1 \approx -1 \cdot 10^9 \text{ Hz} \\ p_2 \approx -2 \cdot 10^{12} \text{ Hz} \end{array}$$



$$c) \underline{I_p(s)} = I_0 \gamma \sqrt{\pi} \exp(-(\gamma \pi s)^2)$$

$$d) \underline{U_a(s)} = \underline{I_p(s)} \cdot \underline{Z_T(s)} \Big|_{s=j\omega} = \frac{R I_0 \gamma \sqrt{\pi} \exp(-(\gamma \pi s)^2)}{1 + j 2\pi f CR + (j 2\pi f)^2 CL}$$

$$e) \underline{I_{pe}(p)} = \frac{I_0}{\sqrt{2}} \frac{1}{p} (1 - \exp(-p T_1))$$

$$f) \underline{Z_T(p)} = \frac{R}{CL} \frac{1}{(p-p_1)(p-p_2)} \quad \underline{U_a(p)} = \underline{I_{pe}(p)} \cdot \underline{Z_T(p)} = \frac{I_0}{\sqrt{2}} \frac{R}{CL} \frac{1}{p(p-p_1)(p-p_2)} (1 - \exp(-p T_1))$$

$$\frac{A}{p} + \frac{B}{p-p_1} + \frac{D}{p-p_2} = \frac{1}{p(p-p_1)(p-p_2)} \quad \underline{A = \frac{1}{p_1 p_2}} \quad \underline{B = \frac{1}{p_1^2 - p_1 p_2}} \quad \underline{D = \frac{-1}{p_1 p_2 - p_2^2}}$$

$$\underline{u_a(t) = \frac{I_0}{\sqrt{2}} \frac{R}{CL} [A s(t) + B s(t) \exp(p_1 t) + D s(t) \exp(p_2 t) - A s(t-T_1) - B s(t-T_1) \exp(p_1(t-T_1)) - D s(t-T_1) \exp(p_2(t-T_1))]}$$

$$g) \int_{-\infty}^{\infty} i_{pe}(t) dt = \int_{-\infty}^{\infty} i_p(t) dt$$

$$\underline{T_1 = \sqrt{2\pi} \gamma}$$

$$a) F(p) = - \frac{\frac{1}{pC}}{R_1} = - \frac{1}{pCR_1}$$

$$b) u_e(t) = U_0 \cdot s(t) \rightarrow V_e(p) = \frac{U_0}{p}$$

$$\Rightarrow u_a(p) = - \frac{1}{p^2 CR_1} \cdot U_0 \rightarrow u_a(t) = - \frac{U_0}{CR_1} \cdot t \cdot s(t)$$

$$c) u_c \text{ kann nicht springen, } u_{amp} = 0V \quad u_{amp} \uparrow \rightarrow \text{opamp symbol}$$

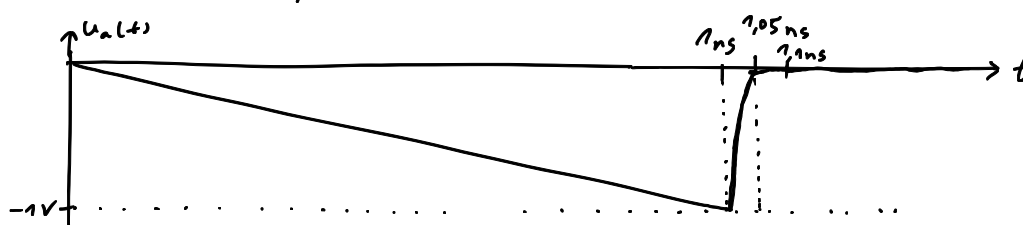
$$u_{a1} = - \frac{t_1 U_0}{CR_1} = - U_{c0}$$

$$u_a(t) \big|_{t > t_1} = - u_c(t)$$

$$u_c \downarrow \quad u_{c0} \downarrow \quad \text{circuit diagram: } C \text{ in parallel with } R_2 \text{ and } \Phi \Rightarrow u_c(\tilde{t}) = U_0 \cdot s(\tilde{t}) \cdot e^{-\frac{1}{R_2 C} \cdot \tilde{t}}$$

$$\Rightarrow u_a(t) = u_{a1} \cdot s(t - t_1) \cdot e^{-\frac{1}{R_2 C} (t - t_1)}$$

$$d) u_a(t_1) = - \frac{t_1}{CR_1} = -1V \quad \tau = R_2 C = 10ps$$



$$e) \frac{\tilde{u}_a(p)}{u_e(p)} = - \frac{\omega_g}{p} \cdot \frac{1}{(1 + R_1(pC + \omega_g C))}$$

$$f) \tilde{v}_a(p) = \frac{U_0}{p} \cdot \left(-\frac{\omega_g}{p}\right) \cdot \frac{1}{pCR_1 + \omega_g CR_1 + 1}$$

$$\tilde{u}_a(t) = - \frac{U_0 \omega_g}{CR_1} \cdot s(t) \cdot \frac{1}{p_1^2} (p_1 t + e^{-p_1 t} - 1)$$

$$p_1 = \frac{\omega_g CR_1 + 1}{CR_1}$$

$$g) \lim_{t \rightarrow \infty} \frac{\tilde{u}_a(t)}{u_a(t)} = \lim_{t \rightarrow \infty} \frac{\omega_g}{p_1} = \frac{\omega_g CR_1}{\omega_g CR_1 + 1} = 0,995$$