

Schaltungstechnik Prüfung SS 22, Kurzlösung

A1

a) $I_D \approx I_S = 1 \cdot 10^{-15} \text{ A}$

b) $I_{D00} = -0,02248 \text{ A}$

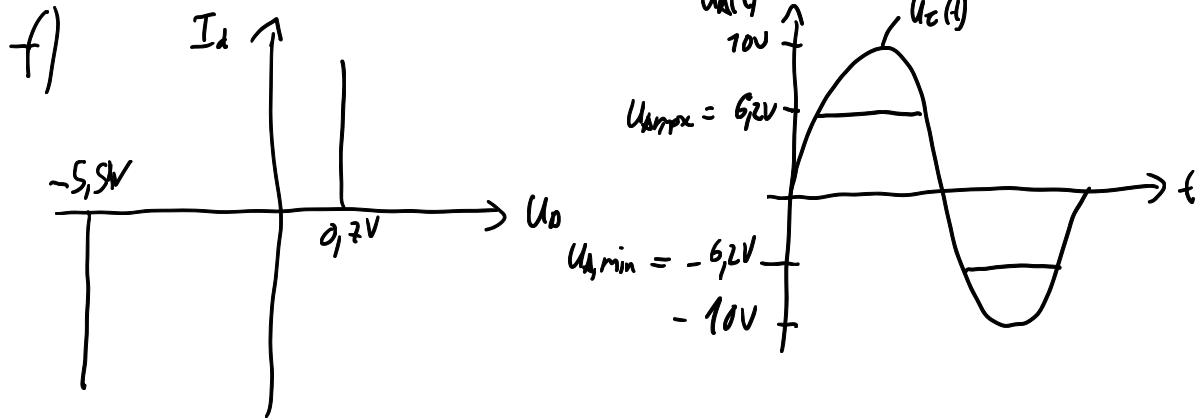
c) $f(U_A) = R_S \cdot I_{D00} \cdot e^{\frac{U_A + U_{D0}}{n \cdot U_T}} + U_A - U_E$

$\vdots$
 $U_A = 5,957 \text{ V}$

d) $P_{R_S} = \frac{(U_E - U_A)^2}{R_S} = 184,9 \text{ } \mu\text{W}$

$P_D = U_A \cdot I_{DE} \approx 0,0256 \text{ W}$

e) $U_D = n \cdot U_T \cdot \ln\left(\frac{|I_{DE,1}|}{I_S} + 1\right) = 0,758 \text{ V}$



AL

a) Parallel-Parallel-Schaltung

$$[A_a] = \frac{1}{g_m - j\omega C_2} \begin{bmatrix} -\frac{1}{R_1} - j\omega C_2 & -1 \\ -j\omega(C_1 + C_2)\left(\frac{1}{R_1} + j\omega C_2\right) + (-j\omega C_2 + g_m)(-j\omega C_2) & -j\omega(C_1 + C_2) \end{bmatrix}$$

$$b) [A_b] = \frac{1}{j\omega M} \begin{bmatrix} R_2 + j\omega L_1 & (R_2 + j\omega L_1)(R_3 + j\omega L_2) - (j\omega M)^2 \\ 1 & R_3 + j\omega L_2 \end{bmatrix}$$

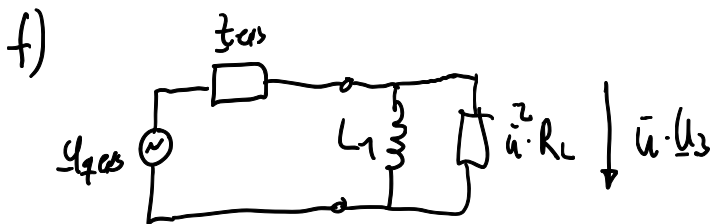
$$c) [A_{ges}] = [A_a] \cdot [A_b] = \begin{bmatrix} A_{a11} \cdot A_{b21} + A_{a12} \cdot A_{b22} & \dots \\ \dots & \dots \end{bmatrix}$$

$$D_B = \frac{1}{i} \left[A_{ges11} \cdot \sqrt{\frac{R_L}{R_1}} + A_{ges12} \cdot \frac{1}{\sqrt{R_L \cdot R_1}} + A_{ges21} \sqrt{R_L \cdot R_1} + A_{ges22} \cdot \sqrt{\frac{R_1}{R_L}} \right]$$

$$d) Y_{in} = \frac{1}{j\omega L_1} + \frac{1}{R_L} \cdot \frac{L_2}{L_1}$$

$$e) \underline{U_{q,\omega}} = \frac{U_0 g_m R_1}{-j\omega C_1 R_1 - 1}$$

$$\underline{Z_{res}} = R_1$$



$$F(j\omega) = \frac{j\omega \frac{L_1}{R_1}}{j\omega L_1 \frac{\bar{u}^2 R_L + R_1}{\bar{u}^2 R_L \cdot R_1} + 1}$$

$$\rightarrow u_u = \frac{\bar{u}^2 R_L \cdot R_1}{L_1 (\bar{u}^2 R_L + R_1)} = \frac{R_L \cdot R_1}{L_1 \cdot R_L + R_1 \cdot L_2}$$

$$g) \quad Y_{in, neu} = j\omega C_p + \underline{Y}_{in} \stackrel{!}{=} \frac{1}{\underline{Z}_{crs}^*} = \frac{1}{R_1}$$

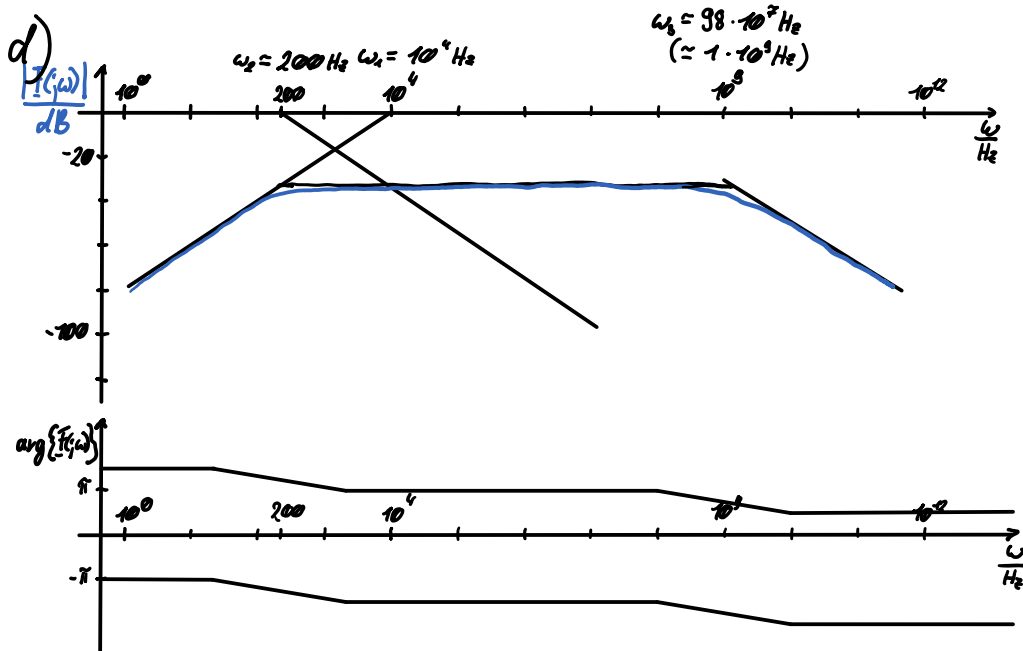
$$C_p = \frac{1}{\omega^2 L_1} = 25,3 \mu F$$

$$L_1 = \frac{R_1}{R_2} \cdot L_2 = 10 \mu H$$

$$a) \quad F(j\omega) = \frac{\overset{S.163}{\underset{S.232}{U_A}}}{U_E} = \frac{-R_2 V_0 \omega_p j\omega C_1}{j\omega C_1 R_2 (\omega_g + j\omega V_0) + (j\omega C_1 R_1 + 1)(\omega_g + j\omega V_0 + V_0 \omega_g)}$$

$$b) \quad F(j\omega) \Big|_{V_0 \rightarrow \infty} = \frac{-j\omega C_1 R_2 \omega_g}{(j\omega)^2 C_1 (R_1 + R_2) + j\omega (C_1 R_1 \omega_g + 1) + \omega_g}$$

$$c) \quad |F(0)| = 0$$



e) LT:

$$u_E(t) = s(t) \left(-\frac{\hat{U}_E}{T_A} (t - T_A) \right) + s(t - T_A) \left(\frac{\hat{U}_E}{T_A} (t - T_A) \right)$$

$u_E(t)$ beschränkt $\Rightarrow d=0$ im VB

$$\underset{0}{V_E(p)} \Big|_{p=j2\pi f} = V_E(f) = \frac{\hat{U}_E}{T_A} \left(\frac{T_A}{j2\pi f} + \frac{1}{(j2\pi f)^2} (e^{-j2\pi f T_A} - 1) \right)$$

f)

$$V_A(f) = F(f) \cdot V_E(f) \text{ mit } F(f) = \frac{-j2\pi f C_1 R_2 \omega_g}{(j2\pi f)^2 C_1 (R_1 + R_2) + j2\pi f (C_1 R_1 \omega_g + 1) + \omega_g}$$

g)

$$V_A(f) \Big|_{p=j2\pi f} = V_A(p) = -\frac{\hat{U}_E}{T_A} \frac{R_2 \omega_g}{R_1 + R_2} \left(\frac{T_A}{p^2 + p \underbrace{\frac{C_1 R_1 \omega_g + 1}{C_1 (R_1 + R_2)}}_b + \underbrace{\frac{\omega_g}{C_1 (R_1 + R_2)}}_c} + \frac{1}{p(p-p_1)(p-p_2)} (e^{-p T_A} - 1) \right)$$

$$p_{1,2} = \frac{-b \pm \sqrt{b^2 - 4c}}{2}$$

$$u_A(t) = -\frac{\hat{U}_E}{T_A} \frac{R_2 \omega_g}{R_1 + R_2} \left(B s(t) e^{p_1 t} + D s(t) e^{p_2 t} - E s(t) - G s(t) e^{p_1 t} - H s(t) e^{p_2 t} + E s(t - T_A) + G s(t - T_A) e^{p_1 (t - T_A)} + H s(t - T_A) e^{p_2 (t - T_A)} \right)$$

$$B = \frac{T_A}{p_1 p_2} ; D = \frac{T_A}{p_2 - p_1} ; E = \frac{1}{p_1 p_2} ; G = \frac{1}{p_1 (p_1 - p_2)} ; H = \frac{1}{p_2 (p_2 - p_1)}$$

a-f)

$$a) \quad V_c(p) = \frac{V_c(p)}{p^2 LC + pC R + 1}$$

$$\underline{B} = \frac{1}{p_1 p_2} ; \quad \underline{D} = \frac{1}{p_1(p_1 - p_2)} ; \quad \underline{E} = \frac{1}{p_2(p_2 - p_1)}$$

$$b) \quad V_c(p) = -\frac{U_B}{LC} \frac{1}{p(p^2 + p \frac{R}{L} + \frac{1}{LC})} \quad p_{1,2} = \frac{-\frac{R}{L} \pm \sqrt{(\frac{R}{L})^2 - 4 \frac{1}{LC}}}{2} \quad p_3 = 0$$

$$u_c(t) = -\frac{U_B}{LC} \left(\underline{B} s(t) + \underline{D} s(t) e^{p_1 t} + \underline{E} s(t) e^{p_2 t} \right)$$

c)

$$p_1 \approx -2,0 \text{ GHz} \quad p_2 \approx -98 \text{ GHz} \Rightarrow \underline{B} \approx 5,1 \cdot 10^{-21} \text{ s}^2 ; \quad \underline{D} \approx -5,2 \cdot 10^{-21} \text{ s}^2$$

$$u_c(t=300 \text{ ps}) \approx -0,45 \text{ V} \quad \underline{E} \approx 1,1 \cdot 10^{-22} \text{ s}^2 ; \quad LC = 5 \cdot 10^{-21} \text{ s}^2$$

$$u_R(t=300 \text{ ps}) \approx -0,55 \text{ V} \Rightarrow u_L(t=300 \text{ ps}) \approx 0$$

d)

$$U_B = RC \frac{du_c}{dt} + LC \frac{d^2 u_c}{dt^2} + u_c \quad \Rightarrow \quad V_c(p) = \frac{1}{LC} \frac{U_B + p^2 LC u_c(t_1) + p(RC u_c(t_1) + LC u'_c(t_1))}{p(p^2 + p \frac{R}{L} + \frac{1}{LC})} \quad p_{1,2} \text{ siehe b)}$$

$$\Rightarrow \underline{G} = \frac{U_B}{p_1 p_2}$$

$$\Rightarrow \underline{H} = \frac{LC u_c(t_1) - \frac{U_B}{p_1 p_2} + \frac{RC u_c(t_1) + LC u'_c(t_1) + \frac{U_B}{p_1 p_2} (p_1 + p_2)}{p_2}}{1 - \frac{p_2}{p_1}}$$

$$\Rightarrow \underline{K} = - \frac{RC u_c(t_1) + LC u'_c(t_1) + U_B \frac{p_1 + p_2}{p_1 p_2}}{p_1} - \frac{LC u_c(t_1) - \frac{U_B}{p_1 p_2} + \frac{RC u_c(t_1) + LC u'_c(t_1) + \frac{p_1 + p_2}{p_1 p_2} U_B}{p_2}}{p_1 - p_2}$$

$$u_c(t) = \frac{1}{LC} \left(\underline{G} s(t - t_1) + \underline{H} s(t - t_1) e^{p_1(t - t_1)} + \underline{K} s(t - t_1) e^{p_2(t - t_1)} \right)$$

e)

$u_c(t)$ hat keinen Gleichanteil

f)

$$-U_B = RC \frac{du_{c1}}{dt} + u_{c1} \quad \Rightarrow \quad -\frac{U_B}{p} = RC(p V_{c1}(p) - u_{c10}) + V_{c1}(p)$$

$$V_{c1}(p) = \frac{-U_B + u_{c10} RC p}{RC p(p + \frac{1}{RC})} \quad p_1 = -\frac{1}{RC}$$

$$u_{c1}(t) = -U_B s(t) + (u_{c10} + U_B) s(t) e^{-\frac{t}{RC}}$$

$$u_{c2}(t) = U_B s(t) + (u_{c20} - U_B) s(t) e^{-\frac{t}{RC}} \quad \left. \begin{array}{l} -U_B \rightarrow U_B ; u_{c10} \rightarrow u_{c20} \end{array} \right\}$$

$$\underline{B} = \frac{U_B}{p_1} ; \quad \underline{D} = \frac{p_1 u_{c10} RC - U_B}{p_1} = RC(u_{c10} + U_B)$$

g)

$$u_{c2}(\tilde{t}=T_1) \stackrel{!}{=} u_{c10} \quad u_{c1}(t=T_1) = u_{c20}$$

$$u_{c2}(\tilde{t}) \Big|_{u_{c20}=u_{c1}(T_1)} = u_B s(\tilde{t}) + (-u_B s(T_1) + (u_{c10} + u_B) s(T_1) e^{-\frac{T_1}{RC}} - u_B) s(\tilde{t}) e^{-\frac{\tilde{t}}{RC}}$$

$$\Rightarrow u_{c10} = u_B + (-2u_B + (u_{c10} + u_B) e^{-\frac{T_1}{RC}}) e^{-\frac{T_1}{RC}} = u_B - 2u_B e^{-\frac{T_1}{RC}} + u_B e^{\frac{2T_1}{RC}} + u_{c10} e^{-\frac{2T_1}{RC}}$$

$$\Leftrightarrow u_{c10} (1 - e^{-\frac{2T_1}{RC}}) = u_B (1 - e^{-\frac{T_1}{RC}})^2$$

$$\Leftrightarrow u_{c10} = u_B \frac{(1 - e^{-\frac{T_1}{RC}})^2}{1 - e^{-\frac{2T_1}{RC}}} \approx 0,3 \text{ V}$$