

Kurzlösung Abgabe 2

A11

$$a) i = I_{CT} - I_{B,I} + I_B \\ = I_S \cdot (e^{U_{BE}/U_T} - e^{U_{BC}/U_T}) - \frac{I_S}{\beta_I} (e^{U_{BC}/U_T} - 1) + \frac{I_S}{\beta_N} (e^{U_{BE}/U_T} - 1) + \frac{I_S}{\beta_I} \cdot (e^{U_{BC}/U_T} - 1)$$

mit $U_{BC} = 0$

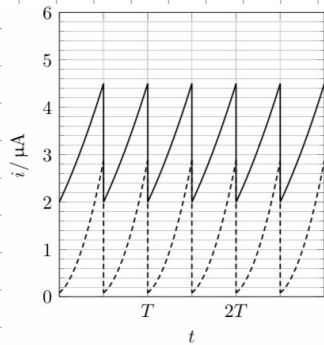
$$= I_S \cdot (e^{U_0/U_T} - 1) \cdot \left(\frac{1}{\beta_N} + 1 \right)$$

• Dioden-Verhalten

$$b) U_{GS} - U_{TH} < U_{DS} \Rightarrow i(U_0) = \frac{1}{2} \beta (U_0 - U_{TH})^2$$

• quadratischer Anstieg von i

c)/d)



— c)

..... d)

$$e) Z_{in}(j\omega) = \frac{1}{j\omega C_{BE} + \frac{1}{R_{BE}} + \frac{1}{R_{CE}} + s}$$

• Tiefpassverhalten

A12

$$a) U_T = \frac{k_B T}{q} \approx 27 \text{ mV}$$

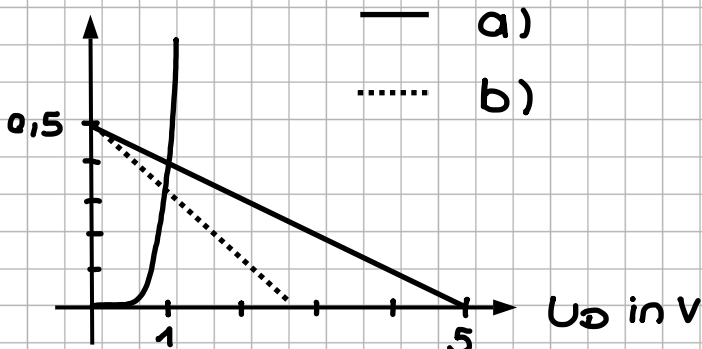
$$f(U_D) = U_D + R \cdot I_S \cdot (e^{U_D/U_T} - 1) - U_0$$

$$f'(U_D) = 1 + \frac{R \cdot I_S}{U_T} \cdot e^{U_D/U_T}$$

→ NRV:

j	1	2	3	4	5
$U_D^{(j)}$ in V	0,8	0,788411	0,785102	0,784883	0,784882

b) I_D in A



— a)

..... b)

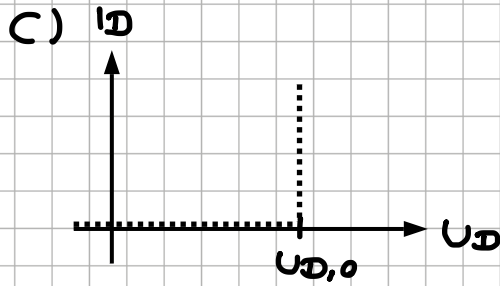
→ $\frac{dI_D}{dU_D}$ sehr groß

→ AP verschiebt sich kaum

$$\rightarrow U_D' \approx 2 \cdot U_D = 1,570 \text{ V}$$

$$f(U_D) = 2 \cdot U_D + R \cdot I_S \cdot (e^{U_D/U_T} - 1) - U_0$$

$$\rightarrow \text{NRV: } U_D^{(1)} = 0,785 \text{ V} \quad U_D = 0,7793 \text{ V}, \quad U_D' = 1,5586 \text{ V}$$



• Durchbruch für $U_D \ll 0$

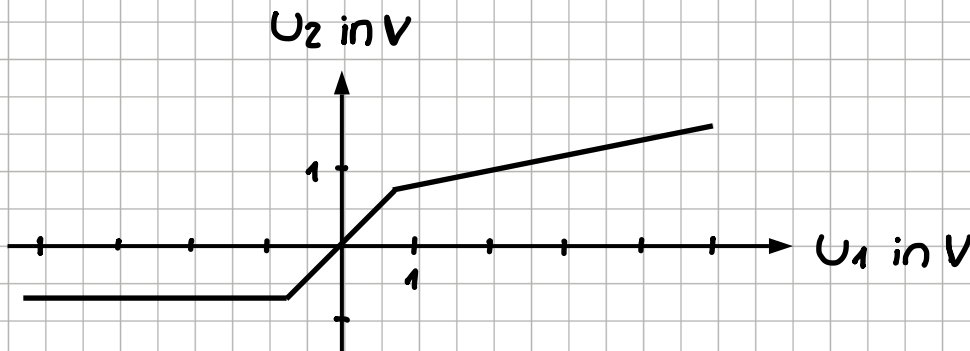
• exponentieller Verlauf

⋮

$$d) \quad U_1 \geq U_{D,0}: \quad U_2 = \frac{R_2}{R_1 + R_2} \cdot (U_1 - U_{D,0}) + U_{D,0}$$

$$-U_{D,0} < U_1 < U_{D,0}: \quad U_2 = U_1$$

$$U_1 \leq -U_{D,0}: \quad U_2 = -U_{D,0}$$



A13

$$a) \quad I_B^{(1)} = \frac{I_S}{\beta} (e^{U_{BE}^{(1)}/U_T} - 1) \approx \frac{I_S}{\beta} \cdot e^{U_{BE}^{(1)}/U_T}$$

$$I_C^{(1)} = \beta \cdot I_B^{(1)}$$

$$b) \quad I_E' = (\beta + 2) \cdot I_B \quad I_E' = (\beta + 1) I_B' \quad \rightarrow I_B' = \frac{\beta + 2}{\beta + 1} \cdot I_B$$

$$I_E = \beta \cdot I_B + I_B' \quad I_Q = \beta \cdot I_B' \quad \Rightarrow \quad \frac{I_Q}{I_E} = \frac{\beta \cdot \frac{\beta + 2}{\beta + 1}}{\beta + \frac{\beta + 2}{\beta + 1}} \quad \beta \gg 1 \quad \approx 1$$

$$c) \quad U_{BE}' + U_{BE} + R_1 \cdot I_E = U_0$$

$$U_{BE}' = U_{BE} + U_T \cdot \ln\left(\frac{\beta + 2}{\beta + 1}\right)$$

$$\Rightarrow f(U_{BE}) = 2 \cdot U_{BE} + U_T \cdot \ln\left(\frac{\beta + 2}{\beta + 1}\right) + R_1 \cdot \left(\beta + \frac{\beta + 2}{\beta + 1}\right) \cdot \frac{I_S}{\beta} \cdot e^{U_{BE}/U_T} - U_0$$

$$\rightarrow \text{NRV: } U_{BE}^{(1)} = 0,7 \quad \rightarrow U_{BE} = 0,744 \text{ V}, \quad U_{BE}' = 0,7442 \text{ V}$$