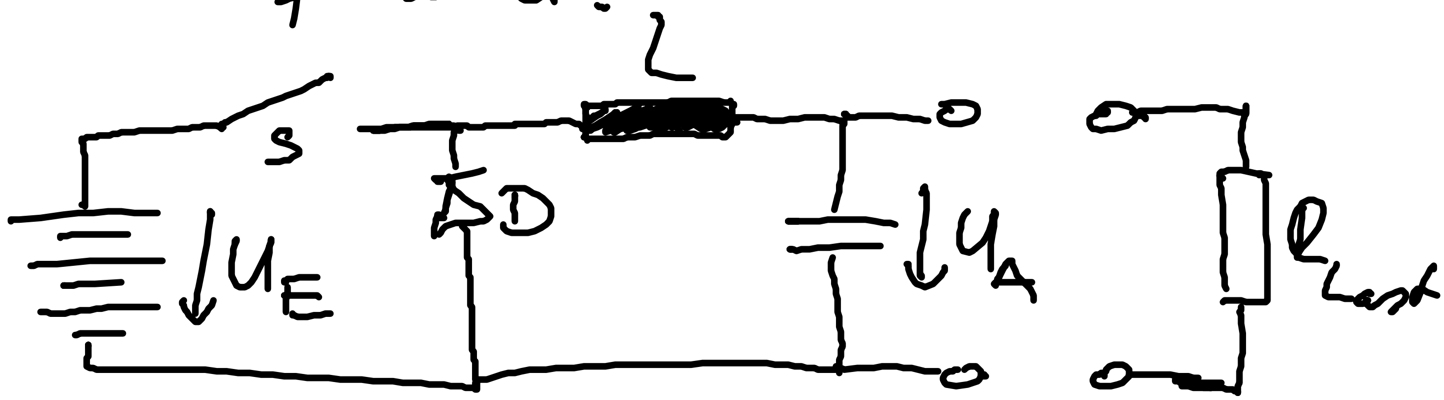
EES Klausurrechnen

1.) a) $U_N = 3{,}7\,V \cdot 3 = 11{,}1\,V > 5\,V$

$U_{bat} = f(SOC) \neq const.$



b) $2C \mathrel{\hat{=}} 6A$, $T_{Lade} = 30\,min$

c) $U_{bat\,max} = 3 \cdot 4\,V$

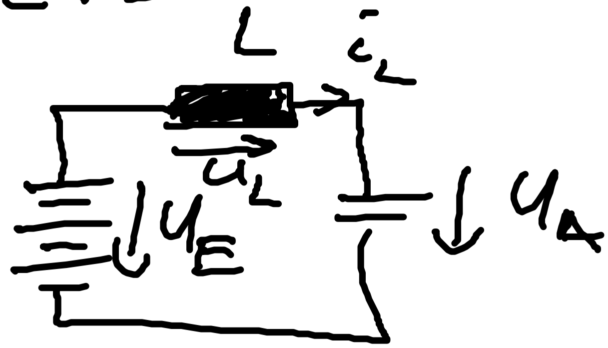
$U_{bat\,min} = 3 \cdot 3\,V$

$U_A = D\,U_E$

$D_{min} = \frac{5}{9}$ $D_{max} = \frac{5}{12}$

d)

z.B. S EIN



$$u_E = L\frac{di_L}{dt} + u_A$$

↓ linear

$$u_E = L\frac{\Delta i_L}{\Delta t} + u_A$$

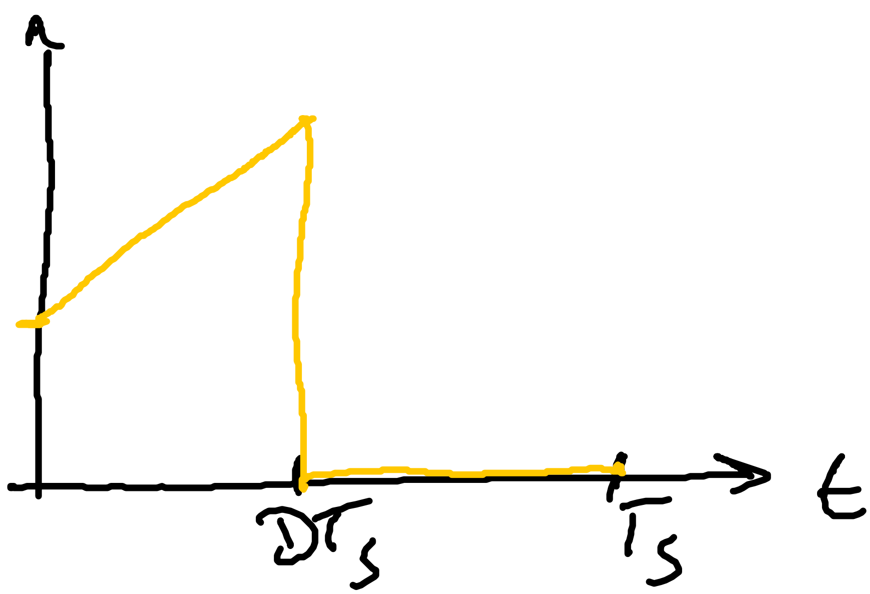
$DT_s = D\frac{1}{f_s}$

$$u_E = L\frac{\Delta i_L}{D\frac{1}{f_s}} + u_A$$

Du_E

$$\Delta i_L = \frac{u_E D(1-D)}{L f_s}$$

e)



2.)

a) I klein → η klein

$$I(\eta) = I_0\left[1 + \frac{\alpha n F}{RT}\eta - 1 + \frac{(1-\alpha) nF}{RT}\eta\right]$$

$$I(\eta) = I_0 \frac{nF}{RT} \eta$$

Einheit?

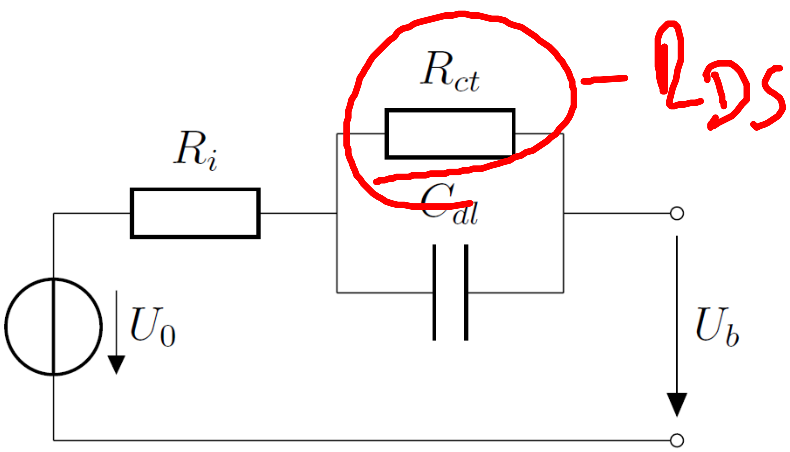
$$\left[I_0 \frac{nF}{RT}\right] = 1S = 1 \frac{1}{\Omega}$$

$$\Rightarrow R_{DS} = \frac{RT}{I_0 nF}$$ Doppelschichtwiderstand

Korrektur der BVG:

$$I(\eta) = I_0 \left(e^{\frac{\alpha nF}{RT}\eta} - e^{-\frac{(1-\alpha)nF}{RT}\eta}\right)$$

b)



ct → Charge Transfer

c) $n_{serie} = \frac{U_{bat}}{U_N} = 33$ Zellen

Mindestanzahl:

$$n_{ges} = \frac{s \cdot E'}{C_N \, U_N} = 1730 \text{ Zellen}$$

$$n_{parallel} = \frac{n_{ges}}{n_s} = 53 \text{ Stacks parallel}$$

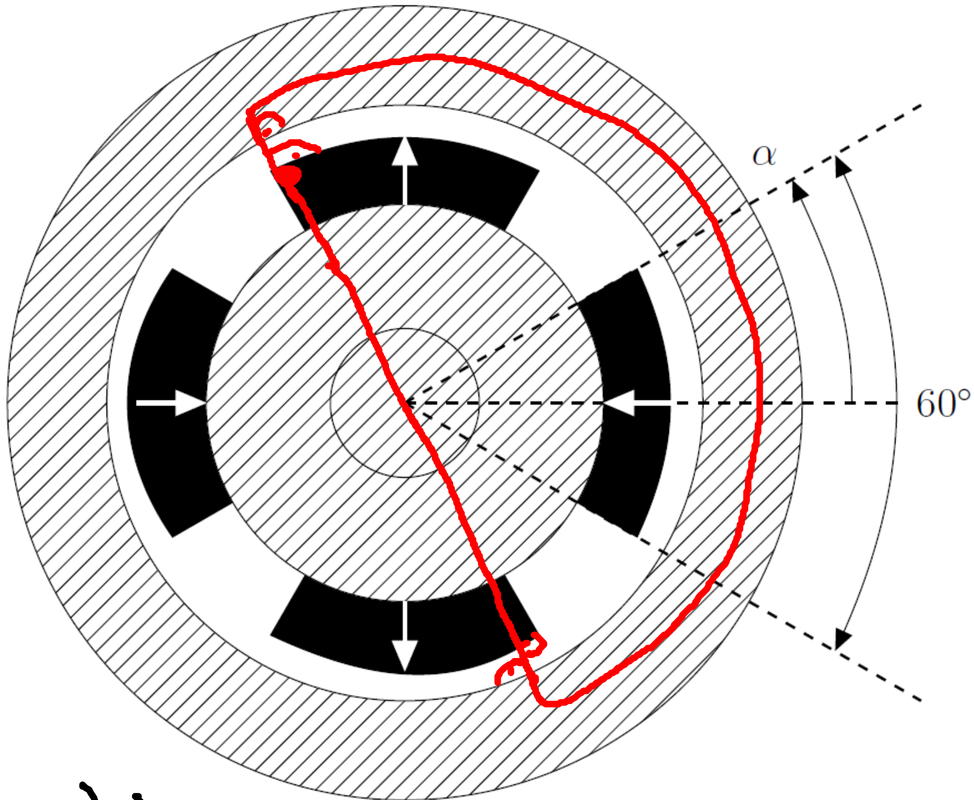
d)

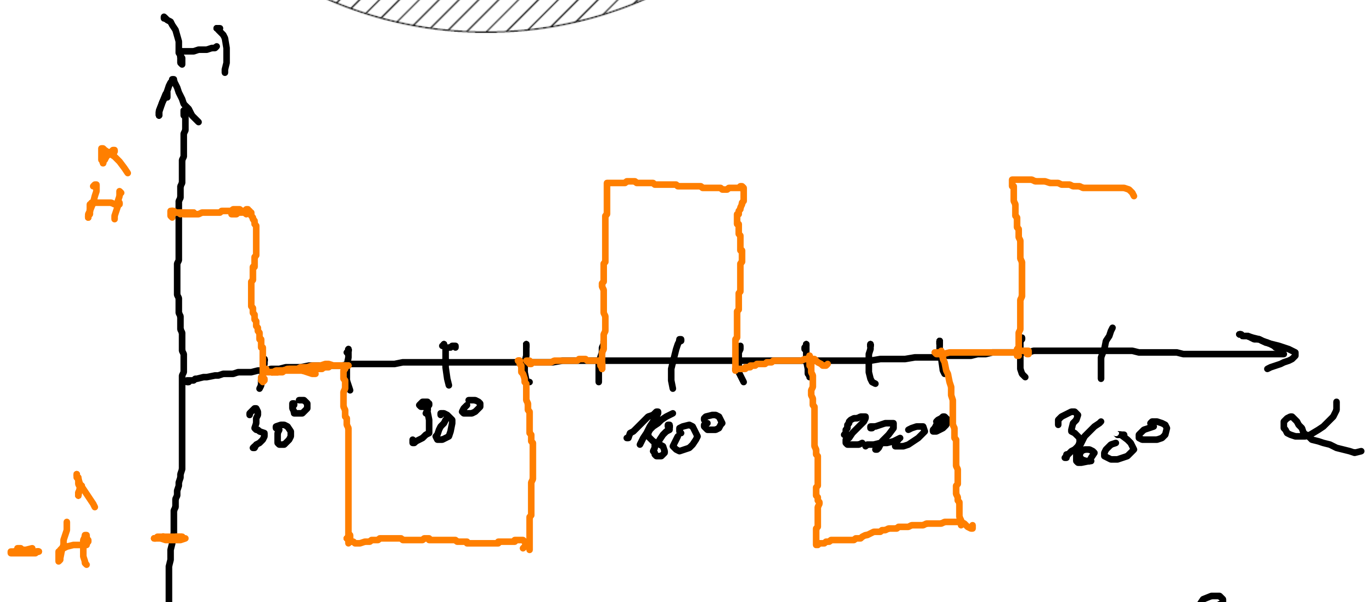
$$I_{Strang} = \frac{I_{bat}}{n_p} = \frac{P_N / U_{bat}}{n_P}$$

$$= \frac{P_N}{U_N \, n_s \cdot n_p} = 3{,}71\,A$$

↯ $> 2{,}5\,A$ (1C-Rate)

3)





b) Scherungsgerade $B_{PM} = f(H_{PM})$

$$\Theta = wI = \int \vec{H}\, d\vec{s}$$

$$wI = H_{PM} l_{PM} + H_{FE_R} l_{FE_R} + H_{PM} l_{PM} + H_\delta \delta + H_{FE_S} l_S + H_\delta \delta$$

($H_{FE_R} \approx 0$, $H_{FE_S} \approx 0$)

$$wI = 2 H_{PM} l_{PM} + 2 H_\delta \delta$$

(i) $\mu_0 H_\delta = B_\delta$ (ii) $\phi_\delta = \phi_{PM}$

$$A_\delta B_\delta = A_{PM} B_{PM}$$

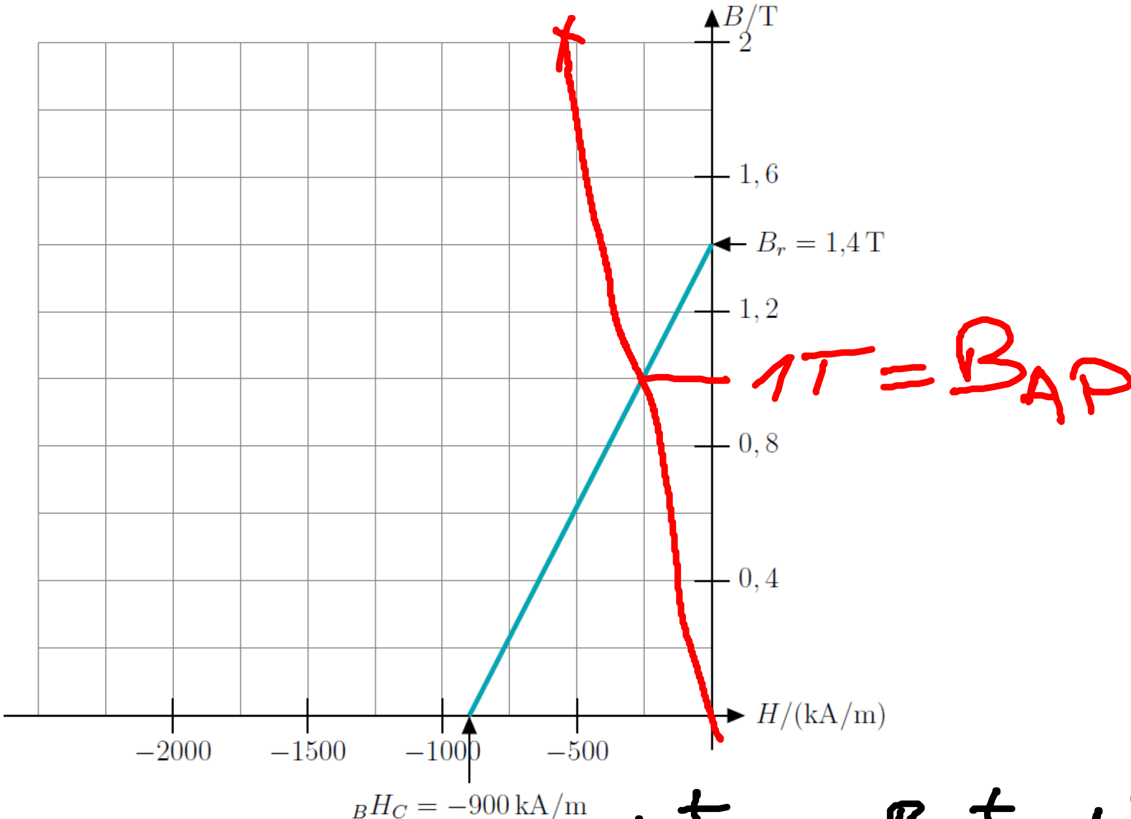
$$B_\delta = \frac{A_{PM}}{A_\delta} B_{PM}$$

$$\Rightarrow B_{PM} = \frac{\mu_0 A_\delta}{2 A_{PM} \cdot \delta} (wI - 2 H_{PM} l_{PM})$$

($wI = 0$)

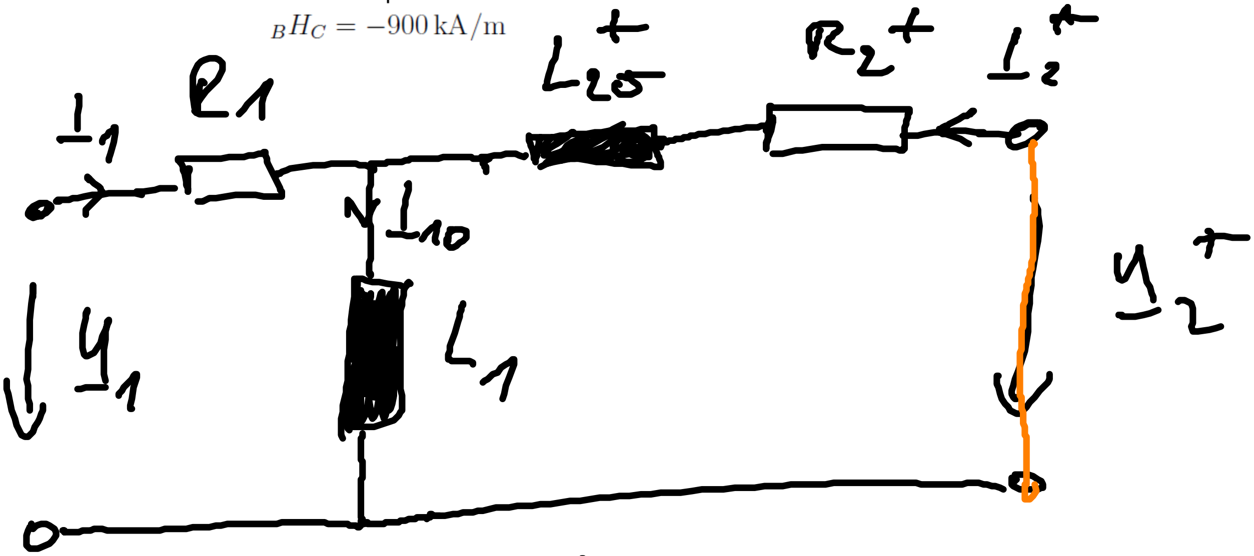
$$B_{PM} = -\mu_0 \frac{l_{PM}}{\delta} H_{PM}$$

$$B_{PM} = 2T \Rightarrow H_{PM} = -530{,}52 \frac{kA}{m}$$



4)

a)



b) $U_2^+ = \ddot{u}^+ \, U_2$

$I_2^+ = \frac{I_2}{\ddot{u}^+}$

$L_{2\sigma}^+ = L_1 \frac{\sigma}{1-\sigma} = (\ddot{u}^+)^2 L_2 - \ddot{u}^+ L_1$

$R_2^+ = (\ddot{u}^+)^2 \, R_2$

c) Im **Kurzschlussfall:**

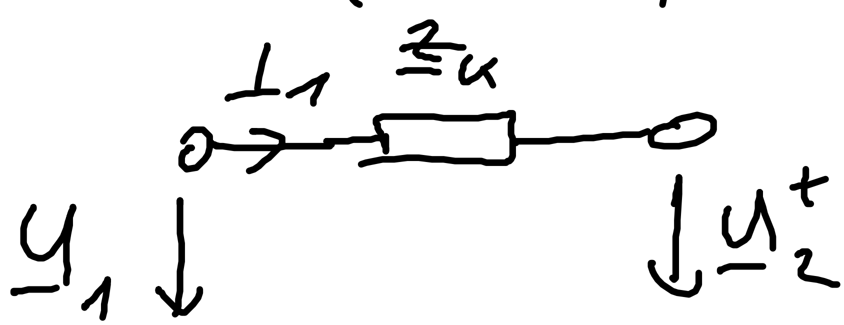
$$\frac{\underline{U}_{1K}}{\underline{I}_{1K}} = \underline{Z}_K = R_1 + \frac{j\omega L_1 (R_2^+ + j\omega L_{2\sigma}^+)}{j\omega L_1 + R_2^+ + j\omega L_{2\sigma}^+}$$

$\sigma \ll 1$ für fast alle Trafos

$$L_{2\sigma}^+ = L_1 \frac{\sigma}{1-\sigma} \approx \sigma L_1 \Rightarrow L_{2\sigma}^+ \ll L_1$$

$$\Rightarrow |j\omega L_1| \gg |R_2^+ + j\omega L_{2\sigma}^+|$$

$$\Rightarrow \underline{Z}_K = R_1 + R_2^+ + j\omega L_{2\sigma}^+$$



d)

$$P_{1K} = \underset{\text{3 Phasen}}{3} R_1 (I_{1K})^2 + 3 R_2^+ (\underline{I}_{2K}^+)^2$$

$$= 3 R_1 I_{1K}^2 + 3 R_2 (\ddot{u}^+)^2 \cdot \left(\frac{I_{2K}}{\ddot{u}^+}\right)^2$$

$$R_2 = \frac{P_{1K} - 3 R_1 I_{1K}^2}{3 I_{2K}^2} = 0{,}8\,\Omega$$

$$R_2^+ = (\ddot{u}^+)^2 \cdot R_2 = 64{,}8\,\Omega$$

$$\frac{|\underline{U}_{1K}|}{|\underline{I}_{1K}|} = |\underline{Z}_K| = \sqrt{(R_1 + R_2^+)^2 + (\omega L_{2\sigma}^+)^2}$$

$$L_{2\sigma}^+ = 39{,}54\,mH$$

$$\Rightarrow \sigma \approx \frac{L_{2\sigma}^+}{L_1} = 0{,}034$$