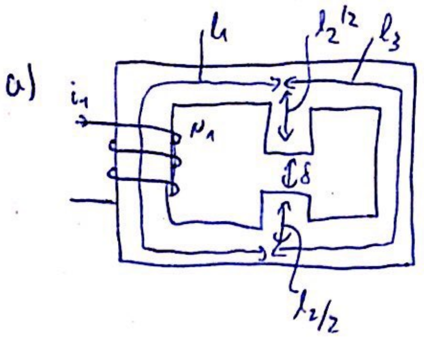
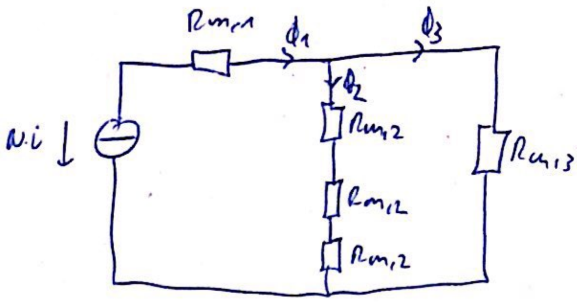
Elektroenergiesysteme Gedächtnisprotokoll (5.)

Aufgabe (1.)

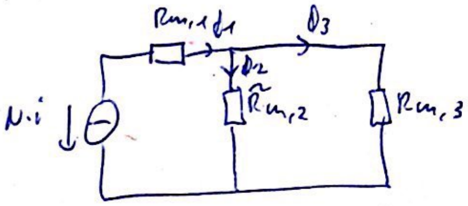
a)



(1.) ESB:



mit $\tilde{R}_{m,2} = 2R_{m,2} + R_{m,L}$ folgt



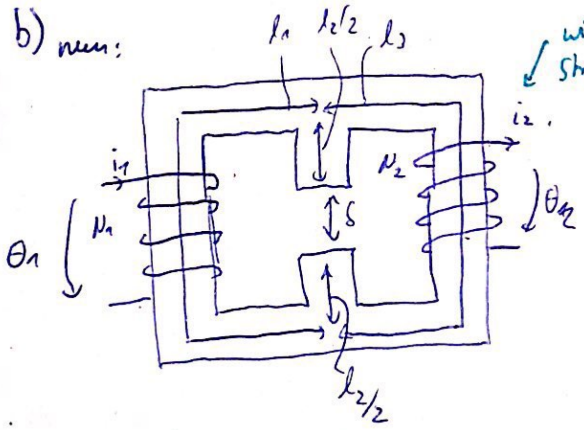
$$\Phi_1 = \frac{N \cdot i}{R_{m,ges}} \quad \text{mit} \quad R_{m,1} = \frac{l_1}{\mu_0 \mu_r A} \quad \tilde{R}_{m,2} = \frac{l_2 + \delta \mu_r}{\mu_0 \mu_r A} \quad R_{m,3} = \frac{l_3}{\mu_0 \mu_r A}$$

$$R_{m,ges} = R_{m,1} + \tilde{R}_{m,2} || R_{m,3} = \frac{l_1}{\mu_0 \mu_r A} + \frac{\frac{(l_2 + \delta \mu_r)\, l_3}{(\mu_0 \mu_r A)^2}}{\frac{l_2 + \delta \mu_r + l_3}{\mu_0 \mu_r A}} = \frac{(l_2 + \delta \mu_r)\, l_3}{(l_2 + \delta \mu_r + l_3)\, \mu_0 \mu_r A}$$

$$\Phi_1 = \frac{N \cdot i}{\frac{(l_2 + \delta \mu_r)\, l_3}{(l_2 + \delta \mu_r + l_3)\, \mu_0 \mu_r A}} = \frac{(l_2 + \delta \mu_r + l_3)\, \mu_0 \mu_r A}{(l_2 + \delta \mu_r)\, l_3} N \cdot i$$

nun: $B_{links} = B_l = \frac{\Phi_1}{A} \Rightarrow B_l = \frac{(l_2 + \delta \mu_r + l_3)\, \mu_0 \mu_r}{(l_2 + \delta \mu_r)\, l_3} N \cdot i$

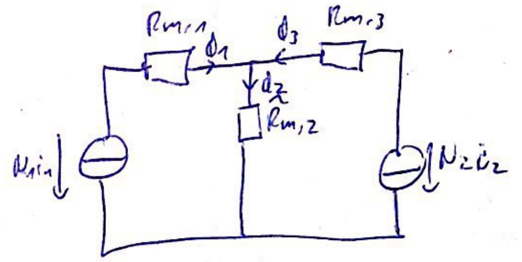
b) nun:



wie muss hier Strom fließen (Richtung?)

Wie groß muss N_2, damit $\Phi_1 = 0$

ESB



(I) $N_1 i_1 = R_{m,1} \Phi_1 + \tilde{R}_{m,2} \Phi_2 \overset{\Phi_1 = 0}{\Longrightarrow} N_1 i_1 = \tilde{R}_{m,2} \Phi_2$

(II) $N_2 i_2 = R_{m,3} \Phi_3 + \tilde{R}_{m,2} \Phi_2 \Rightarrow N_2 i_2 = R_{m,3} \Phi_3 + \tilde{R}_{m,2} \Phi_2$

(III) $\Phi_1 + \Phi_3 = \Phi_2 \Rightarrow \Phi_3 = \Phi_2$

① $N_1 i_1 = \tilde{R}_{m,2}\, \Phi_2$. & N_2 gesucht.

② $N_2 i_2 = R_{m,3}\, \Phi_3 + \tilde{R}_{m,2}\, \Phi_2$ aus ① $\Phi_2 = \Phi_3 = \frac{N_1 i_1}{\tilde{R}_{m,2}}$ (*)

③ $\Phi_3 = \Phi_2$

③ in ② $N_2 i_2 = (R_{m,3} + \tilde{R}_{m,2})\, \Phi_2$ (**)

nun * in ** $N_2 i_2 = \frac{R_{m,3} + \tilde{R}_{m,2}}{\tilde{R}_{m,2}} \cdot N_1 i_1$

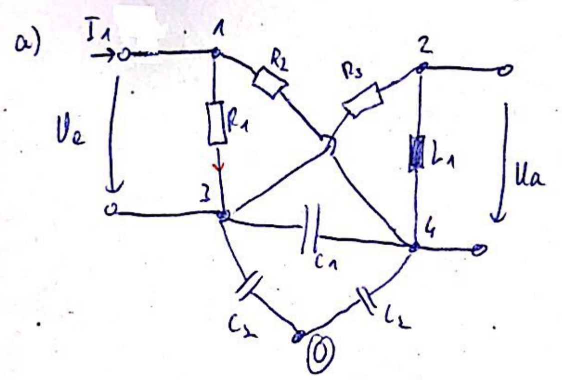
$$\rightarrow N_2 \overset{!}{=} \frac{R_{m,3} + \tilde{R}_{m,2}}{\tilde{R}_{m,2}} \frac{i_1}{i_2} \cdot N_1 = \boxed{\frac{l_3 + l_2 + \delta\mu_r}{l_2 + \delta\mu_r} \frac{i_1}{i_2} N_1 = N_2}$$

für $i_1 = i_2$ $\boxed{N_2 = \frac{l_3 + l_2 + \delta\mu_r}{l_2 + \delta\mu_r} N_1}$

wie kommt er auf $N_1 = N_2$, dafür müsste $R_{m,3} = 0$ laut meiner Lösung.

Aufgabe ②

a)



$U_1(p)$	$U_2(p)$	$U_3(p)$	$U_4(p)$	=
$-(\frac{1}{R_1} + \frac{1}{R_2})$	0	$\frac{1}{R_1}$	$\frac{1}{R_2}$	$-I_1(p)$
0	$-(\frac{1}{R_3} + \frac{1}{pL_1})$	$\frac{1}{R_3}$	$\frac{1}{pL_1}$	0
$\frac{1}{R_1}$	$\frac{1}{R_3}$	$-(\frac{1}{R_1} + \frac{1}{R_3} + pC_1 + pC_2)$	pC_1	0
$\frac{1}{R_2}$	$\frac{1}{pL_1}$	pC_1	$-(\frac{1}{R_2} + \frac{1}{pL_1} + pC_1 + pC_2)$	0

b) Ansatz für $F(p) = \frac{U_a(p)}{U_e(p)}$ → mithilfe der Cramerschen Regel, da gilt:

$U_a(p) = U_2(p) - U_4(p)$ & $U_e(p) = U_1(p) - U_3(p)$.

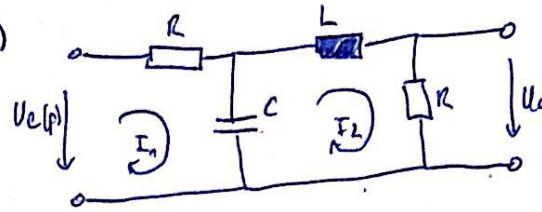
zudem gilt: $U_2(p) = \frac{\det U_2}{\det U}$, $U_4(p) = \frac{\det U_4}{\det U}$, $U_1(p) = \frac{\det U_1}{\det U}$, $U_3(p) = \frac{\det U_3}{\det U}$

und somit: $\frac{U_a(p)}{U_e(p)} = \frac{\det(U_2) - \det(U_4)}{\det(U_1) - \det(U_3)}$

Elektroenergiesysteme Gedächtnisprotokoll (5.)

zu Aufgabe (2.)

c)



$U_a(p) = I_2(p) \cdot R$

$$\frac{U_a(p)}{U_e(p)} = \frac{I_2(p) \cdot R}{U_e(p)} = \frac{\det(I_2) \cdot R}{\det(I) \cdot U_e(p)}$$

$$\det I_2 = \begin{vmatrix} R + \frac{1}{pC} & U_e(p) \\ -\frac{1}{pC} & 0 \end{vmatrix} = U_e(p) \cdot \frac{1}{pC}$$

$I_1(p)$	$I_2(p)$	=
$R + \frac{1}{pC}$	$-\frac{1}{pC}$	$U_e(p)$
$-\frac{1}{pC}$	$R + \frac{1}{pC} + pL$	0

$$\det I = \begin{vmatrix} R + \frac{1}{pC} & -\frac{1}{pC} \\ -\frac{1}{pC} & R + \frac{1}{pC} + pL \end{vmatrix}$$

$$\det I = \left(R + \frac{1}{pC}\right)\left(R + \frac{1}{pC} + pL\right) - \left(\frac{1}{pC}\right)^2$$

es folgt: $$\frac{U_a(p)}{U_e(p)} = \frac{\frac{1}{pC} \cdot R}{\left(R + \frac{1}{pC}\right)\left(R + \frac{1}{pC} + pL\right) + \left(\frac{1}{pC}\right)^2} = \frac{R}{(pCR+1)\left(R + \frac{1}{pC} + pL\right) - \frac{1}{pC}}$$

$$\frac{U_a(p)}{U_e(p)} = \frac{R}{pCR^2 + R + p^2CRL + R + \frac{1}{pC} + pL - \frac{1}{pC}} = \frac{R}{p^2(CRL) + p\left[L + CR^2\right] + 2R}$$

d) $p = j\omega$ $\quad F(\omega) = \dfrac{R}{2R - \omega^2 CRL + j\omega\left[L + CR^2\right]}$

$$|F(\omega)| = \frac{R\cancel{2}}{\sqrt{(2R - \omega^2 CRL)^2 + (\omega\left[L + CR^2\right])^2}}$$

bei $\omega_0 = \frac{1}{\sqrt{LC}}$ $\quad F(\omega_0) = \dfrac{R}{2R - R + j\left[\sqrt{\frac{L}{C}} + \sqrt{\frac{C}{L}}R^2\right]}$

bitte besprechen, mache ich schon zum max falsch

$$|F(\omega_0)| = \frac{R\cancel{2}}{\sqrt{R^2 + \left(\sqrt{\frac{L}{C}} + \sqrt{\frac{C}{L}}R^2\right)^2}} = \frac{R^{\cancel{2}}}{\sqrt{R^2 + \left(2R^2 + \frac{L}{C} + \frac{C}{L}R^4\right)}}$$

$$= \frac{R\cancel{2}}{\sqrt{3R^2 + \frac{C}{L}R^4 + \frac{L}{C}}} \quad ??$$

zu Aufgabe (2.)

es Analyse mit DGL ??

(I) $u_e(t) = iR + u_C(t)$ mit $i = i_L + C \cdot \frac{du_C(t)}{dt}$

(II) $R \cdot i_L(t) + L \cdot \frac{di_L(t)}{dt} \mp u_C(t) = 0 \rightarrow u_C(t) = +R i_L(t) + L \cdot \frac{di_L(t)}{dt}$

(III) $R \cdot i_L(t) = u_a(t)$

in (I) $u_e(t) = R \cdot i_L + RC \frac{du_C(t)}{dt} + u_C(t)$

$$u_e(t) = R \cdot i_L + R^2 C \cdot \frac{di_L(t)}{dt} + RLC \frac{d^2 i_L(t)}{dt} + R \cdot i_L(t) + L \cdot \frac{di_L(t)}{dt}$$

$$\rightarrow u_e(t) = \frac{d^2 i_L(t)}{dt^2} [+RLC] + \frac{di_L(t)}{dt} [+R^2C + L] + i_L(t) [R + R]$$

$$u_e(t) = \frac{d^2 i_L(t)}{dt^2} (-RLC) + \frac{di_L(t)}{dt} (-R^2 C - L) + i_L(t) \cdot 2R$$

→ Lösung für $i_L(t)$ finden

dann $u_a(t) = R \cdot i_L(t)$

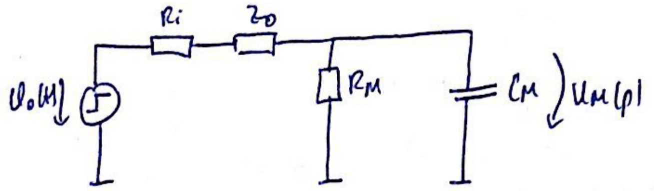
Scanned with CamScanner

Elektroenergiesysteme – Gedächtnisprotokoll ⑤

Aufgabe ③

a) $Z_0 = \sqrt{\frac{L'}{C'}}$ wenn $\frac{L'}{C'}$ gegeben.

b)



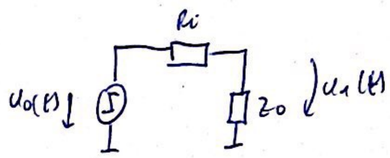
$X(p) = \frac{\tilde{Z}_L(p)}{\tilde{Z}_0 + \tilde{Z}_L(p)}$ mit $\tilde{Z}_L = Z_0$ & $\tilde{Z}_0 = R_i$

für Anpassung gilt: $X(p) = \frac{1}{2} \Rightarrow \frac{1}{2} = \frac{Z_0}{R_i + Z_0} \Rightarrow \frac{1}{2}R_i + \frac{1}{2}Z_0 = Z_0$

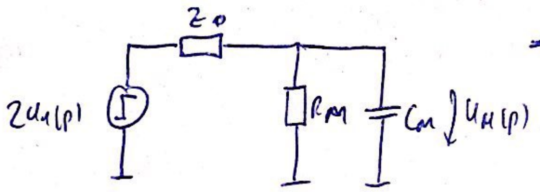
$\frac{1}{2}R_i = \frac{1}{2}Z_0 \Rightarrow \boxed{R_i \stackrel{!}{=} Z_0}$

c)

2 Möglichkeiten: ①



$U_1(p) = U_0(p) \cdot \frac{R_i}{R_i + Z_0} = \frac{1}{2} \cdot \frac{U_0}{p} = \frac{U_0}{2p}$



$\Rightarrow U_M(p) = 2U_1(p) \cdot \frac{Z_A}{Z_A + Z_0}$

mit $Z_0 = \frac{R_M \cdot \frac{1}{pC}}{R_M + \frac{1}{pC}} = \frac{R_M}{1 + pCR_M}$

$U_M(p) = 2 \cdot \frac{U_0}{2p} \cdot \frac{R_M}{1+pCR_M} \cdot \frac{1}{Z_0 + \frac{R_M}{1+pCR_M}} = \frac{U_0}{p} \cdot \frac{R_M}{R_M + Z_0 + pCR_M Z_0}$

2. Möglichkeit:

$U_1(p) = X(p) \cdot U_0(p) = \frac{1}{2}\frac{U_0}{p}$

$U_M(p) = X(p) U_0(p) \cdot C(p) = \frac{1}{2}\frac{U_0}{p} \cdot 2 \cdot \frac{R_M}{R_M + Z_0 + pCR_M Z_0} = \frac{U_0}{p} \frac{R_M}{R_M + Z_0 + pCR_M Z_0}$

Aufgabe 4.

a) → Trafo Design in H14 → noch mal genauer durchgehen

b) $M_p = 3 \frac{p}{\omega_s} \frac{U_p U_1}{X_d} \sin\theta$ vermutlich vorher U_p berechnen & θ.

c) $M_{neu} = 0{,}8 M_{alt}$

↳ U_p bleibt const, aber θ ändert sich aus

$M_{Neu} = \underline{0{,}8 M_{alt}} = 3 \frac{p}{\omega_s} \cdot \frac{U_{p,neu} \cdot U_{1,alt}}{X_d} \cdot \sin(\theta_{neu})$

θ_{neu} berechnen.

nun mit θ_{neu} P_{neu} & Q_{neu} berechnen

↳ $S_{neu} = P_{neu} + j\, Q_{neu}$.

d) Phasenschiebebetrieb ⟺ $\theta \overset{!}{=} 0$, $P = 0$

Aufgabe 5.

Feranti - Effekt

GIS → Skript seite 229 laut Inhaltsverzeichnis