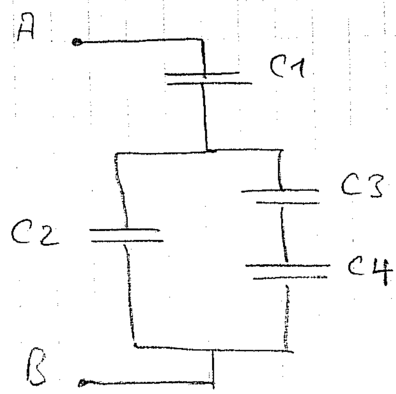
(1')

Aufgabe (1)

a) $\sum_{1a} 3$



* C_3, C_4 sind im R.

$$C_{34} = \frac{C_3}{2} = \frac{C_4}{2} = 1pF. \quad \text{1pkt}$$

* C_2, C_{34} sind ||

$$C_{234} = C_2 + C_{34} = 3pF + 1pF \quad \text{1pkt}$$

$$\therefore C_{234} = 4pF.$$

* C_1, C_{234} sind R.

$$C_{ges} = \frac{C_1}{2} = \frac{C_{234}}{2} \quad \therefore \underline{\underline{C_{ges} = 2pF}}. \quad \text{1pkt}$$

b) * $U_0 = U_1 + U_2 \quad \therefore U_1 + U_2 = 100\,(V)$ — ①

* $U_3 + U_4 = U_2$ — ②

* Da C_3, C_4 in R. sind $\Rightarrow Q_3 = Q_4$.

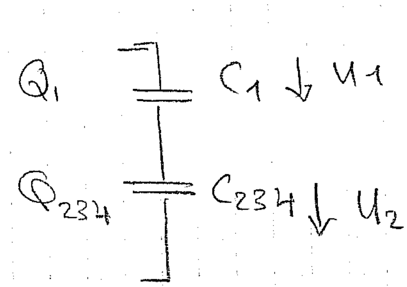
$$\therefore \cancel{C_3} \cdot U_3 = \cancel{C_4} \cdot U_4. \quad \text{und. } C_3 = C_4$$

$$\therefore U_3 = U_4 \Rightarrow \boxed{U_2 = 2 \cdot U_3} \text{ — ③}$$

* $Q_1 = Q_{234}$.

$$\cancel{C_1} \cdot U_1 = \cancel{C_{234}} \cdot U_2.$$

$$\boxed{U_1 = U_2} \text{ — ④}$$



* Zusammenfassung:- 1) $U_1 = U_2$ — 1pkt

2) $U_1 + U_2 = 100\,(V)$. — 1pkt.

$\sum 6$ pkt. 1b

3) $U_3 + U_4 = U_2$ — 1pkt

4) $U_3 = U_4$. — 1pkt.

* solve 1,2,3,4 $\Rightarrow$

$$\left.\begin{array}{l} U_1 = 50\,(V). \\ U_2 = 50\,(V) \end{array}\right\} \text{1 pkt}$$

$$\left.\begin{array}{l} U_3 = 25\,(V) \\ U_4 = 25\,(V) \end{array}\right\} \text{1 pkt.}$$

c) $Q_1 = C_1 . U_1$. 1pkt.

$\sum 2$ pkt. 1c

$= 4 * 10^{-12}\,(F) * 50\,(V)$.

$Q_1 = 2 * 10^{-10}$ (Coloumbs) 1pkt.

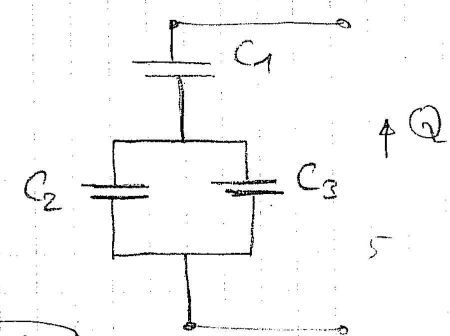
d)

* Wenn das Abklingen des Einschwingvorgang abgewartet wird, dann ist der Kondensator C_4 ungeladen ist.

Also, $U_4^* = 0\ (V)$. (1 Pkt.)

$\sum$ 7 Pkt. d

* Auf dem Kondensator C_1 bleibt der Ladung Q_1.



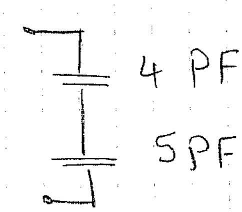
Daher $U_1^* = U_1$.

$\therefore U_1^* = 50\ (V)$. (1 Pkt.)

* $Q_{alt} = Q_1$ $\therefore Q_{alt} = 2 * 10^{-10}$ (Coloumbs) (1 Pkt.)

* $Q_{alt} = Q_{neu} = C_{ges}^* * U_{neu}$ (1 Pkt.)

* $C_{ges}^* = \frac{4 \times 5}{4+5} = \frac{20}{9}\ (pF)$.



* $U_{neu} = 90\ (V)$. (1 Pkt.)

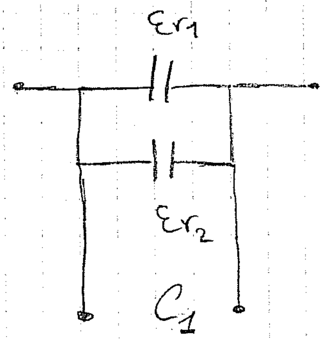
* $U_2^* = U_{neu} - U_1^*$

$U_2^* = 40\ (V)$. (1 Pkt.)

* $U_2^* = U_3^*$

$U_3^* = 40\ (V)$. (1 Pkt.)

e)



2 pkt.

f) $Q_1^* = \oint |\vec{D}_i| \cdot \vec{dA}$

$$Q_1^* = D_1 \cdot A_1 + D_2 A_2 \qquad 1$$

wobei $A_1 = 3\pi r^2$ u. $A_2 = \pi r^2$ (1)

$$\therefore \quad Q_1^* = 3|D_1|\pi r^2 + |D_2|\pi r^2$$

$$\Rightarrow \quad \vec{D}_1 = \varepsilon_0 \varepsilon_{r_1} \cdot \vec{E} \quad ; \quad \vec{D}_2 = \varepsilon_0 \varepsilon_{r_2} \cdot \vec{E}$$

$$\therefore \quad Q_1^* = 3\varepsilon_0 \varepsilon_{r_1} E \cdot \pi r^2 + \varepsilon_0 \varepsilon_{r_2} E \cdot \pi r^2$$

$$Q_1^* = \varepsilon_0 \cdot E \cdot \pi r^2 \left\{ 3\varepsilon_{r_1} + \varepsilon_{r_2} \right\} \qquad 1$$

$$\therefore \quad E(Q_1^*, r) = \frac{Q_1^*}{\varepsilon_0 \cdot \pi r^2 \left\{ 3\varepsilon_{r_1} + \varepsilon_{r_2} \right\}}$$

$$U_1^* = \oint \vec{E} \cdot \vec{dr} = \int_{r_1}^{r_2} \vec{E} \cdot \vec{dr}$$

$$\therefore \quad U_1^* = \frac{Q_1^*}{\varepsilon_0 \cdot \pi \left\{ 3\varepsilon_{r_1} + \varepsilon_{r_2} \right\}} \cdot \left. -\frac{1}{r} \right|_{r_1}^{r_2} \qquad 1$$

5

$$\therefore\ U_1^* = \frac{Q_1^*}{\varepsilon_0 \pi \{3\varepsilon_{r_1} + \varepsilon_{r_2}\}} * \frac{r_2 - r_1}{r_1 \cdot r_2}$$

$$Q_1^* = \frac{(r_1 \cdot r_2) \cdot \varepsilon_0 \pi \{3\varepsilon_{r_1} + \varepsilon_{r_2}\}}{r_2 - r_1} \cdot U_1^* \quad (1)$$

$\sum_f$ 5 pkt.

g) $U_1^* = 50 (V) \qquad Q_1^* = 2 \cdot 10^{-10} (C)$.

$$2 \cdot 10^{-10} = \frac{5 r_1^2 * 10^{-9} * \cancel{\pi} * (12+3)}{36 \cancel{\pi} * 4 \cancel{r_1}} * 50 (V)$$

$$\underline{\underline{r_1 = 0.0077 \ (m)}}$$

$\sum_g$ 2 pkt

$$\underline{\underline{r_1 = 7{,}7 \ (mm)}}.$$

oder

$$C_{ges} = C_1 = \frac{Q_1^*}{U_1^*} = \pi \varepsilon_0 \{3\varepsilon_{r_1} + \varepsilon_{r_2}\} \cdot \frac{5 r_1^2}{4 \cancel{r_1}}$$

$$4 * 10^{-12} = \cancel{\pi} * \frac{10^{-9}}{36 \cancel{\pi}} \{15\} \cdot \frac{5}{4} * r_1.$$

$$r_1 = 0.0077 \ (m)$$

$$\underline{\underline{r_1 = 7{,}7 \ (mm)}}$$

Aufgabe (2) (1)

a) $$I(t) = I_0 * \left(e^{-t/\tau}\right).$$ $\sum_a$ 3pkt.

$$\Rightarrow I_0 = \frac{U_0}{R_0}$$ — (1) pkt

$$\Rightarrow \tau = R_{ges} * C_{ges}$$

$$\tau = R_0 * \frac{C_1 . C_2}{C_1 + C_2}$$ — (1) pkt.

$$\therefore I(t) = \frac{U_0}{R_0} * \left\{ e^{-t / R_0 . \frac{C_1 . C_2}{C_1 + C_2}} \right\}$$ → (1) pkt

b) parallelschaltung von $\varepsilon_0, \varepsilon_{r_2}$.

$$A^* \Leftarrow \therefore C_2 = \frac{2\pi\varepsilon_0}{\ln\left(\frac{r_2}{r_1}\right)} * \frac{\ell}{2} * \left\{ \varepsilon_{r_2} + 1 \right\}$$ (1) pkt.

$$\Rightarrow C_1 = \varepsilon_0 . \varepsilon_{r_1} . \frac{A}{d}$$

$$\therefore C_1 = 1{,}4147 * 10^{-11} \ (F)$$ $\times 10^{\cdot} . 10^{-2}$

$$C_1 = 0.01414 \ (nF)$$ 1pkt.

$$\Rightarrow Q_1 = C_1 . U_1.$$

$$Q_1 = 7{,}0736 * 10^{-10} \ (C)$$ 1pkt.

Da C_1, C_2 R. sind, Daher $Q_1 = Q_2$

$$Q_2 = 7{,}0736 * 10^{-10} \ (C)$$ 1pkt

$$Q_2 = C_2 * U_2 \quad , \text{Da } U_1 = U_2 , \ Q_1 = Q_2$$

$\sum_6$ 6pkt.

$$\therefore C_2 = C_1$$

$$C_2 = 0.01414 * 10^{-9} \ (F)$$ 1pkt.

$\Rightarrow$ Insert C_2 in A^* : u. $r_2 = 2 \cdot r_1$.

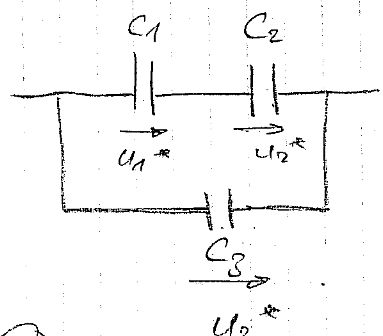
$$0.01414 * \cancel{10^{-9}} = \frac{2\pi \cdot \cancel{10^{-9}}}{36\pi \cdot \ln 2} * \frac{\ell}{2} * 4 .$$

$$\underline{\underline{\ell = 0.0883 \ (m)}}$$

1 pkt.

$$\underline{\underline{\ell = 8{,}8 \ cm}}$$

c) (3)



* $Q_{ges} = Q_1$. → (1p/4)

* $Q_{ges} = C_{ges} * U_3^*$ → (1p)

* $\therefore C_{ges} = 1{,}4147 * 10^{-11}$ (F) → (1p)

* $C_{ges} = \dfrac{C_1 . C_2}{C_1 + C_2} + C_3$. $\qquad C_1 = C_2$. (1p)

$C_{ges} = \dfrac{C_1}{2} + C_3 \Rightarrow \underline{\underline{C_3 = 7{,}0736 * 10^{-12}}}$ (F)

* $C_3 = \varepsilon_0 \varepsilon_{r3} * \dfrac{A}{d}$. (1p)

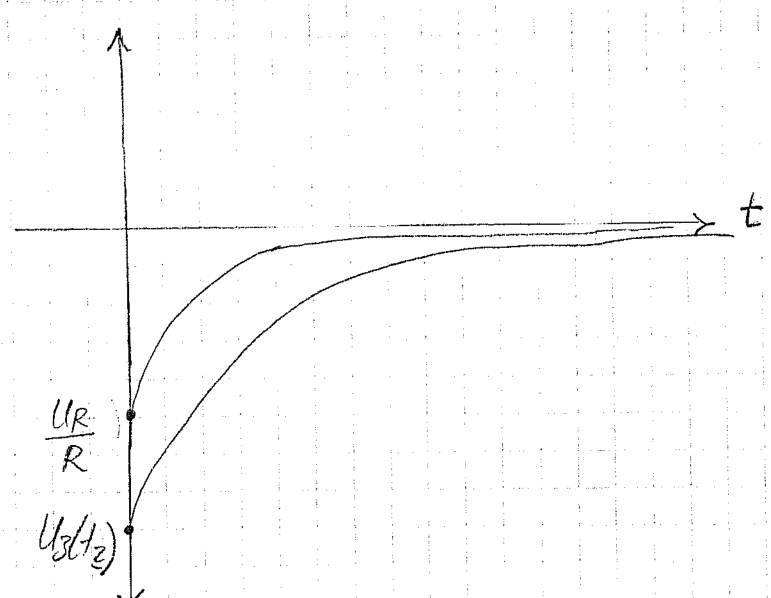
$\therefore \underline{\underline{\varepsilon_{r3} = 2}}$.

$\sum_c 5p$

d) $U_R = - U_3$, $I_R = I_3$.

$\sum 4$

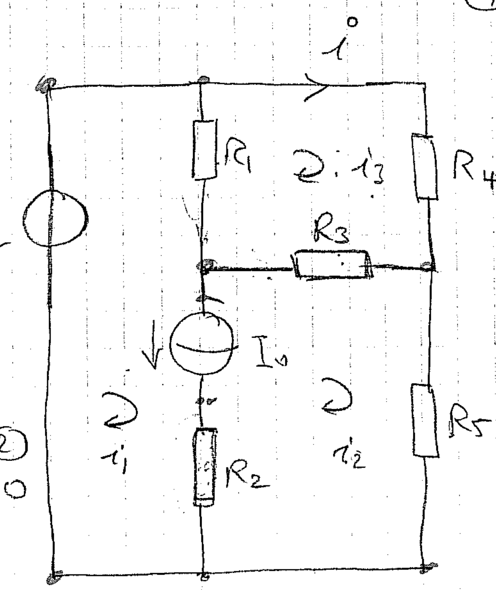
2 profil.
1 Axes.
1 I_3 vor U



Aufgabe (3) :-

1

a)



M1 :- $- U_0 + R_1(i_1 - i_3) + R_3(i_2 - i_3)$ (1P)

$+ R_5 \cdot i_2 = 0$ — ①.

(1P) M2 :- $(\overset{1}{R_1} + \overset{3}{R_3} + \overset{2}{R_4})\, i_3 - i_1 \cdot \overset{1}{R_1} - i_2 R_3 = 0$ — ②

(1P) $i_1 - i_2 = 5\ (A)$ — ③

③ in ① :-

$-10 + 1(5 + \cancel{i_2} - i_3) + 3(i_2 - i_3) + 2(i_2) = 0$

(1P) $6 i_2 - 4 i_3 = 5 \rightarrow A^*$.

③ in ② :- $6 i_3 - 5 - i_2 - 3 i_2 = 0$

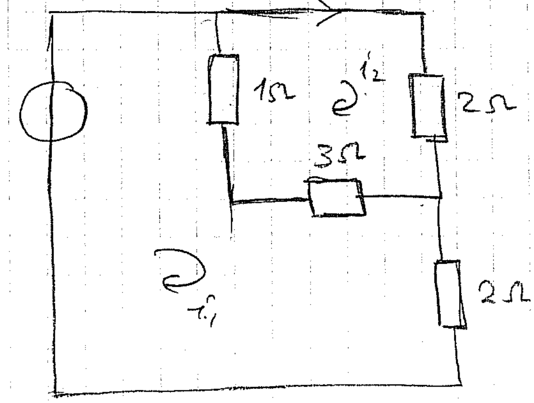
(1P) $-4 i_2 + 6 i_3 = 5 \rightarrow B^*$.

solve A^*, B^* :- $i^0 = 2{,}5\ (A)$. (1P)

$\sum_a 6P$

b) $\sum 10P$ (6)

②



(1P)

M1: $-u_0 + 1\Omega(\cancel{i_1'} - i_2) + 3\Omega(\cancel{i_1'} - \cancel{i_2}) + 2i_1 = 0$

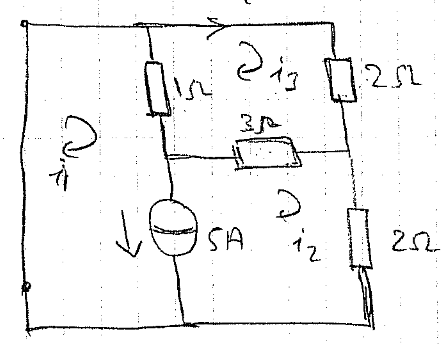
M2: $6i_2 - 1i_1 - 3\cancel{i_1} = 0$

$$6i_1 - 4i_2 = 10 \longrightarrow A^*$$ (1P)

$$-4i_1 + 6i_2 = 0 \longrightarrow B^*$$ (1P)

solve A^*, B^* $\underline{\underline{i' = 2(A)}}$ (1P)

(1P) M1: $1\Omega(i_1 - i_3) + 3\Omega(i_2 - i_3) + 2i_2 = 0$



(1P)

(1P) M2: $6i_3 - 1i_1 - 3i_2 = 0$

$$i_1 - i_2 = 5\,(A)$$

$$5 + \cancel{i_2} - i_3 + 0 + 3i_2 - 3\cancel{i_3} + 2i_2 = 0$$

$$6i_2 - 4i_3 = -5 \longrightarrow$$ (1P) C^*

$$6i_3 - 5 - i_2 - 3i_2 = 0$$

$$-4i_2 + 6i_3 = 5 \longrightarrow$$ (1P) D^*

solve C^*, D^*: $\underline{\underline{i'' = 0{,}5\,(A)}}$

$i = i' + i''$ $\underline{\underline{i = 2{,}5\,(A)}}$ (1P) c)

i) der strom i bleibt gleich, da der widerstand R_2 * mit einer strom Quelle in R. angeschlossen ist. Also, $i = 2{,}5\,(A)$ (1P)

ii) Nach dem "linearitätsprinzip":

$$i'\big)_{neu} = 2 \cdot i'\big)_{alt} \quad \text{(1P)}$$

$\sum 3P$ c

$$\therefore \; i'\big)_{neu} = 4\,(A). \qquad i'' = 2{,}5\,(A).$$

$$i = 4{,}5\,(A). \quad \text{(1P)}$$

---

d) R_6, R_7, R_8, R_9 are parallel $\Rightarrow R' = 1\,\Omega$. (1P)

R' in Rei. mit R_{10}

Daher $R_{ges} = R_{10} + R'$ (1P)

$\sum 3P$ d

$$R_{ges} = 2\,(\Omega) \quad \text{(1P)}$$

---

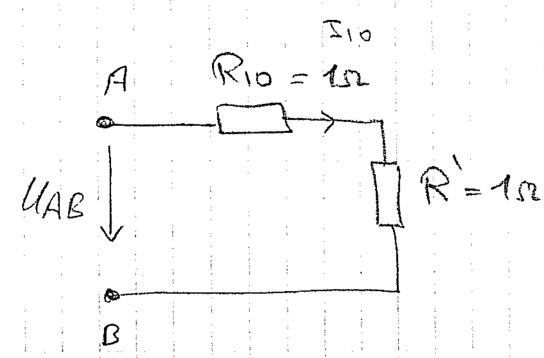
(4)

e) Wenn der Schalter S geschlossen ist,

Dann $U_{AB} = U_0$. (1P)

$\sum_e 2P$

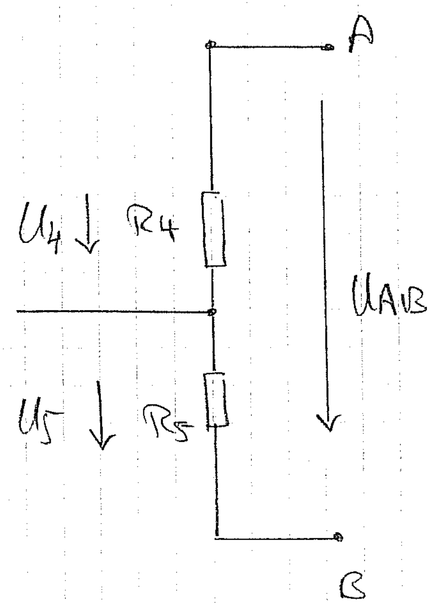
$\therefore U_{AB} = 10\,(V)$.



$$I_{10} = \frac{U_{AB}}{R' + R_{10}}$$

$$\underline{\underline{I_{10} = 5\,(A)}}$$ (1P)

f)



$$P_{R4} = \frac{(U_4)^2}{R_4}$$

$\sum_f 3P$

$\therefore U_4 = 5\,(V)$. (1P)

$U_5 = U_{AB} - U_4$.

$U_5 = 10\,(V) - 5\,(V)$

$U_5 = 5\,(V)$. (1P)

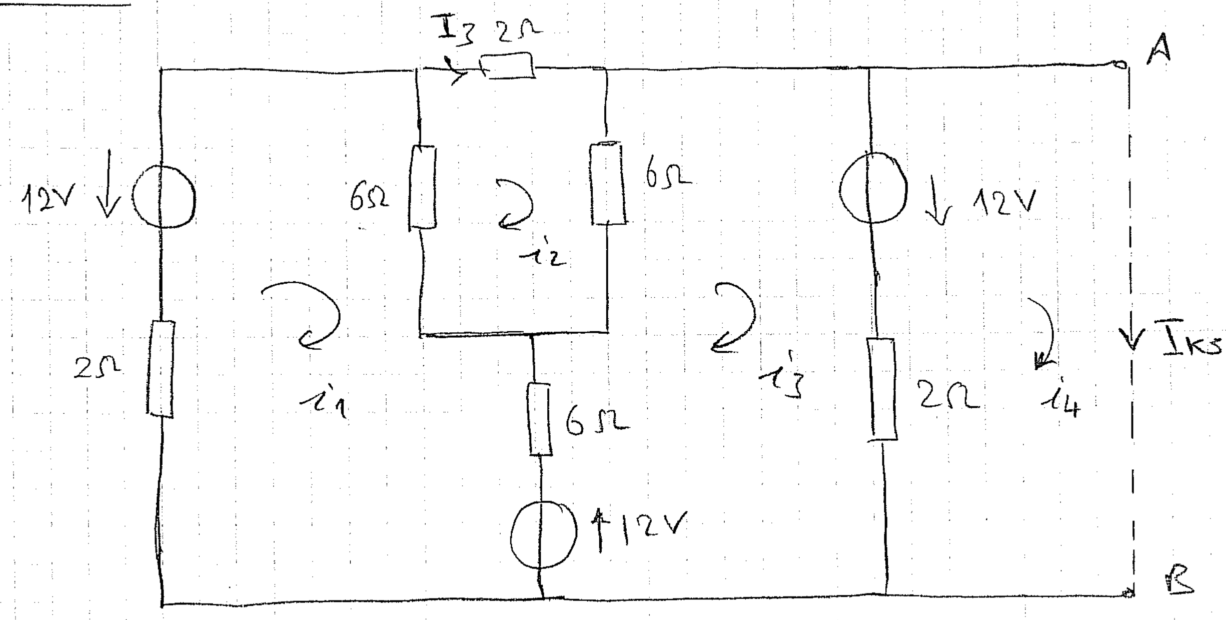
$$I_5 = \frac{U_5}{R_5} = \frac{5\,(V)}{2\Omega}$$

$$\underline{\underline{I_5 = 2{,}5\,(A)}}$$ (1P)

Aufgabe (4)

(1)

a)



a) $2\cancel{i_1} - 12(V) + 6(i_1 - \cancel{i_2}) + 6(i_1 - \cancel{i_3}) - 12 = 0$

A^* $\quad 14 i_1 - 6 i_2 - 6 i_3 = 24$ — (1P)

$14 i_2 - 6 i_1 - 6 i_3 = 0$

B^* $\quad -6 i_1 + 14 i_2 - 6 i_3 = 0$ — (1P)

$12(V) + 2 i_3 + 12 + 6(\cancel{i_3} - \cancel{i_1}) + 6(\cancel{i_3} - \cancel{i_2}) = 0$

C^* $\quad -6 i_1 - 6 i_2 + 14 i_3 = -24$ — (1P)

using Krammer's Method. (2P)

$$\Rightarrow \quad i = \begin{Bmatrix} 1.2\,A \\ 0 \\ -1.2\,A \end{Bmatrix} \quad \Rightarrow \quad \underline{\underline{I_3 \equiv 0\ (A)}}$$ (1P)

$\sum_a 6P$

(2)

b)

* $u_0 = (i_3)(R_6) + u_3$ — 1P

$= -1{,}2(A) * 2(\Omega) + 12(V).$

$u_0 = 9{,}6\ (V).$ — 1P

* Berechnung von I_{KS} :-

1) $14 i_1 - 6 i_2 - 6 i_3 = 24$ — 1P

2) $-6 i_1 + 14 i_2 - 6 i_3 = 0$ — 1P

3) $-6 i_1 - 6 i_2 + 14 i_3 - 2 i_4 = -24$ — 1P

4) $-2 i_3 + 2 i_4 = 12$ — 1P

$\sum_6 10P$

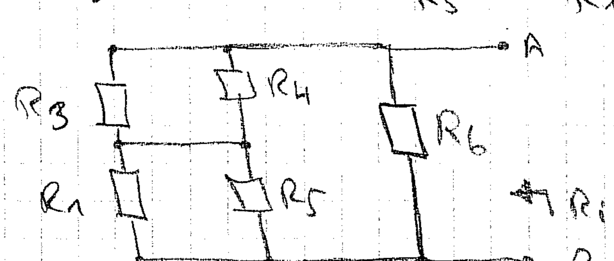
solve 1,2,3,4 ⇒ 2P

$i = \begin{Bmatrix} 3{,}6 \\ 2{,}4 \\ 2 \\ 8 \end{Bmatrix} A \qquad i_4 = 8\ (A).$

$I_{KS} = 8\ (A).$ 1P.

* $R_i = \dfrac{u_0}{I_{KS}} = \dfrac{9{,}6\ (V)}{8\ (A)} = 1{,}2\ (\Omega).$ 1P

⇒ Lösung (2).. Da $\dfrac{R_4}{R_5} = \dfrac{R_3}{R_1}$ Dann $I_{R2} = 0.$



⇒ $R_i = 1{,}2\ (\Omega).$

c) Da Durch den widerstand R_3 kein Strom fließt, $(I_3 = 0)$, wird die spannung U_0 von dem widerstand nicht beeinflusst. 3P

D.h. $U_0 = 9{,}6\,(V)$.

" Mathematische, Text klärung ist erfordrliche".

d) Wenn der Schalter S geöffnet ist:-

$$R_i^* = R_i + R_7. \quad \text{1P}$$

$$R_i^* = 1{,}2 + 10$$

$$\underline{\underline{R_i^* = 11{,}2\,(\Omega)}} \quad \text{1P}$$

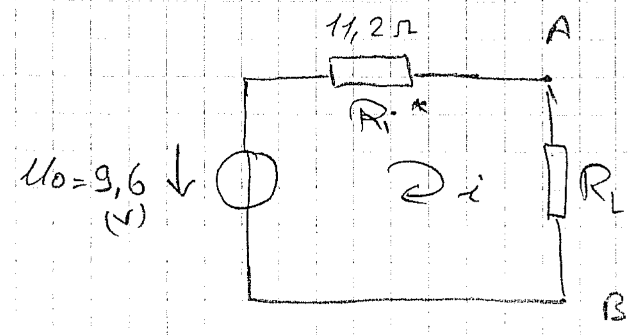
$$U_0^* = U_0 \qquad \underline{\underline{U_0^* = 9{,}6\,(V)}}. \quad \text{1P}$$

$$I_0 = \frac{U_0^*}{R_i^*} = \underline{\underline{0.8571\,(A)}}. \quad \text{1P}$$

$\sum_d 4.$

(4)

e) $\sum_e 2P$



$$i = \frac{u_0}{R_i^* + R_L}$$ (1P)

$$P(R_L) = i^2 * R_L \quad \therefore \quad P(R_L) = \left(\frac{u_0}{R_i^* + R_L}\right)^2 * R_L$$ (1P)

---

f) $$\frac{dP(R_L)}{dR_L} \overset{!}{=} 0$$ (1P) $\sum_f 3P$

$$\therefore \quad P_{R_L} = (u_0)^2 * (R_i^* + R_L)^{-2} * R_L$$

$$\frac{dP(R_L)}{dR_L} = u_0^2 \left\{ (R_i^* + R_L)^{-2} * 1 + (R_L)(-2)(R_i^* + R_L)^{-3} \right\} \overset{!}{=} 0$$ (1P)

$$\frac{1}{\cancel{(R_i^* + R_L)^2}} = \frac{2R_L}{(R_i^* + R_L)^{\cancel{3}}}$$

$$R_i^* + R_L = 2R_L$$

$$R_L = R_i^*$$ (1P)

---

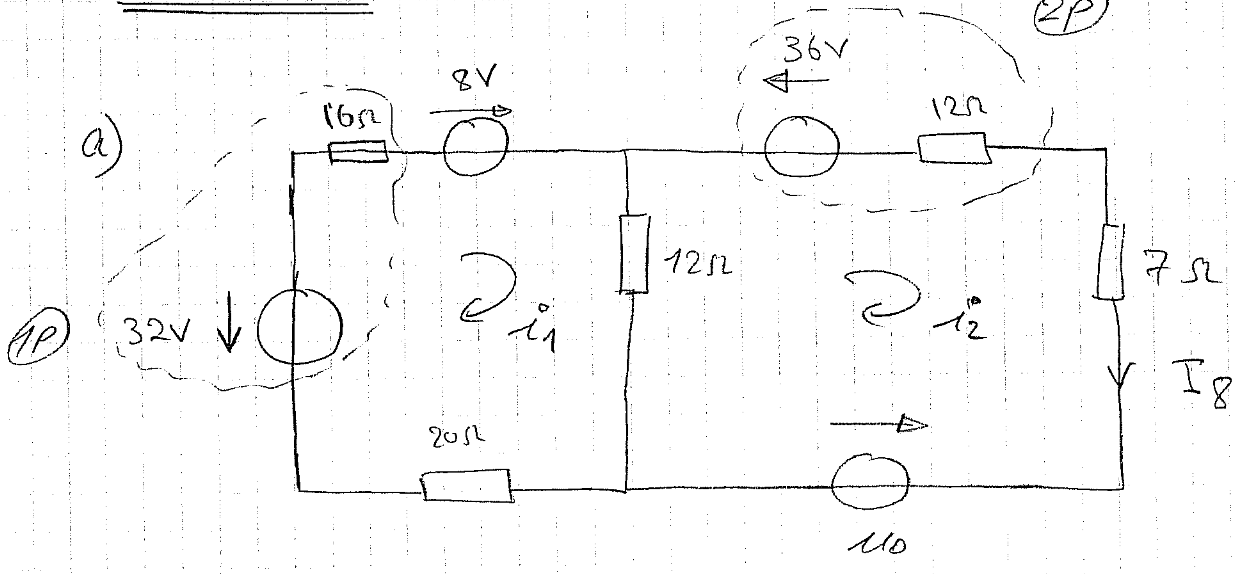
g) $$P_{R_L,max} = \left(\frac{9,6\ (V)}{11,2 + 11,2}\right)^2 * 11,2$$ (2P)

$$= 2,0571 \text{ (watt)}$$

Aufgabe (5)

1

a)



$$M1: \quad -32(V) + \cancel{16 i_1} + 8(V) + \cancel{12(i_1 - i_2)} + \cancel{20 i_1} = 0$$

$$48 i_1 - 12 i_2 = 24. \quad \text{—} \quad 1P$$

$$i_2 = I_8 = 2{,}5\,(A).$$

$$\therefore \quad i_1 = 1{,}125\,(A) \quad \text{—} \quad 1P$$

$$M2: \quad -\cancel{36} + \cancel{12 i_2} + \cancel{7 i_2} - u_0 + \cancel{12(i_2 - i_1)} = 0.$$

$$31 i_2 - (12)(1{,}125) - 36 = u_0.$$

$$\therefore \quad \underline{\underline{u_0 = 28\,(V).}} \quad 1P$$

$\sum_a 6P$

b)

i) $u_0 = 28(V)$. 1P

R_7 ist in e Rei mit einer Stromquelle.

$\sum_b 2P$

ii) $u_0 = 28(V)$. 1P

R_9 ist parallel zu einer Spannungsquelle.

c) Wenn der Schalter S_3 geschlossen ist;

Dann $U_{AC} = u_0$

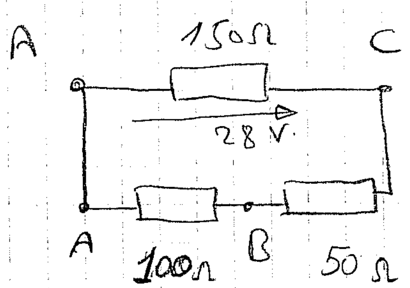
$\therefore u_{AC} = 28(V)$ — 1P.

$$I_{10} = \frac{U_{AC}}{R_{10}}$$

$\sum_c 2P$

$\therefore I_{10} = 0.1867\ (A)$ — 1P

d)



$\sum_d 2P$

Spannungsteiler : $u_{AB} = \frac{100}{150} \cdot u_0$ — 1P

$$u_{AB} = \frac{100}{150} \cdot 28\ (V).$$

$u_{AB} = 18.6667\ (V)$ — 1P

e) $U_{BC} = U_{AC} - U_{AB}$

$= 28 - 18.6667.$

$\sum_e 2P$

$U_{BC} = 9{,}3333\ (V)$ — 1P

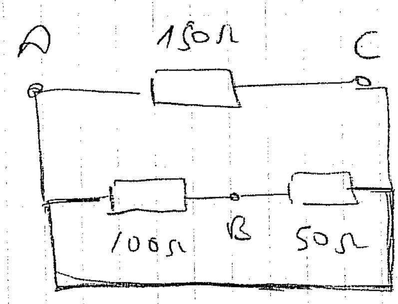
$I_{14} = \frac{U_{BC}}{R_{14}} = 0.09333\ (A)$ — 1P

f) R_{11}, R_{13} //

R_{12}, R_{14} //

kurzschluss zwischen A und C.

$R_{ges} = 0\ (\Omega)$



$\sum_f 4P$

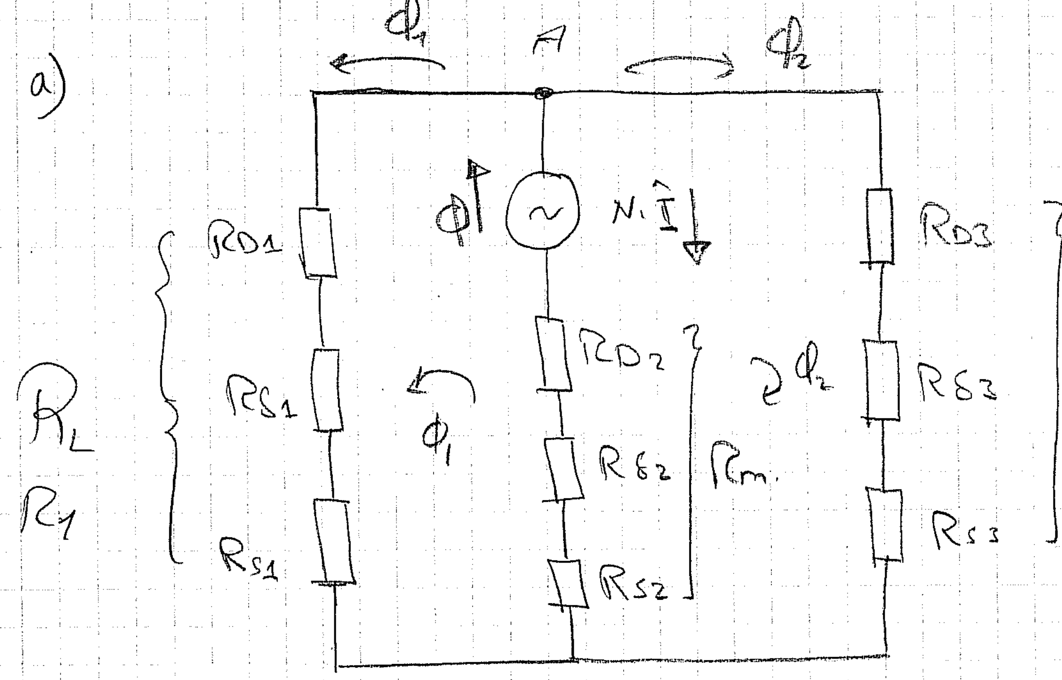
Aufgabe (6)

(1)

a)

(2P) Bild

(1P) Größen



Σ_a 3P

b) $$R_1 = \frac{a/2 + b + \frac{a}{2} + \frac{a}{2} + b}{\mu_0 \mu_{r1} \cdot a^2} + \frac{\delta}{\mu_0 \cdot a^2} + \frac{a + b + \frac{a}{2}}{\mu_0 \cdot \mu_{r2} \cdot a^2}$$ (1P)

Σ_b 5P

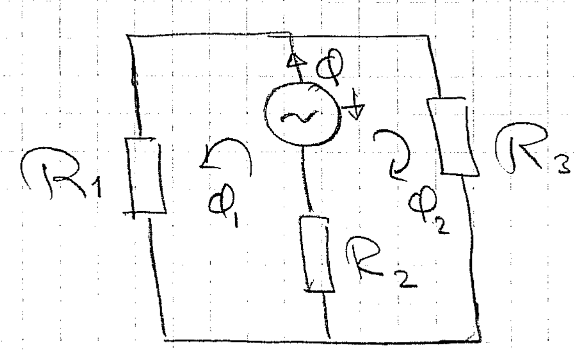
$$R_1 = 4{,}0982 * 10^5 \left(\frac{A}{Vs}\right)$$ (1P)

$$R_1 = R_3 \qquad R_3 = 4{,}0982 * 10^5 \left(\frac{A}{Vs}\right)$$ (1P)

$$R_2 = \frac{a/2 + b}{\mu_0 \cdot \mu_{r1} \cdot a^2} + \frac{\delta}{\mu_0 \cdot a^2} + \frac{a/2}{\mu_0 \cdot \mu_{r2} \cdot a^2}$$ (1P)

$$R_2 = 2{,}9046 * 10^5 \left(\frac{A}{Vs}\right)$$ (1P)

c)



$$* \quad (\hat{\Phi}_1 + \hat{\Phi}_2) \cdot R_2 - N \cdot \hat{I} + \hat{\Phi}_1 R_1 = 0$$

$$A^* \quad (R_1 + R_2)\,\hat{\Phi}_1 + (R_2)\,\hat{\Phi}_2 = N \cdot \hat{I} \quad \text{— 1P}$$

$$* \quad \hat{\Phi}_2 \cdot R_3 + R_2(\hat{\Phi}_2 + \hat{\Phi}_1) - N\hat{I} = 0$$

$$B^* \quad (R_2)\,\hat{\Phi}_1 + (R_2 + R_3)\,\hat{\Phi}_2 = N \cdot \hat{I} \quad \text{— 1P}$$

solve A^*, B^* 2P für Mathe

$$\hat{\Phi}_1 = 0{,}001 \text{ (Wb)}$$

$$\hat{\Phi}_2 = 0{,}001 \text{ (Wb)}$$

$$\sum_c 5P$$

$$\hat{\Phi} = \hat{\Phi}_1 + \hat{\Phi}_2 \quad \text{1P}$$

$$\hat{\Phi}_{Ac} = -0{,}002 \text{ (Wb)} \quad \text{da } -\hat{\Phi} = \hat{\Phi}_{Ac}$$

d)

$$R_{ges} = \frac{R_1 \cdot R_3}{R_1 + R_3} + R_2. \quad \text{— 1P}$$

$\sum_d 2P$

$$R_{ges} = 4{,}9537 * 10^5 \quad A/Vs. \quad \text{— 1P}$$

---

oder

$\sum 2P.$

d)

$$N \cdot \hat{I} = \hat{\Phi} \cdot R_{ges}. \quad \text{— 1P}$$

$$R_{ges} = 4{,}9537 * 10^5 \quad A/Vs. \quad \text{— 1P}$$

---

e)

$$\hat{B}_{\delta_1} = \frac{\hat{\Phi}_1}{A} = \frac{\hat{\Phi}_1}{a^2} = 2{,}5234 \text{ (Tesla)} \quad 1P$$

$\sum_e 3P$

$$\hat{B}_{\delta_3} = 2{,}5234 \text{ (Tesla)} \quad 1P$$

$$\hat{B}_{\delta_2} = -2\,\hat{B}_{\delta_1} \qquad \hat{B}_{\delta_2} = -5{,}0467 \text{ Tesla.} \quad 1P$$

---

f)

$$\hat{\vartheta}_{m,ACD} = \hat{\vartheta}_{m,AC} + \hat{\vartheta}_{m,CD} + \ominus$$

Σ 3P

$$= R_{AC} * \hat{\Phi}_{AC} + R_{CD} * \hat{\Phi}_2 + \ominus \quad \text{(1P)}$$

$$R_{AC} = R_2 = 2{,}9046 * 10^5 \frac{A}{Vs} \; \ldots\ldots$$

(1P) $$R_{CD} = \frac{a/2 + b + a/2}{\mu_0 \, \mu_{r2} \, a^2} = 1{,}9894 * 10^4 \frac{A}{Vs}.$$

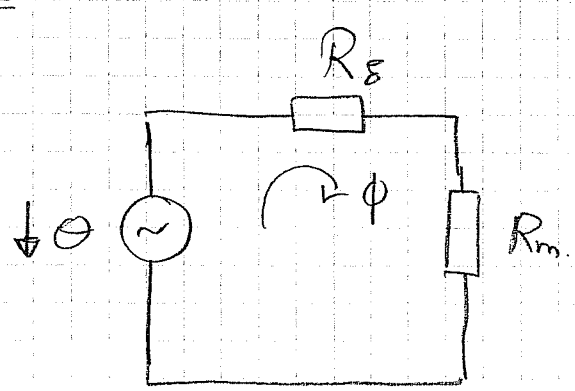
(1P) $$\hat{\vartheta}_{m,ACD} = \underline{\underline{-606 \cdot 4257 + N.\hat{I}}}$$ $N = 500$, $\hat{I} = 2(A)$

$$\underline{\underline{\hat{\vartheta}_{m,ACD} = 393{,}5743 \; (A)}}$$

Aufgabe 7

1

a)



2P

b)

$$\Delta\hat{\phi} = \frac{N \cdot \hat{I}_1}{\Delta R}$$

$$\Delta R = \frac{l}{\mu \cdot A} = \frac{2\pi \cdot r}{\mu_0 \cdot \mu_r \cdot \underbrace{d \cdot dr}_{1P}} \quad \text{1P} \qquad \text{2P}$$

Σ 4P

$$\therefore \Delta\hat{\phi} = \frac{N \cdot \hat{I}_1}{2\pi r} \cdot \mu_0 \mu_r \cdot d \, dr$$

$$\Delta\hat{\phi} = \frac{N * \hat{I}_1 * \mu_0 \mu_r}{2\pi} * d \quad \frac{dr}{r} \qquad \text{1P}$$

$$\hat{\phi} = \int_{r_1}^{r_2} \Delta\hat{\phi}$$

$$\hat{\phi} = \frac{\mu_0 \cdot \mu_r \cdot d}{2\pi} * N \cdot \hat{I}_1 * \ln \frac{r_2}{r_1} \qquad \text{1P}$$

c) Aus b) $R = \frac{N \cdot \hat{I}}{\hat{\Phi}}$ ② $\sum SP$

1P $R_{alt}\Big|_{ohne(\delta)} = \frac{2\pi}{\mu_0 \mu_r d \cdot \ln\left(\frac{r_2}{r_1}\right)}$ A^*

B^*

1P $R_{neu}\Big|_{mit\ \delta} = \left(\frac{(2\pi - \alpha)}{\mu_0 \cdot \mu_r \cdot d} + \frac{\alpha}{\mu_0 \cdot d}\right) * \frac{1}{\ln \frac{r_2}{r_1}}$.

$R_{neu}\Big|_{mit\ \delta} = \frac{1}{\mu_0 \cdot d \cdot \ln \frac{r_2}{r_1}} \left\{ \frac{(2\pi - \alpha) + \alpha \cdot \mu_r}{\mu_r} \right\}$

$N_1 \cdot \hat{I}_1 = \hat{\Phi}_1 \cdot R_{alt}$ $N_1 = N_2$

$N_2 \cdot \hat{I}_2 = \hat{\Phi}_2 \cdot R_{neu}$ $\hat{\Phi}_1 = \hat{\Phi}_2$

1P $\therefore \frac{I_2}{\hat{I}_1} = \frac{R_{neu}}{R_{alt}}$

2P $\therefore \hat{I}_2 = \underbrace{\left\{ 1 + \frac{\alpha}{2\pi} \{ \mu_r - 1 \} \right\}}_{K} * \hat{I}_1$

$\hat{I}_2 = K \cdot \hat{I}_1$

③

d)

α	μ_r	$\hat{I}_2 / \hat{I}_1$
$1{,}8^\circ$	10^2	$1{,}5$
9°	10^4	251

$\sum_{d} 2p$

Aufgabe (8):

a) • $R = \rho \cdot \frac{l}{A} = \frac{1}{\kappa} \cdot \frac{l}{A}$ (1P)

• $i_1(t) = \frac{u_1(t)}{2 \cdot R}$ (1P)

• $i_1(t) = i_2(t)$ (1P)

$\sum_a 3P$

b) $\vec{B}_1(t) = \frac{\mu_0 \cdot i_1(t)}{2\pi \cdot r} \cdot -\vec{e}_z$ (1P)

$\vec{B}_2(t) = \frac{\mu_0 \cdot i_2(t)}{2\pi (h-r)} \cdot -\vec{e}_z$ (1P)

$\vec{B}(t) = \frac{\mu_0}{2\pi} \left\{ \frac{i_1(t)}{r} + \frac{i_2(t)}{h-r} \right\} -\vec{e}_z$ (1P)

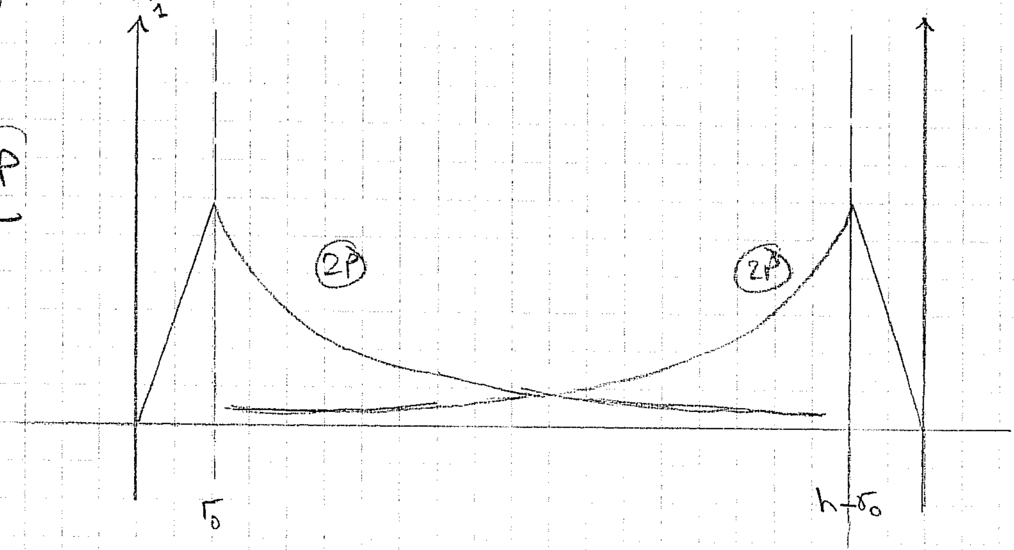
oder: falls, wie hier, $i_1(t) = i_2(t) = i(t)$

$\vec{B}(t) = \frac{\mu_0 \cdot i(t)}{2\pi} * \left\{ \frac{1}{r} + \frac{1}{h-r} \right\} \cdot -\vec{e}_z$ (1P)

$\sum_b 3P.$

c) ②

$\sum_c 4P$



d) $\Phi = \oint \vec{B} \cdot \vec{dA} \qquad dA = \ell \cdot dr$ 1P

$$= \int_{r_0}^{h-r_0} \frac{\mu_0 \cdot i(t)}{2\pi} * \left(\frac{1}{r} + \frac{1}{h-r} \right) \cdot \ell \cdot dr$$ 1P

$\sum_d 4P$

$$= \frac{\mu_0 \cdot \ell \cdot i(t)}{2\pi} \cdot \int_{r_0}^{h-r_0} \frac{1}{r} + \frac{1}{h-r} \cdot dr$$

$$= \frac{\mu_0 \cdot \ell \cdot i(t)}{2\pi} \cdot \ln(r) - \ln(h-r) \Big]_{r_0}^{h-r_0}$$ 1P

$$= \frac{\mu_0 \cdot \ell \cdot i(t)}{2\pi} \cdot \Big\{ \big(\ln(h-r_0) - \ln(r_0)\big) - \big(\ln(r_0) - \ln(h-r_0)\big)$$

$$= \frac{\mu_0 \cdot \ell \cdot i(t)}{2\pi} \cdot \left\{ \ln\left(\frac{h-r_0}{r_0}\right) + \ln\left(\frac{h-r_0}{r_0}\right) \right\}$$

$$\Phi(t) = \frac{\mu_0 \cdot \ell \cdot i(t)}{\pi} \cdot \ln\left(\frac{h-r_0}{r_0}\right)$$ 1P

(3)

e) → Um die Leiterpaar i_2, i_3 sich abstoßen, muss der strom $i_3(t)$ im gegenrichtung von $i_2(t)$ fließen. (1P)

→ Da der Strom $i_3(t)$ und die entsprechende Spannung $u^*(t)$ in die gleiche richtung sein müssen, (1P)

→ Dann muss der Schalter im Position (C) sein. (1P)

$\sum_e 3P$

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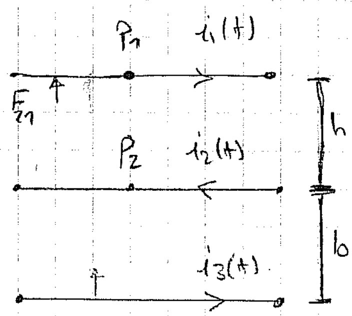
f) 

$\sum_F 5P$

- $\vec{F}_{31} = \dfrac{\mu_0 \cdot i_3(t)}{2\pi(h+b)} \cdot I_1 \cdot l_1 \cdot -\vec{e_y}$ (1P)
- $\vec{F}_{21} = \dfrac{\mu_0 \cdot i_2(t)}{2\pi \cdot h} \cdot I_1 \cdot l_1 \cdot \vec{e_y}$ (1P)
- $\vec{F}_{ges(1)} = \vec{F}_{31} + \vec{F}_{21} = \dfrac{\mu_0 \cdot I_1 \cdot l_1}{2\pi} \left\{ -\dfrac{i_3(t)}{h+b} + \dfrac{i_2(t)}{h} \right\} \cdot \vec{e_y}$ (1P)
- $\vec{F}_{ges(2)} = \dfrac{\mu_0 \cdot I_2 \cdot l_2}{2\pi} \left\{ -\dfrac{I_1}{h} + \dfrac{I_3}{b} \right\} \cdot \vec{e_y}$ (2P)

(g) (4)

$$B(t) = \hat{B} \cdot \left\{ 1 + \cos(\omega t) \right\} \quad \omega = \text{konstant}$$

- $$u_i = -N \frac{d\phi(t)}{dt} = -N \cdot \left(A \cdot \frac{dB}{dt} + B \cdot \cancel{\frac{dA}{dt}}^{\,0} \right)$$

$$= \cancel{-}N \cdot (A) \cdot \hat{B} \left(\cancel{-}\sin(\omega t) \right) \cdot \omega$$

$$u_i = (l \cdot h)(N \cdot \hat{B} \cdot \omega) \sin(\omega t) \quad 1P$$

- B_i $\odot$ 1P

- $\cdot\, x$ $\uparrow u_i$ 1P $\cdot\, y$

$\sum_g 3P$

Aufgabe 9

a) $f = \frac{1}{2\pi} 10^6\,Hz \Leftrightarrow \omega = 2\pi f = 10^6\,Hz$

$|\underline{U}_L| = 10\,V$ $\sum 3P$

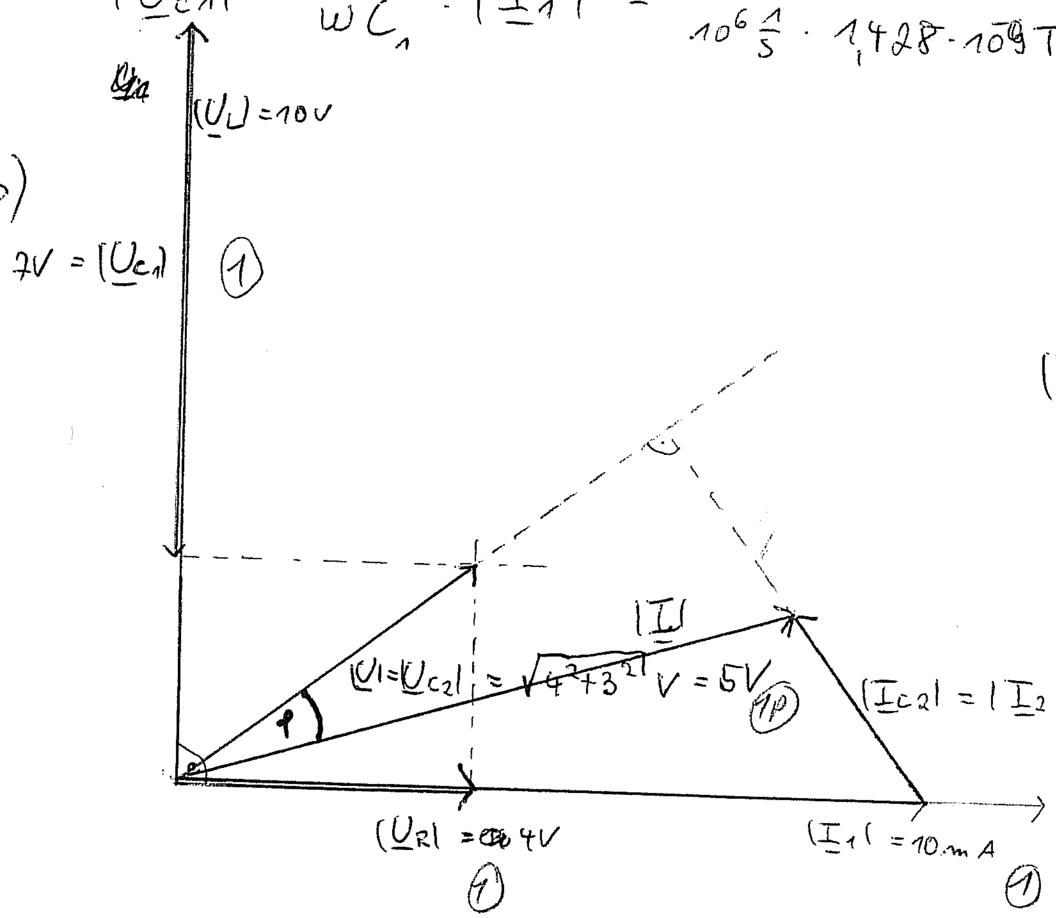
$$X_L = \frac{|\underline{U}_L|}{|\underline{I}_L|} \Leftrightarrow |\underline{I}_L| = \frac{|\underline{U}_L|}{X_L} = \frac{10\,V}{\omega \cdot L} = \frac{10\,V}{10^6 \frac{1}{s} \cdot 10^{-3}\,H}$$

$$= |\underline{I}_1| \qquad = 10\,mA \quad (1P)$$

$$|\underline{U}_R| = R \cdot |\underline{I}_1| = 400\,\Omega \cdot 10\,mA = 4\,V \quad (1P)$$

$$|\underline{U}_{C1}| = \frac{1}{\omega C_1} \cdot |\underline{I}_1| = \frac{1}{10^6 \frac{1}{s} \cdot 1{,}428 \cdot 10^{-9}\,T} \cdot 10\,mA = 7V \quad (1P)$$

b)



$$|\underline{I}_{C2}| = \frac{|\underline{U}_{C2}|}{X_{C2}} \quad (1P)$$

$$= 5V \cdot \omega \cdot C_2$$

$$= 3\,mA$$

$\sum 6P$

$\varphi = 21^\circ$ $\qquad |\underline{I}| = 8{,}6\,mA$ (1P)

c) ~~Ps~~ ~~Qs~~ $\sum 2P$

$S = |\underline{I}| \cdot |\underline{U}| = 5V \cdot 8{,}6\,mA = 43\,mW$ (mVA)

$Q = |\underline{I}| \cdot |\underline{U}| \cdot \sin 21^\circ = 15{,}41\,mW$ (mVAR).

$P = |\underline{I}| \cdot |\underline{U}| \cdot \cos 21^\circ = 40{,}01\,mW$

d)

$\underline{Z} = \left(j\omega L + \frac{1}{j\omega C_1}\right) \parallel \frac{1}{j\omega C_2}$ (1P)

$$= \frac{\frac{j\left(\omega L - \frac{1}{\omega C_1}\right)}{j\omega C_2}}{j\left(\omega L - \frac{1}{\omega C_1}\right) + \frac{1}{j\omega C_2}} = \frac{j\left(\omega L - \frac{1}{\omega C_1}\right)}{\omega C_2\left(\frac{1}{\omega C_1} - \omega L\right) + 1}$$ (1P)

$$= j\,\frac{\omega^2 L C_1 - 1}{\omega C_2 - \omega^2 C_1 C_2 L +}$$ (1P)

T ~~17~~ 2	II
T ~~8~~7	IIII
T 3	II
T 1	III
T 5	IIII
T 4	III
ST 6	