Aufgabe (1): 18 punkte.

(a): $I * t_1 = Q = C_1 * U_1$

$\Sigma 2$

$$\Rightarrow C_1 = \varepsilon_0 \varepsilon_r \frac{A}{d}$$

$$= 8{,}854 * 10^{-12} * (2) * \frac{200 * 10^{-6}}{0{,}5 * 10^{-3}}$$

$$= 7{,}0832 * 10^{-12} \ (F)$$

$$C_1 = 7{,}0832 \ (PF) \qquad 1$$

$$\Rightarrow I_L = \frac{C_1 * U_1}{t_1}$$

$$= \frac{7{,}0832 * 10^{-12} * 100}{0{,}5}$$

$$= 1{,}4164 * 10^{-9} \ (A)$$

$$I_L = 1{,}4164 \ (nA) \qquad 1$$

b) $W = \frac{1}{2} C_1 . U_1^2$

/2

$W = \left(\frac{1}{2}\right)(7,0832)(10^{-12})(100)(100)$ ①

$= 3,5416 * 10^{-8}$ Joule

$\underline{\underline{W = 35,416 \text{ nJoule}}}$ ①

c) $E_D = \frac{U_{max}}{d} \Rightarrow U_{max} = E_D * d$

/2

$U_{max} = 100 * \frac{10^3}{10^{-2}} * (0,5)(10^{-3})$ ①

$= 5000$ volt.

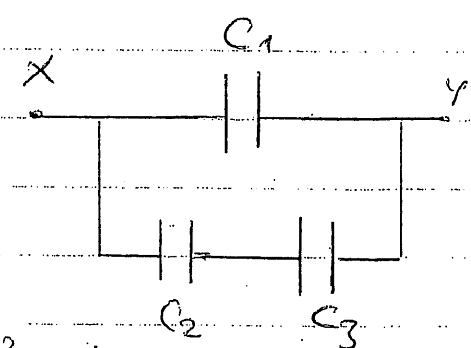
$\underline{\underline{U_{max} = 5 \text{ KV}}}$ ①

d)

5.4 $C_2 = (8{,}854 * 10^{-12})(4)\left(\frac{200}{0.5}\right)\left(\frac{10^{-6}}{10^{-3}}\right)$

$$\underline{\underline{C_2 = 14{,}1664 * 10^{-12} \ (F)}}$$ ①

$$\underline{\underline{C_3 = 14{,}1664 * 10^{-12} \ (F)}}$$ ①



* C_2, C_3 (Series) :-

$$C_{23} = \frac{C_2}{2}$$

$$\therefore \underline{\underline{C_{23} = 7{,}0832 * 10^{-12} \ (F)}}$$ ①

* C_1, C_{23} (Parallel) :-

$$C_{123} = C_1 + C_{23}$$

$$= 14{,}1664 * 10^{-12} \ (F)$$

$$\underline{\underline{C_{ges} = 14{,}1664 * 10^{-12} \ (F)}}$$ oder

①

$$\underline{\underline{C_{ges} = 14{,}1664 \ (PF)}}$$

e) /5 $\Rightarrow Q$: Vor schliessen von (S_2) :

$$Q = C_1 * U_1$$

$$= (7{,}0832 * 10^{-12}) * 100$$

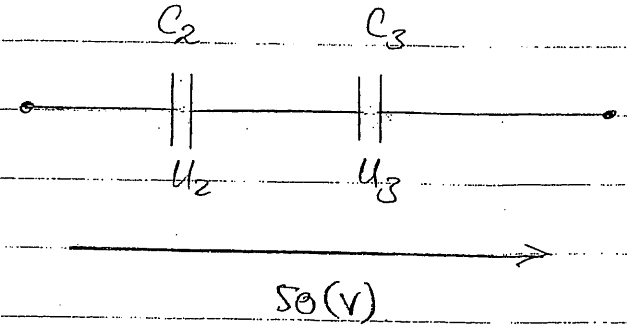
$$\underline{\underline{Q = 7{,}0832 * 10^{-10}}} \ As \qquad 1$$

$\Rightarrow$ nach schliessen von S_2 : Q bleibt konstant 1

$$\Rightarrow \quad Q = C_{ges} * U_1)_{new}$$

$$U_1)_{new} = 50 \ (V) \qquad 1$$

$\Rightarrow$



1 Ansatz

$$\begin{cases} U_2 + U_3 = 50 \ (V) \quad \ldots (1) \\ Q_2 = Q_3 \\ U_2 C_2 = U_3 C_3 \\ \qquad U_2 = U_3 \ldots (2) \end{cases}$$

From (1), (2) :

$$\begin{cases} \underline{\underline{U_2 = 25 \ (Volt)}} \\ \underline{\underline{U_3 = 25 \ (Volt)}} \qquad 1 \end{cases}$$

f) $\{1$

$$W^* = \frac{1}{2} C_{gcs} \cdot U_{new}^2$$

$$= \left(\frac{1}{2}\right)(14,1664)(10^{-12})(50)(50)$$

$$W^* = 17,708 \text{ (nJ)}$$ ①

g) $\{2$

→ ΔW is reduced by 50 %.

→ Energy is lost in the attached resistor (R) in the form of I^2R (Heat loss) ②

Aufgabe (2) 16 punkte

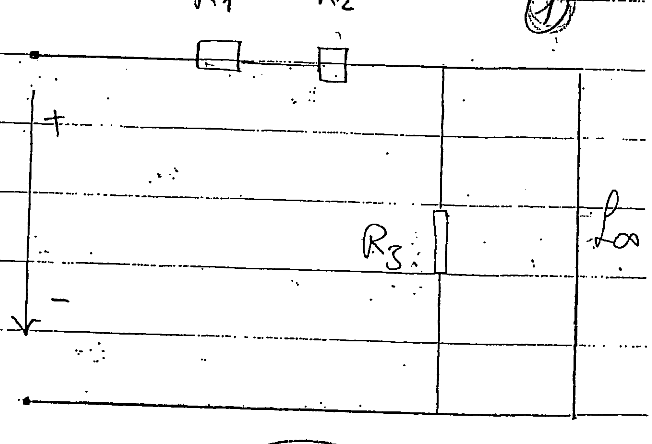
a) $\Sigma 3$

- L_1, L_2 Series $\Rightarrow L_{12} = 20\ (H)$ 1
- L_{12}, L_3 parallel $\Rightarrow L_{123} = 4\ (H)$ 1
- L_{123}, L_4 parallel $\Rightarrow L = 2\ (H)$ 1

$$\underline{\underline{L = 2\ (H)}}$$

b) $\Sigma 4$ if $t \to +\infty$, then the Conductor (L) acts as a Short circuit.

b1) 1

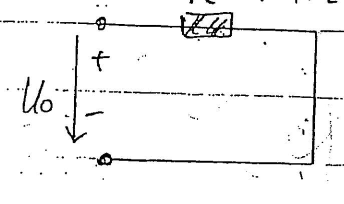


b2) $I_L(\infty) \overset{t\to\infty}{=} \dfrac{U_0}{R_1+R_2}$ 1

$$\underline{\underline{I_L(\infty) = 2\ (A)}}$$ 1

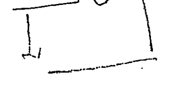
oder

$R = R_1 + R_2$



b3) $W = (1/2)(L)(I_\infty)^2$

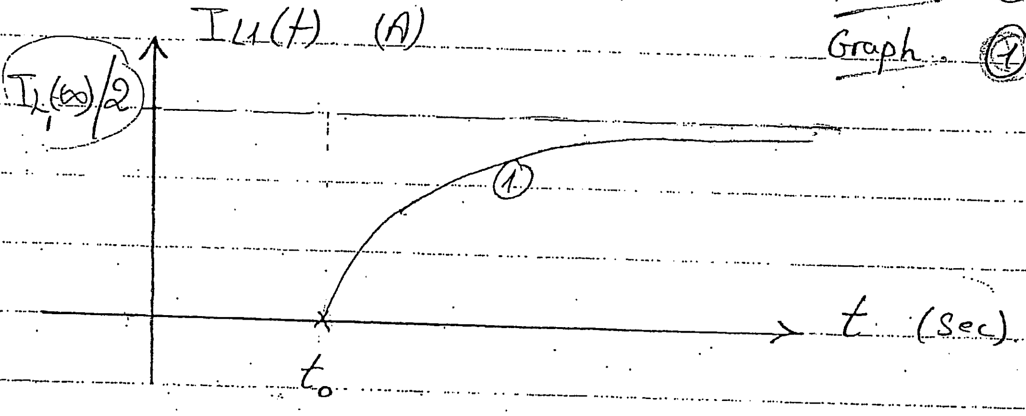
$\underline{\underline{W_1 = 4 \text{ Joules}}}$ 1



c) Bevor dem schluss des schalter(s) :
{2

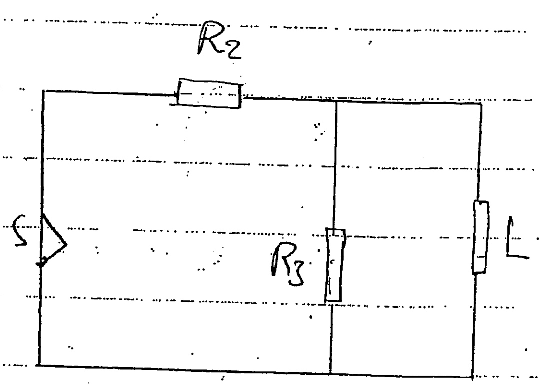
"Charging Mode"

Labels (1)
Graph (1)



$\{t_0\}$ Kann auch (Zero) sein!

d) $\tau = \dfrac{L}{R_{ges}}$
{2



- $R_{ges} = R_2 \parallel R_3$

$$R_{ges} = 2\ (\Omega)$$ (1)

- $\tau = \dfrac{L}{R_{ges}} = \dfrac{2\ (H)}{2\ (\Omega)} = 1$ sec.

$$\tau = 1 \text{ sec.}$$ (1)

(10)

→ entladen:

e) Discharging Mode:

{2

$$I(t) = I_\infty \, e^{-t^*/\tau}$$

$I(t)$: 1A, I_∞: 2A, I_∞: I_{L1}

(1)
$$I(t) = \frac{1}{2} I_\infty$$

$$\Rightarrow \times \frac{1}{2} \cancel{I_\infty} = \cancel{I_\infty} \, e^{-t^*/\tau}$$

(1)
$$e^{-t/\tau} = 0.5 \qquad \tau = 1 \text{ Sec.}$$

$$t^* = 0.693 \text{ (Sec)} \qquad e^{-t^*/\tau} = e^{-t^*} = 0{,}5$$

$$t^* = -\ln(0{,}5) = 0{,}693$$

f) $W_2 = \frac{1}{2} L I_2^2 = \left(\frac{1}{2}\right)(2)(1)^2 = 1$ Joule

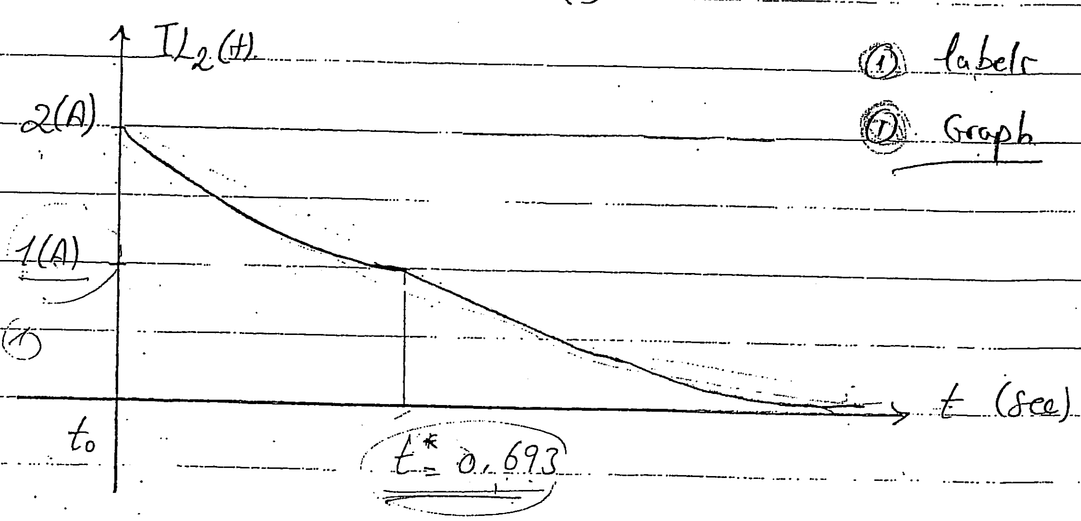
{1

$$\Delta W = |W_2 - W_1| = 3 \text{ Joule}$$

(1)

g) Nach dem Abschluss des Schalters (S)

{2



(1) labels

(1) Graph

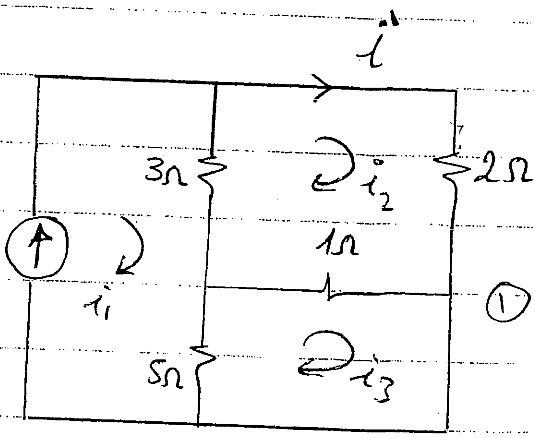
Aufgabe (3) :-

Punkte : 22

(a) :-

$\Sigma 10$

* i': Strom von dem Strom Quelle $I_0 = 4\,(A)$



① → Mesh(1) :- $i_1 = 4\,(A)$ ... (1)

① → Mesh (2) :- $6 i_2 - i_3 = 12\ \cancel{(V)}$ ... (2)

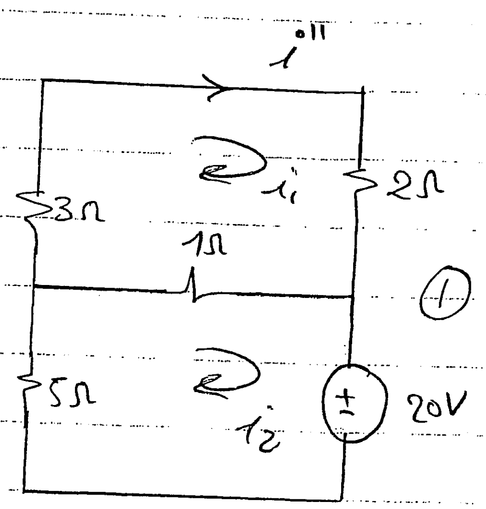
① → Mesh (3) :- $-i_2 + 6 i_3 = 20\ \cancel{(V)}$ ... (3)

→ From 2,3 :- $i_2 = 2{,}6286\,(A) = i'$

$i_3 = 3{,}7714\,(A)$

① ⇒ $i' = 2{,}6286\,(A)$.

* i'': Strom von dem Spannungs Quelle $U_1 = 20\,V$



① Mesh(1) :- $6 i_1 - i_2 = 0$ ... (1)

① Mesh(2) :- $-i_1 + 6 i_2 = -20$ ... (2)

From 1,2 :- ① $i'' = -0{,}5714\,(A)$

$$\Rightarrow \quad \overset{\circ}{i} = \overset{\circ}{i}{}'\Big]_{I_0} + \overset{\circ}{i}{}''\Big]_{U_1}.$$

$$\underline{\underline{\overset{\circ}{i} = 2{,}0554 \text{ (A)}.}} \quad ①$$

B) $\Rightarrow \overset{\circ}{i}{}'$ Vom strom Quelle 4(A) $= 2{,}6268$ (A).

{3

$\Rightarrow$ ① $\overset{\circ}{i}{}'$ Vom strom Quelle 8(A) $= 2\cdot(2{,}6268)$

$= 5{,}2536$ (A).

$\Rightarrow$ ① $\overset{\circ}{i}{}''$ Vom spannungs Quelle $= -0{,}5714$ (A).

$$\therefore \quad \underline{\underline{\overset{\circ}{i} = 4{,}6822 \text{ (A)}}} \quad ①$$

c) Ergebniss aus (A) : $\overset{\circ}{i} = 2{,}0554$ (A)

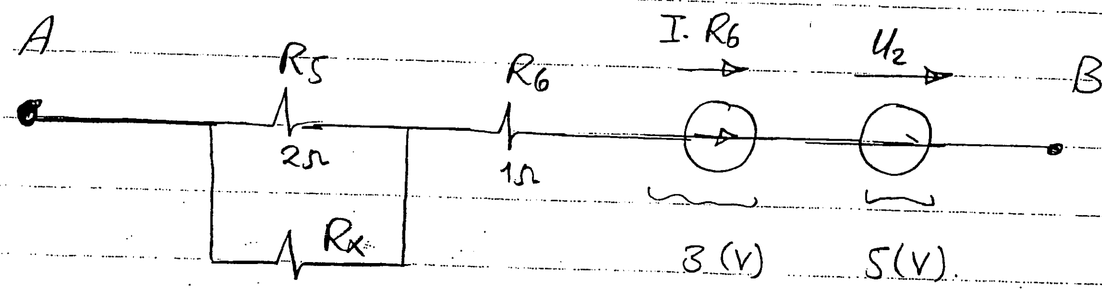
{2

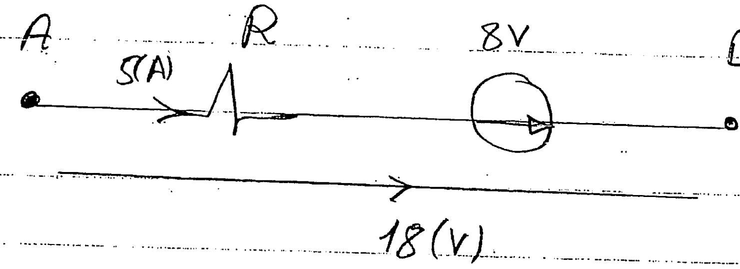
$$P\{R_4\} = \overset{\circ}{i}{}^2 \cdot R_4.$$

$$= (2{,}0554)^2 \cdot (2) \quad ①$$

$$\underline{\underline{P\{R_4\} = 8{,}45 \text{ Watt}.}} \quad ①$$

d)
{5



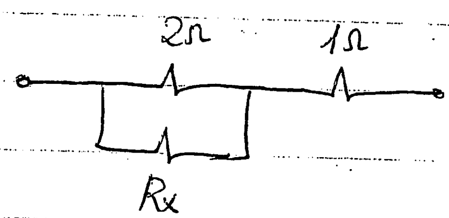


(2)

$\cdot \quad U_{AB} = (I_{AB})(R) + 8(V).$

$$\therefore \quad R = \frac{18-8}{5} = 2\,\Omega. \quad (2)$$

$\cdot$

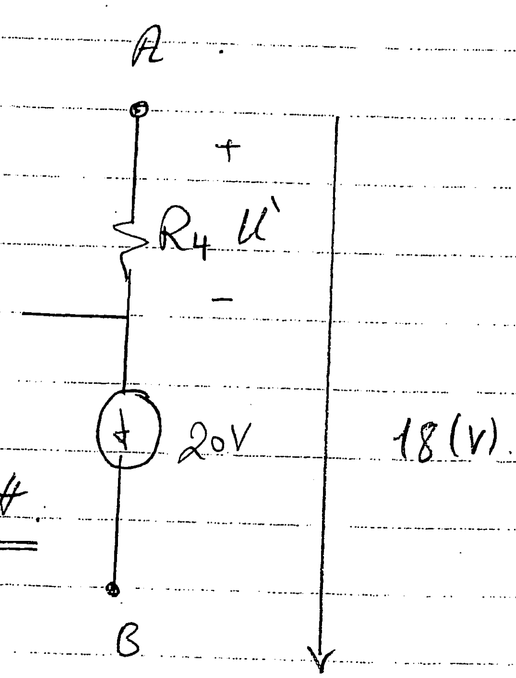


$\therefore \quad \underline{\underline{R_x = 2\,\Omega.}} \quad (1)$

e) nach dem schluss :
{2

$U_{AB} = 18\,(V).$

$|U'| = 2\,(V).$ (1)



$$P^{*}_{R_4} = \frac{U'^2}{R_4} = \frac{(4)}{2} = \underline{\underline{2 \text{ Watt}}}$$

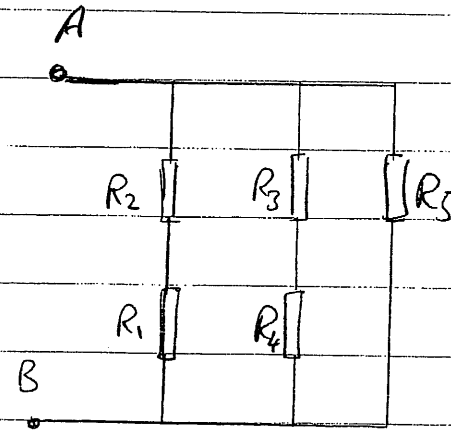
(1)

Aufgabe (4) :-

Puntete : 17

a) Innenwiederstand "R_i" :-

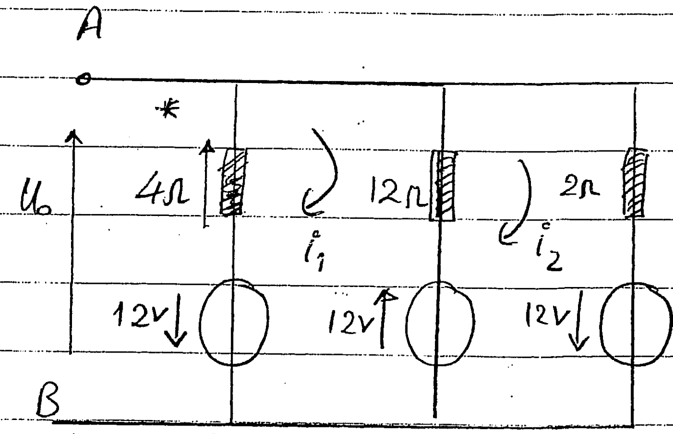
{3



- R_1, R_2 (series) :- $R_{12} = 4\ (\Omega)$ ①
- R_3, R_4 (series) :- $R_{34} = 12\ (\Omega)$ ①
- R_{12}, R_{34}, R_5 (Parallel) :- ①

$$\underline{\underline{R_i = 1{,}2\ \Omega}}$$

b) {4



Mesh (1) :-

$\cancel{12}(i_1 - i_2) - 12 - 12 + 4 i_1 = 0$

$\therefore\ 16 i_1 - 12 i_2 = 24 \quad (1)$ ①

Mesh (2) :-

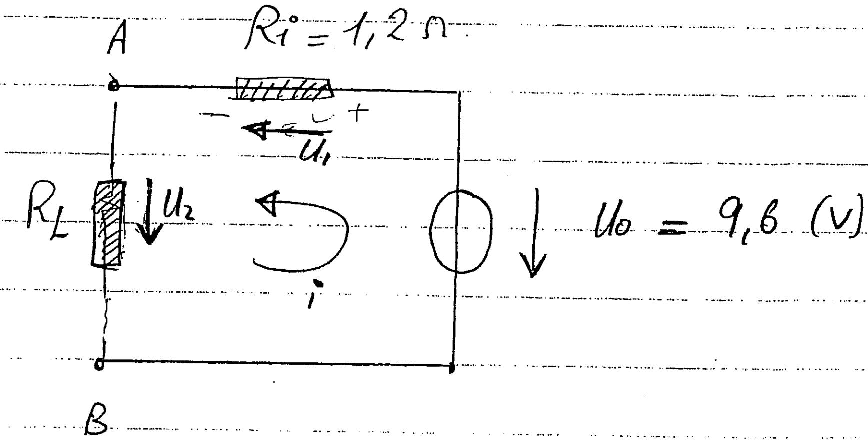
$2(i_2) + 12 + 12 + 12(i_2 - i_1) = 0$

$-12 i_1 + 14 i_2 = -24 \quad (2)$ ①

From 1,2 :- $i_1 = 0{,}6\ (A)$ $\quad i_2 = -1{,}2\ (A)$ ①

Mesh (*) :- * $U_0 - 4(0{,}6) + 12 = 0.$ $\quad \underline{\underline{U_0 = -9{,}6\ (V)}}$ ①

c) {2



$$-U_2 - U_1 + U_0 = 0.$$

$$* \quad U_0 = U_1 + U_2$$

$$* \quad U_2 = (i)(R_L) \qquad \Rightarrow \quad i = \frac{U_0}{R_i + R_L} \qquad (1)$$

$$\Rightarrow \quad P_{RL}\{R_L\} = i^2 \cdot R_L$$

$$P_{RL} = \left\{\frac{9{,}6}{1{,}2 + R_L}\right\}^2 * R_L \qquad (1)$$

---

d) {2 Maximum power Transfer Condition: $R_i = R_L$ (1)

$$\therefore \quad R_L = 1{,}2\ \Omega \qquad (1)$$

---

e) {2

$$P_{RL}\{max\} = \left\{\frac{9{,}6}{(1{,}2) + (1{,}2)}\right\}^2 * 1{,}2 \qquad (1)$$

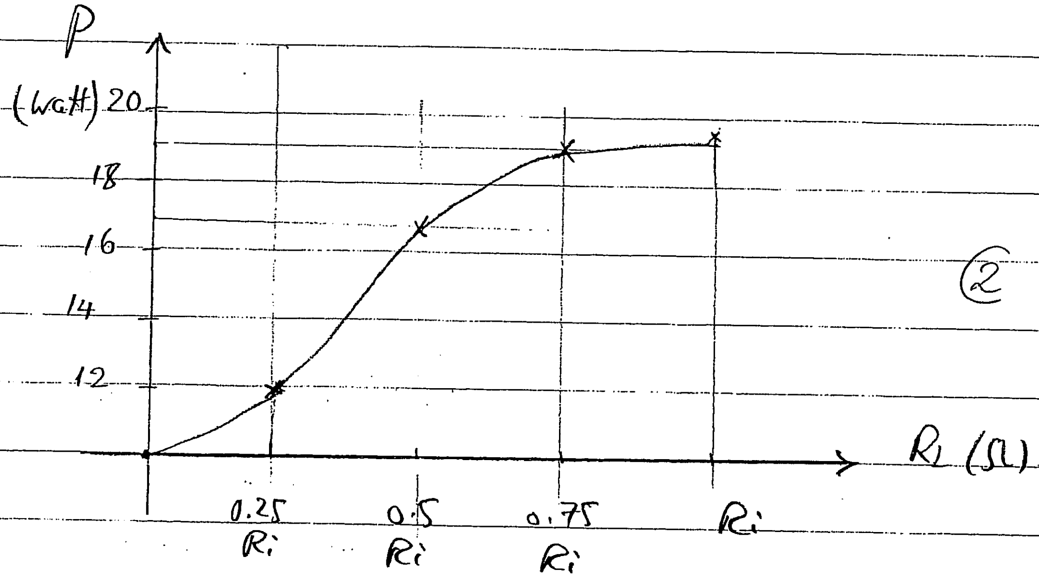
$$P_{RL}\{max\} = 19{,}2 \text{ Watt} \qquad (1)$$

f) $P = \left\{ \dfrac{9{,}6}{1{,}2 + R_L} \right\}^2 * R_L$

4//

R_L (Ω)	P (Watt)
0.25 Ri	12,288
0.5 Ri	17,0667
0.75 Ri	18,8082
Ri	19,2

②



②

Aufgabe (5):

(22 punkte)

a) $$\Phi(t) = \int_0^{x(t)} B(t) \cdot dA$$

$$= \int_0^{x(t)} B(t) \cdot h \cdot dx$$

6

$$\Phi(t) = B_0 \cdot \sin(\omega t) \cdot h \cdot x(t)$$

$$\Phi(t) = B_0 \cdot \sin(\omega t) \cdot h \cdot v \cdot t$$

b) $$U = -N \frac{d\Phi(t)}{dt} \qquad N = 1$$

6

$$U = -\left\{ B_0 \sin(\omega t) \cdot h \cdot v + (t)(B_0)(h)(v) \cdot \cos(\omega t) \cdot \omega \right\}$$

$$U = -B_0 \, h \, v \left\{ \sin(\omega t) + t\omega \cdot \cos(\omega t) \right\}$$

c) $I = \dfrac{U}{R_1 + R_2}$ 6

$$I = \frac{-B_0 . h . v .}{R_1 + R_2} \left\{ \sin(\omega t) + t\omega . \cos(\omega t) \right\}.$$

d) $U_1 = I . * R_1.$ 2

$$U_1 = \frac{-B_0 . h . v . R_1}{R_1 + R_2} \left\{ \sin(\omega t) + t\omega . \cos(\omega t) \right\}.$$

e) $U_2 = I . R_2.$ 2

$$= \frac{-B_0 . h . v . R_2}{R_1 + R_2} \left\{ \sin(\omega t) + t\omega . \cos(\omega t) \right\}.$$

Aufgabe (6) :-

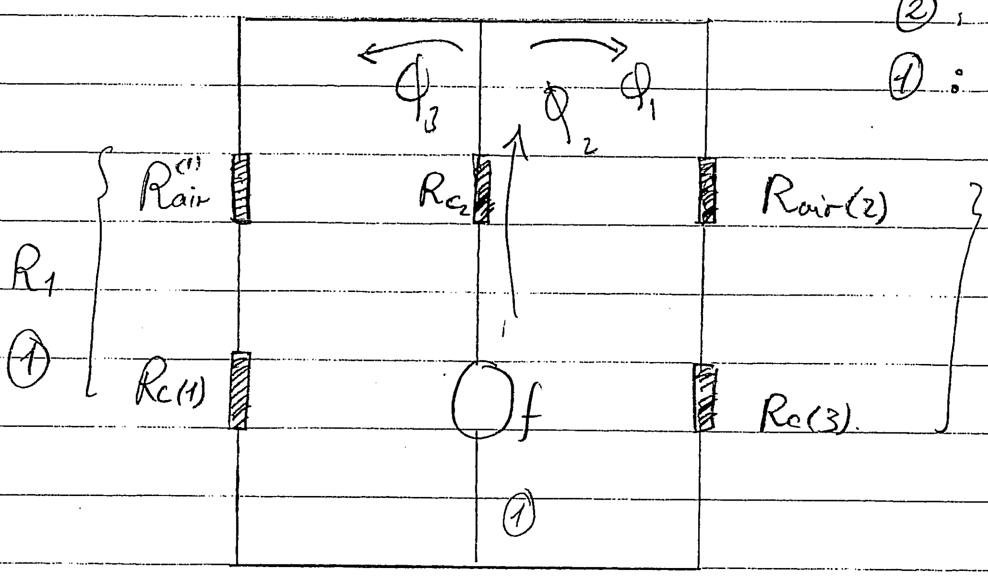
(18 punkte)

(a) :-

3

② : Bild.

① : Φ :- labels.



b) :-

6 * $R_1 = R_{Air(1)} + R_{core(1)}$.

$$= \frac{d_1}{\mu_0 . A} + \frac{L_1 - d_1}{\mu_0 \mu_r A} \quad ①$$

$$= \underline{\underline{2,0471 * 10^7 \quad A/Vs}} \quad ①$$

* $R_2 = R_{core(2)} = \dfrac{L_2}{\mu_0 \mu_r A}$ ①

$$= \underline{\underline{1,989 * 10^5 \quad A/Vs}} \quad ①$$

$* \; R_3 = R_{Air(2)} + R_{Core(3)}$

$$= \frac{d_2}{\mu_0 A} + \frac{L_3 - d_2}{\mu_0 \mu_r A} \quad ①$$

$$= \underline{\underline{1{,}0534 * 10^7 \; A/Vs}} \quad ①$$

c) $\underline{\underline{\Sigma 3}}$

$$R_{ges} = R_2 + \frac{R_1 \cdot R_3}{R_1 + R_3} \quad ②$$

$$\underline{\underline{R_{ges} = 7{,}154 * 10^6 \; A/Vs}} \quad ①$$

d) $\Sigma 1$

$$\hat{\phi}_{12} = \frac{\Theta}{R_{ges}} = \frac{N \cdot \hat{I}}{R_{ges}} = \frac{500 \cdot 2}{7{,}154 * 10^6}$$

①

$$\underline{\underline{\phi_{12} = 1{,}3978 * 10^{-4} \; Wb}}$$

e) $B_{12} = \frac{\Phi_{12}}{A} = \frac{1,3978 * 10^{-4}}{4 * 10^{-4}}$

1

$$\underline{\underline{B_{12} = 0,3495 \text{ Tesla}}}$$ 1

f) $\mathcal{L} = \frac{N^2}{R_{ges}} = \frac{500.500}{7,154 * 10^6}$

Σ1

1

$$\underline{\underline{\mathcal{L} = 34,9456 \text{ (mH)}}}$$

g) • Φ_2 wird erhört. 1

Σ3

• $d_1 = 0 \Rightarrow R_1$ wird red.
R_{ges} wird red. 1

• $\Phi_2 \propto \frac{1}{R_{ges}} \Rightarrow \Phi_2$ wird erhört. 1

Aufgabe (7) :   18 punkte

a)

(2) $\rightarrow$ $|U_R| = |I_R| * R$

$= 40 \cdot 10^{-3} \cdot 250$

$\underline{\underline{|U_R| = 10 \ (V)}}$ (1)

$\rightarrow$ $|I_L|$: $|U_L| = \omega \cdot L \cdot |I_L|$

$|U_L| = |U_R| = 10 (V)$

$I_L = \dfrac{10}{2 \cdot 10^3 \cdot 100 \cdot 10^{-3}} = 0.05 (A)$

$\underline{\underline{I_L = 50 \ (mA)}}$ (1)

$\rightarrow |\underline{I}_R| = 40\ mA$ & $|\underline{I}_L| = 50\ mA$

$\rightarrow |\underline{I}_0| \perp |\underline{U}_C|$ $\Leftrightarrow$ kapazitive Belastung

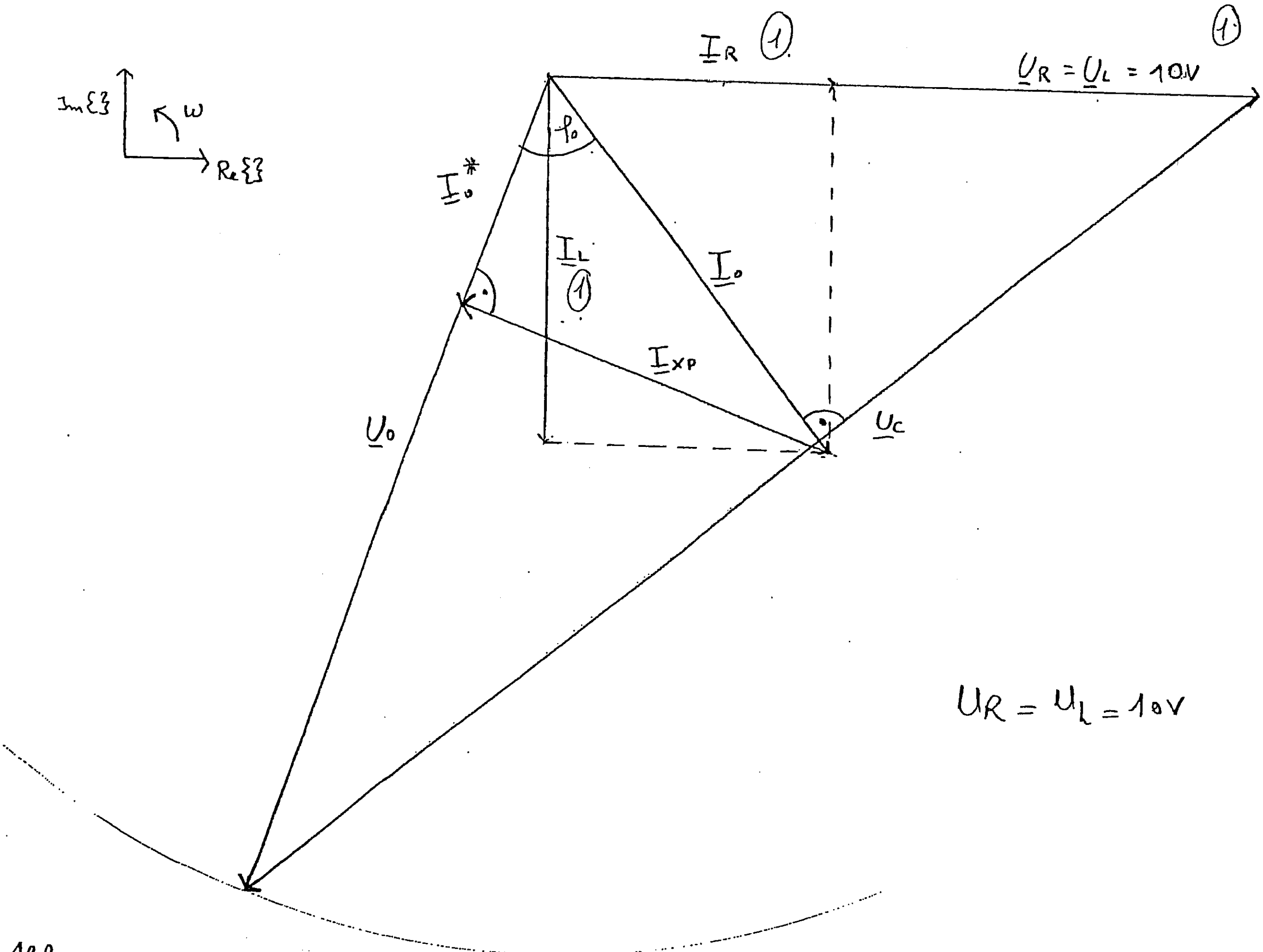
$\rightarrow |\underline{U}_0| = 12\ V$

$\rightarrow \underline{U}_0 = \underline{U}_C + \underline{U}_L = \underline{U}_C + \underline{U}_R$

$\rightarrow \underline{I}_0 = \underline{I}_R + \underline{I}_L$ & $|\underline{I}_R| \perp |\underline{I}_L|$

Maßstab: $1V \hat{=} 1\,cm$ $10\,mA \hat{=} 1\,cm$

$$|\underline{I}_0| = \sqrt{|\underline{I}_R|^2 + |\underline{I}_L|^2} = \sqrt{(40\,mA)^2 + (50\,mA)^2} = 64{,}03\,mA \quad (1)$$



$U_R = U_L = 10V$

Ablesen:

$\varphi_0 = 59°$ (1)

$|\underline{U}_C| = 18V$ (1)

$\Sigma 6$

$$C = \frac{|\underline{I}_0|}{\omega \cdot |\underline{U}_C|} = \frac{64 \cdot 10^{-3}\,A}{2 \cdot 10^3 \frac{1}{s} \cdot 18\,V} = 1{,}778\ \mu F \quad (1)$$

(3)

$|\underline{U}_0| = 12\,V$

$|\underline{I}_0| = 64\ mA$

$\varphi_0 = 59°$

(1) => Scheinleistung: $S = |\underline{U}_0| \cdot |\underline{I}_0| = 12\,V \cdot 64\,mA$

$= 0{,}768\,W$

(1) => Wirkleistung: $P = |\underline{U}_0| \cdot |\underline{I}_0| \cdot \cos\varphi_0 = 12\,V \cdot 64\,mA \cdot \cos 59°$

$= 0{,}3955\ W$

(1) => Blindleistung $Q = |\underline{U}_0| \cdot |\underline{I}_0| \cdot \sin\varphi_0 = 12\,V \cdot 64\,mA \cdot \sin 59°$

$= 0{,}6583\ W$

e) U_0 kapazitiv belastet => X_p muss eine Induktivität sein.

Σ3 $\cos(\varphi_0^*) = 1 \Leftrightarrow \varphi_0^* = 0$ $\quad U_0$ und I_0^* in Phase (1)

$\Rightarrow |\underline{I}_{xp}| \overset{!}{=} |\underline{I}_0| \cdot \sin\varphi_0 = 64\,mA \cdot \sin 59° = 54{,}86\ mA$ (1)

(oder aus Graph ablesen)

$|\underline{U}_{xp}| = |\underline{U}_0| = \omega L \cdot |\underline{I}_{xp}| \qquad X_p = \frac{|\underline{U}_0|}{|\underline{I}_{xp}|} = 218{,}74\ \Omega$

$$L = \frac{|\underline{U}_0|}{\omega\,|\underline{I}_{xp}|} = \frac{12\,V}{2 \cdot 10^3 \frac{1}{s} \cdot 54{,}86\,mA} = 109{,}37\ mH \quad (1)$$

$|\underline{I}_0^*| = |\underline{I}_0| \cdot \cos \varphi_0 = 64\,mA \cdot \cos 59° = 32{,}96\,mA$

(oder aus Graph ablesen)

$\varphi_0^* = 0°$

$\rightarrow \quad S^* = |\underline{U}_0| \cdot |\underline{I}_0^*| = 0{,}3955\,W$ (1)

$\rightarrow \quad P^* = S^* = 0{,}3955\,W$ (1)

$\rightarrow \quad Q^* = 0$ (1)

Aufgabe (8)

20 punkte

a) Series schaltung :-

$$Z = R + jwL_1 + \frac{1}{jwC_1}$$

(1)

$$Z = R + j\left(wL_1 - \frac{1}{wC_1}\right).$$

b)

b1) $w_0 L_1 = \frac{1}{w_0 C_1} \Rightarrow w_0 = \frac{1}{\sqrt{L_1 C_1}}$ (1).

b2) $w_0 = \frac{1}{\sqrt{\cancel{100} \cdot 10^{-3} \cdot \cancel{10} \cdot 10^{-6}}} = 10^3$ rad/sec (1)

b3) $\underset{(series)}{Q} = \frac{1}{w_0 RC} = \frac{1}{10^3 \cdot 500 \cdot 10 \cdot 10^{-6}} = 0.2$ (1)

b4) Rhein Resonance fall (1)

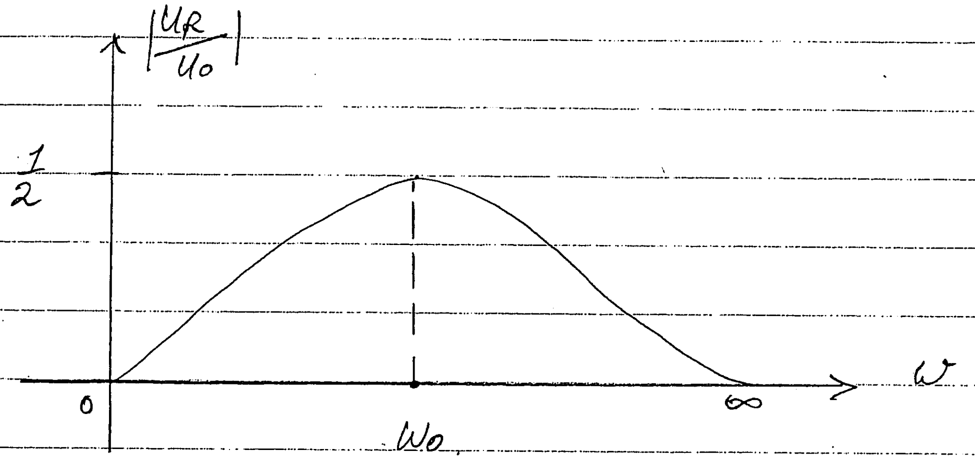
b5)

$$\frac{U_R}{U_0} = \frac{R}{R + j\left(\omega L_1 - \frac{1}{\omega C_1}\right) + R_i}$$ (1)

- $\omega = 0 \Rightarrow \frac{U}{U_0} = 0$ (1)
- $\omega = \omega_0$, $R = R_i \Rightarrow \frac{U}{U_0} = \frac{1}{2}$ (1)
- $\omega = \infty \Rightarrow \frac{U}{U_0} = 0$ (1)

c)

2//

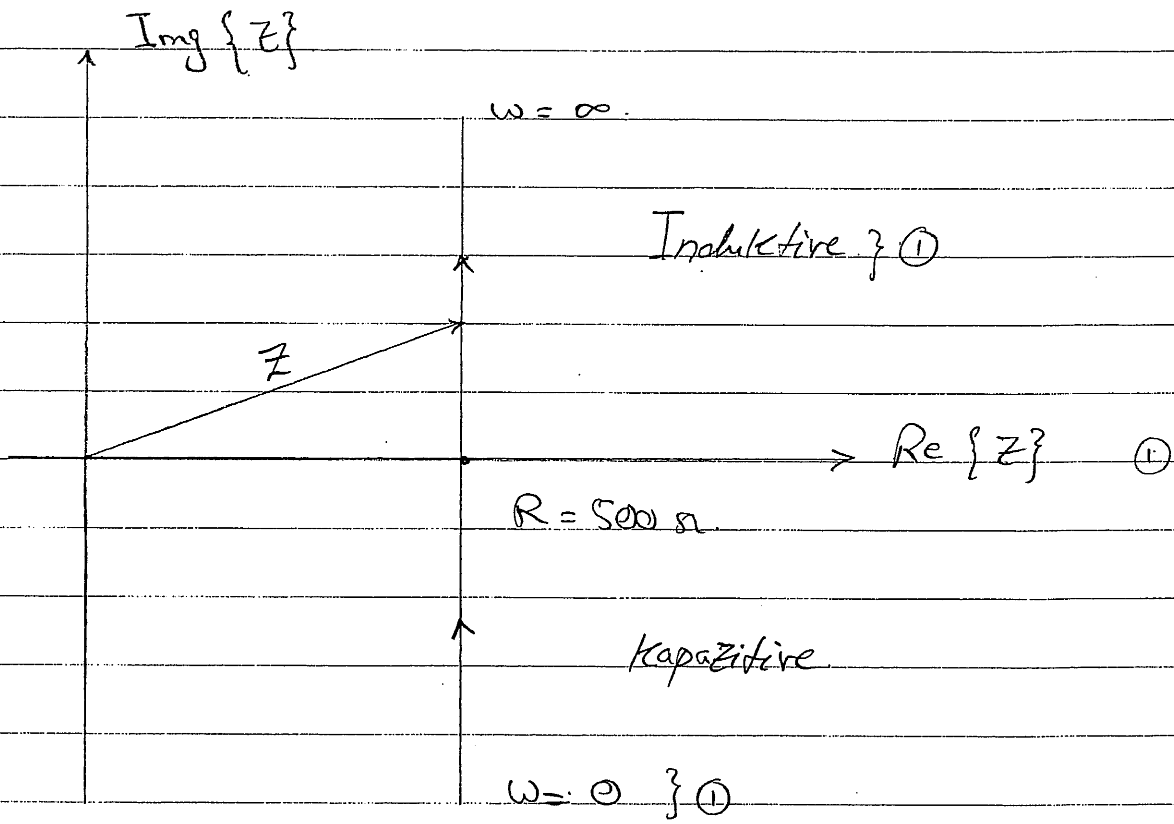


(2)

l)

$$Z = R + j\left(\omega L_1 - \frac{1}{\omega C_1}\right)$$

$$= \begin{cases} \omega = 0 \rightarrow Z = R - j\infty & ① \\ \omega = \omega_0 \rightarrow Z = R & ① \\ \omega = \infty \rightarrow Z = R + j\infty & ① \end{cases}$$



f) $\omega_0^* = 1000$ rad/sec

$Q^* = 2$

$\cdot\ \omega_0^* = \dfrac{1}{\sqrt{L_2 C_2}} \qquad \therefore \quad L_2 C_2 = 10^{-6} \qquad (1)$

$*\ Q^*_{(parallel)} = R\sqrt{\dfrac{C_2}{L_2}} = 2 \qquad (2)$

$\therefore \quad \cancel{500} * \left(\sqrt{\left(\dfrac{C_2}{L_2}\right)}\right)^2 = \left(\dfrac{2}{500}\right)^2$

$\dfrac{C_2}{L_2} = \left(\dfrac{4}{25}\right) \cdot 10^{-4} \longrightarrow (2)$

$\therefore \quad (L_2)(L_2)\left(\dfrac{4}{25}\right)\left(\cancel{10^{-4}}\right) = 10^{-6}$

$(L^2)\left(\dfrac{4}{25}\right) = 10^{-2}$

$L_2^2 = \left(\dfrac{1}{\cancel{100}_4}\right)\left(\dfrac{\cancel{25}^1}{4}\right)$

$L_2^2 = \dfrac{1}{16} \qquad \therefore \quad L_2 = \dfrac{1}{4}$

$\underline{\underline{L_2 = 0.25\ H}}$

$\underline{\underline{C_2 = 4\ \mu F}}$