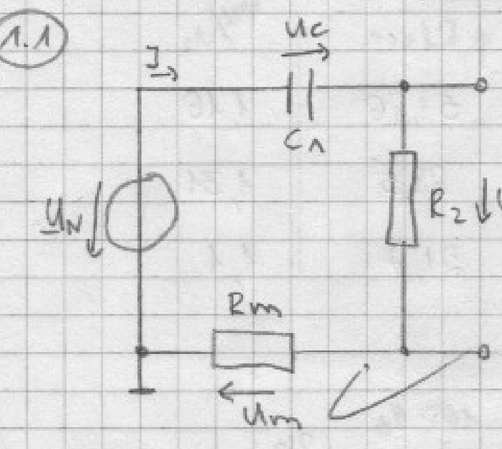
Protokoll PK2 |501d|

(1.1)



$C_1 = 1\mu F$

$R_2 = 2k\Omega$

$\underline{U}_N = 7V$

$\varphi =$

$f = 50\ Hz$

$Z_C = \frac{1}{j\omega C_1} = 3\,183{,}1\Omega$

$I = \frac{U_N}{Z_{ges.}} = 1{,}86mA \quad |Z|_{ges} = \sqrt{R_2^2 + \left(\frac{1}{j\omega C_1}\right)^2} = 3759{,}27\Omega$

$U_2 = R_2 \cdot I = \frac{R_2 \cdot U_N}{|Z|_{ges.}}$ $\qquad u_C = Z_C \cdot I = 5{,}927V$

$U_2 = 3{,}72V$

$\varphi = \arctan \frac{Im}{Re} = \arctan \frac{\frac{1}{j\omega C_1}}{R_2}$

$\varphi = 57{,}86°$

wenn U_N Gleichspannung ⇒ $f = 0$ ⇒ $\lim_{f \to 0} \underline{U}_2 = \frac{U_N \cdot R_2}{\infty} = \underline{\underline{0}}$

(1.2)

f [Hz]	gemessen [V] U_N	U_C	U_2	errechnet [V] U_N	U_C	U_2	rel. Meßfehler [%] U_N	U_C	U_2
50	7,14	6,16	3,53		5,93	3,72		3,73	5,1
100	7,07	4,35	5,4		4,4	5,48		1,1	1,46
200	7	2,66	6,5		2,61	6,50		1,92	0,77
0	0	0	0		0	0			

rel. Meßfehler = $\frac{\text{absol. Meßfehler}}{\text{Messwert}}$

50Hz Δt = 3 ms

100Hz Δt = 1,1 ms

200Hz Δt = 0,3 ms

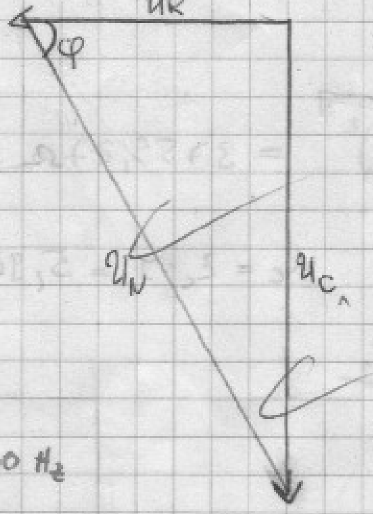
Phasenverschiebung

1.2

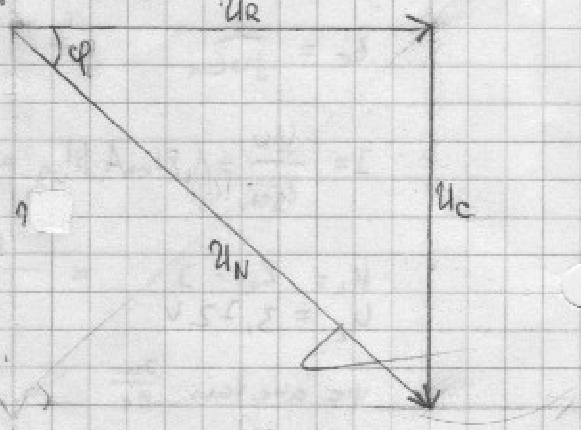
	f [Hz]	φ [°] Oszi	φ [°] gra	φ [°] err.	U_N/U_2
	50	54	60	51,86	1,16
Δt=1,1ms	100	39,6	42	38,5	1,31
Δt=0,3ms	200	21,6	22	21,7	1,1

Fuhrt. Maßstab 1mm = 1mV

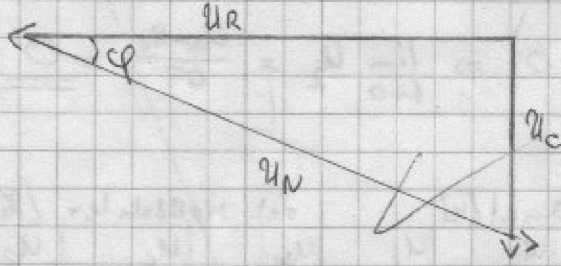
f = 50 Hz



f = 100 Hz



f = 200 Hz

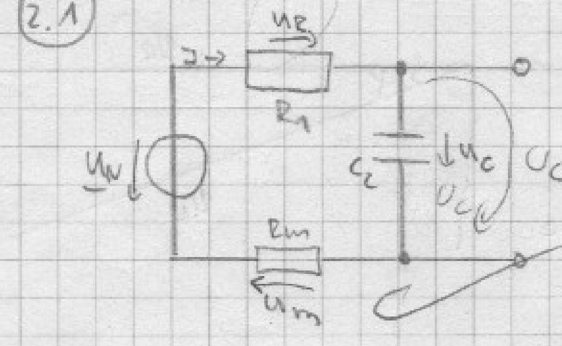


φ zu f siehe Blatt (3)

(1.3) – als Hochpass, oberhalb der Grenzfrequenz werden Signale/Töne durchgelassen; Unterdrückung tiefer Frequenzen

– Kompensation von Blindleistung

(2.1)



$R_1 = 1k\Omega$

$C_2 = 22\mu F$

$U_N = 7V$

$f = 50\,Hz$

$I = \frac{U_N}{|Z_{ges}|}$ $\quad |Z|_{ges.} = \sqrt{R_1^2 + \left(\frac{1}{2\pi f C_2}\right)^2}$

$|Z|_{ges.} = 1958{,}8\,\Omega$

$I = 4\,mA$

$U_C = \frac{1}{2\pi f C_2} \cdot I = 5{,}76\,V$

$\frac{U_C}{U_N} = \frac{\frac{1}{\omega C_2}}{R_1 + \frac{1}{\omega C_2}}$

$\frac{U_R}{U_N}$ $\quad U_R = \frac{U_N \cdot R_1}{Z_{ges}} = 3{,}98\,V$; $\varphi = \arctan \frac{\frac{1}{2\pi \cdot f \cdot C}}{R} = 55{,}34$

Wenn U_N Gleichspannung ⇒ $f = 0$ $\quad \lim_{f \to 0} U_2 = U_N \cdot \infty$

$U_c \approx U_N$

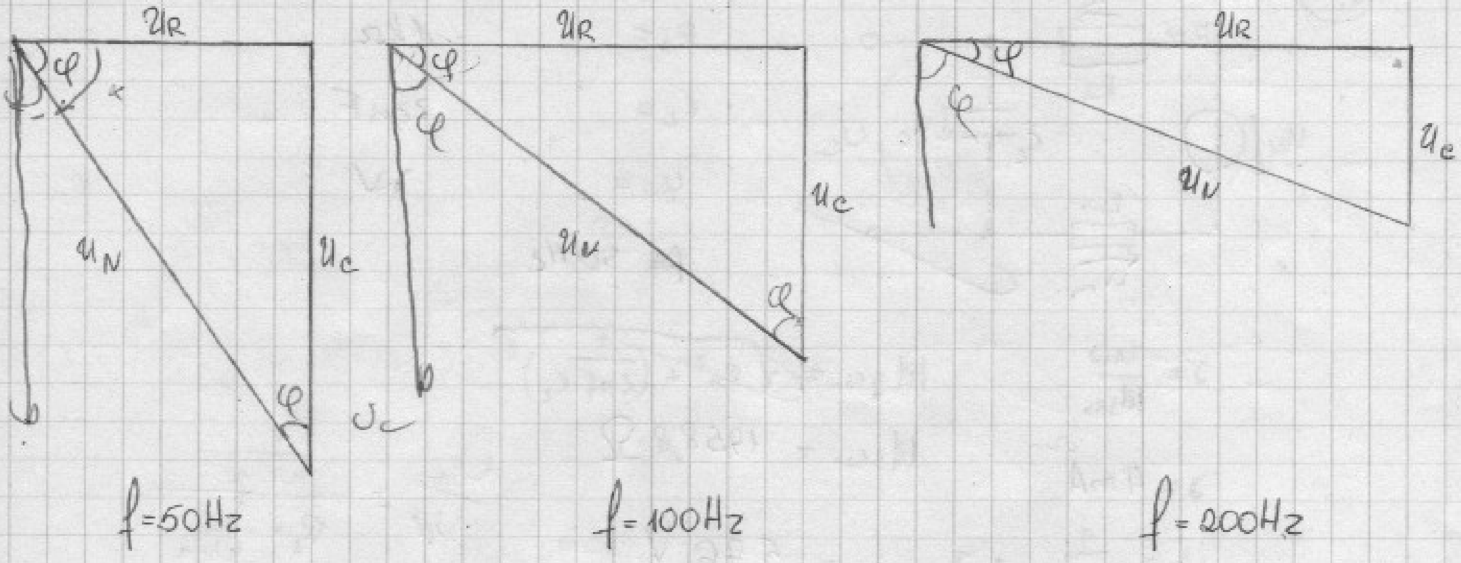
(2.2)

f [Hz]	gemessen [V] U_N	U_C	U_R	errechnet [V] U_N	U_C	U_R	rel Meßfehler [%] U_N	U_C	U_R
50	7,05	5,75	4		5,80	4,01		0,86	0,25
100	6,9	4,15	5,5		4,04	5,71		2,65	3,81
200	6,8	2,4	6,4		2,31	6,63		3,62	3,59
0	7	7	0,4						

Phasenverschiebung:

	f [Hz]	φ [°] Oszi	φ [°] gem.	φ [°] err	U_N/U_C
Δt= 1,9 ms	50	– 34,2	– 55	– 55,35	1,24
Δt= 1,5 ms	100	– 27	– 37	– 35,88	1,66
Δt= 1 ms	200	– 18	– 20	– 19,88	2,83

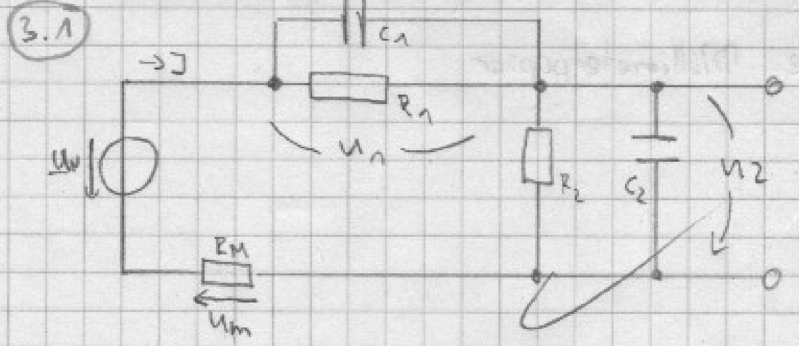
Fnh.

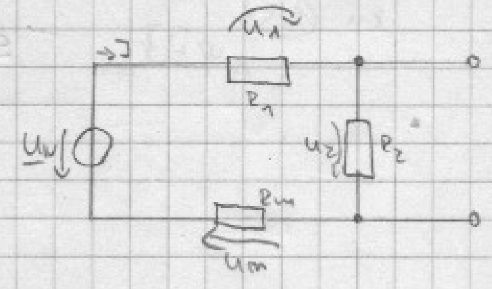


(2.3) - Tiefpass, unterhalb der Grenzfrequenz werden Signale / Töne durchgelassen, höheren Signale werden abgeschwächt.

zu (2.2) siehe Millimeterpapier

3.1





Wechselstrom ~

$$\frac{U_2}{U_N} = \frac{Z_2}{Z_2 + Z_1} \quad Z_1 = \frac{1}{\sqrt{\frac{1}{R_1^2} + \frac{1}{4\pi^2 f^2 C_1^2}}}$$

$$Z_2 = \frac{1}{\sqrt{\frac{1}{R_2^2} + \frac{1}{4\pi^2 f^2 C_2^2}}}$$

$$U_2 = \frac{U_{N_1} Z_2}{Z_1 + Z_2 + R_m}$$

$$\hat{U}_1 = U_2 \sqrt{2}$$

Gleichstrom —

$$I_1 = I_2$$

$$\frac{U_{R_1}}{U_{R_2}} = \frac{R_1}{R_2} \qquad \frac{U_{R_m}}{U_{R_2}} = \frac{R_m}{R_2}$$

$$U_{N_0} = U_{R_1} + U_{R_2}$$

$$U_2 = \frac{U_{N0}}{\frac{R_1}{R_2} - 1 + \frac{R_m}{R_2}}$$

3.2

	f [Hz]	U_{N_0} [V]	U_{M} [V]	U_{R_2} [V]	φ [°] gem.
	0	6,8	2,2	4,5	-0
Δt = 1ms	50	[illegible]7	3,32	4,03	− 18
= 0,25ms	200	6,9	4,57	2,6	− 18
= 0,19	300	6,9	4,68	2,4	− 20,52
= 0,10	400	6,9	4,7	2,3	− 14,4
Δt = 0,65	100	6,9	4,0	3,32	− 23,4

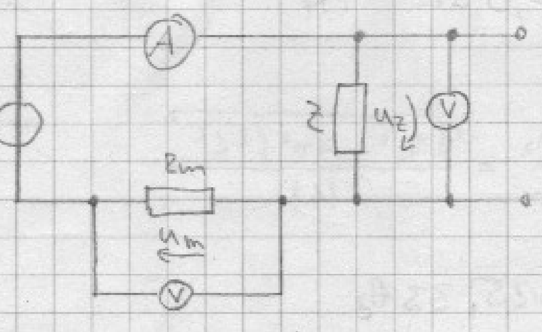
(3.3)

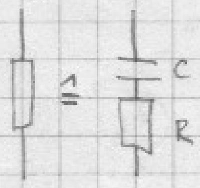
Δt am Oszilloskop ist gleich ⇒

keine Phasenverschiebung.

$u_z(t)$ zeigt kein charakteristisches Rechtecksignal

(4.1)





(4.2)

$U_z = 17{,}08\ V$ $\quad I_z = 4{,}5\ mA$ $\quad \varphi = 72°$

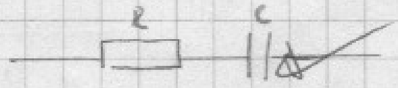
$f = 50\ Hz$ $\quad \Delta t = 4\ ms$

→ Die Spannung eilt der Stromstärke nach

→ passive Zweipol muss ein Kondensator gekoppelt mit einem ohmschen Widerstand sein

$Z_z = R + \frac{1}{j\omega C}$ $\quad Z_z = \frac{U_0}{I_z} = 1573{,}33\ \Omega$

(4.3)



ohm. Widerst. u. Kondensator

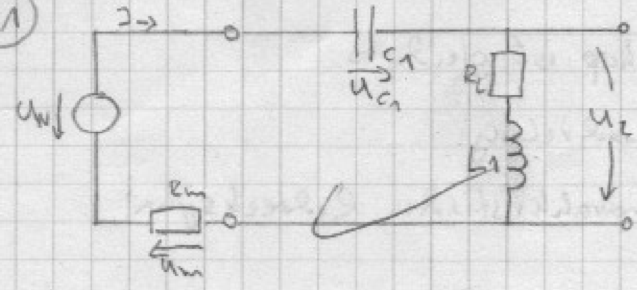
$f = 50\ Hz$ $\quad R = \frac{P}{I^2}$

$\frac{1}{\omega C} = \frac{Q}{I^2}$ $\quad Q = U I \sin\varphi$

$Q = 0{,}030\ var$

$\frac{1}{\omega C} = 1496{,}33\ \Omega$ $\Rightarrow C = \frac{1}{1496{,}33 \cdot \omega}$ $\quad C = 2\ \mu F$

(5.1)



$R_L = 140\,\Omega$
$L_1 = 1H$
$C_1 = 1\mu F$

$\underline{Z} = R_L + (X_L - X_C)$ $\qquad |Z| = 140{,}4\,\Omega$

$= R_L + j\omega L_1 - \frac{1}{j\omega C_1}$

$= 140\Omega + j\left(2\pi\, 160Hz - \frac{1}{2\pi \cdot 160 Hz \cdot 1 \cdot 10^{-6} F}\right)$

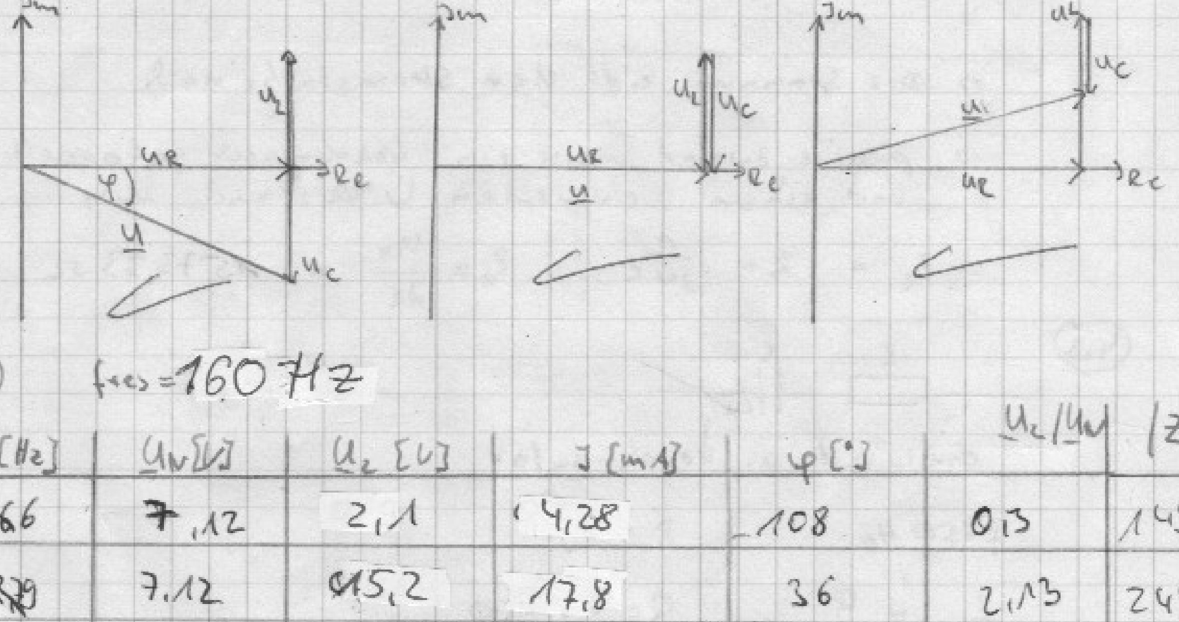
$= 140\Omega + j\; 10{,}6\,\Omega \cdot 1H$

$\frac{U_N}{\underline{Z}} = I =$

$\frac{U_2}{U_N} = \frac{Z_2}{Z} \qquad \frac{U_2}{U_N} = \frac{\sqrt{R_L^2 + 4\pi^2 f^2 L^2}}{|Z|}$

$f_r = \frac{1}{2\pi} \cdot \frac{1}{\sqrt{LC}} = 160\; Hz$

(5.2) 1. $f_N / f_{res} = 0{,}5$ $\qquad$ 2. $f_N/f_{res} = 1$ $\qquad$ 3. $f_N/f_{res} = 2$

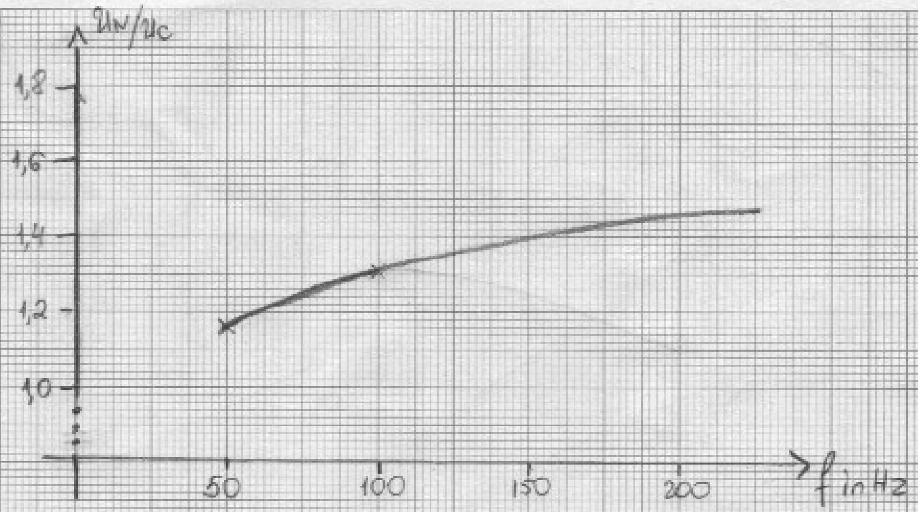


(5.3) $f_{res} = 160\,Hz$

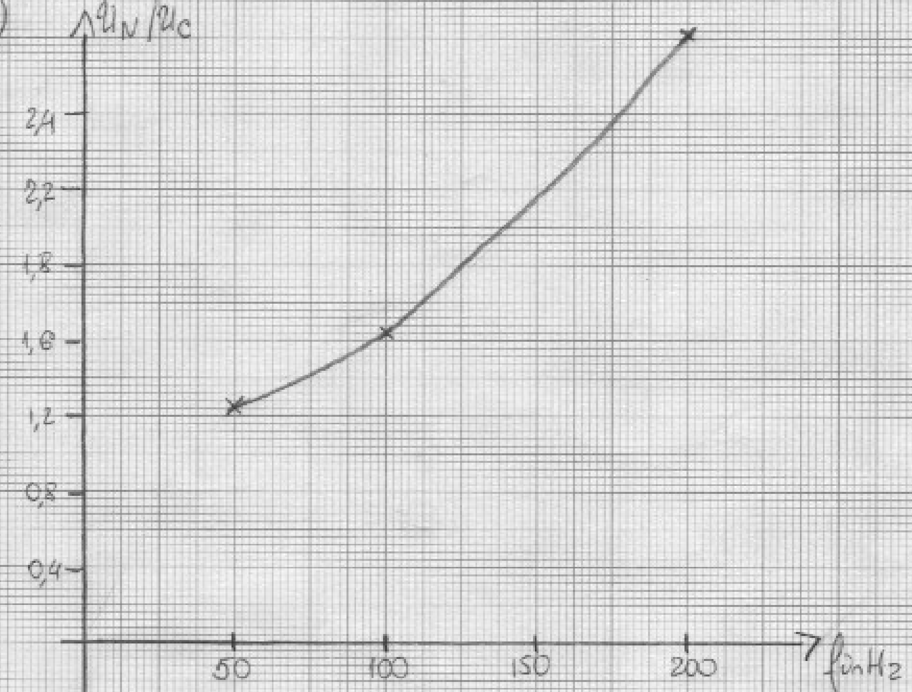
f [Hz]	U_N [V]	U_2 [V]	I [mA]	φ [°]	U_2/U_N	|Z|
80 17,66	7,12	2,1	4,28	-108	0,3	1493 Ω
144 27,9	7.12	15,2	17,8	36	2,13	244 Ω
160 25,33	,6	3,0	30,8	0	4,9	140 Ω
176 27,86	5,8	30,4	28	+43	5,2	255 Ω
320 50,66	7,12	9,72	5,05		1,36	145,7 Ω

Alles ergab 7,5 Punkte !

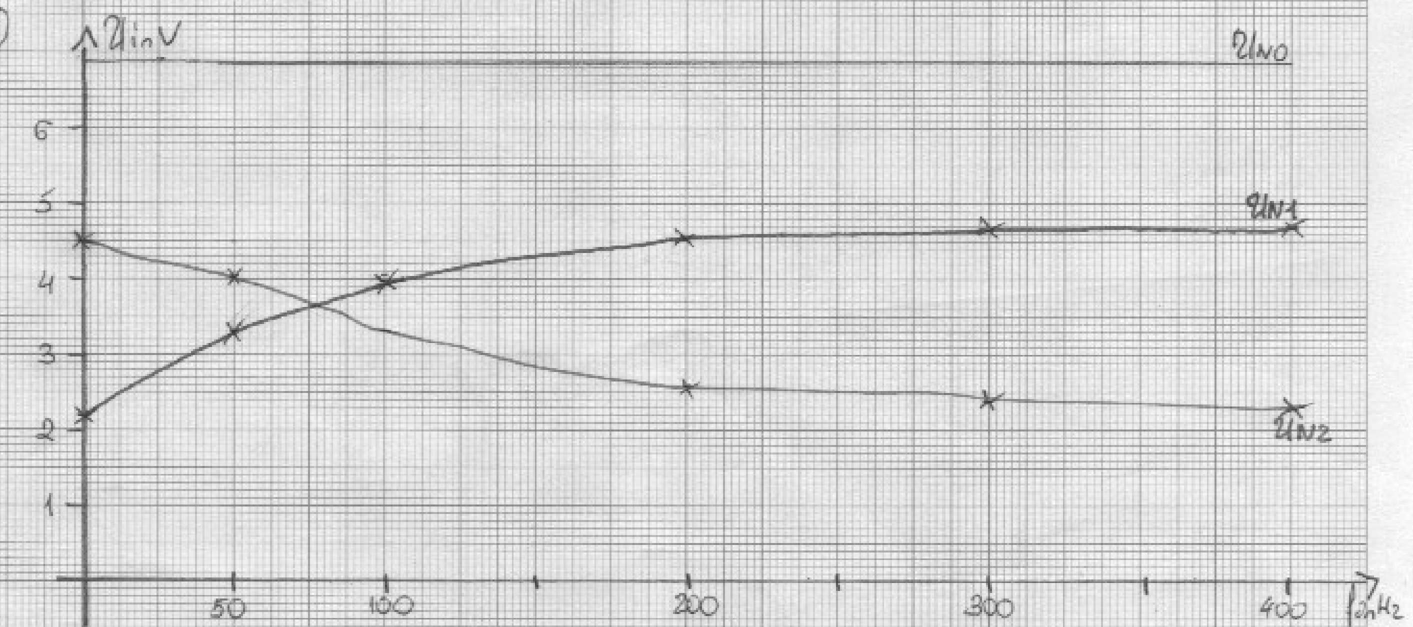
1.2


uN/uC
1,8
1,6
1,4
1,2
1,0
50
100
150
200
f in Hz

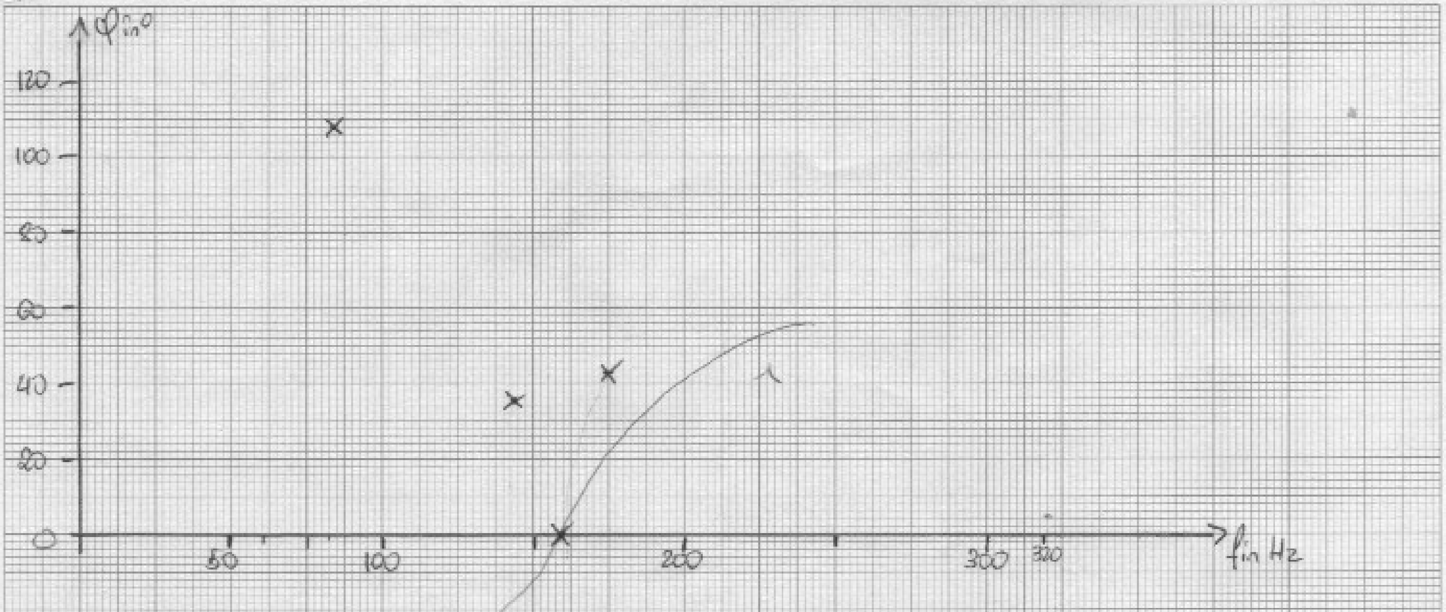
2.2

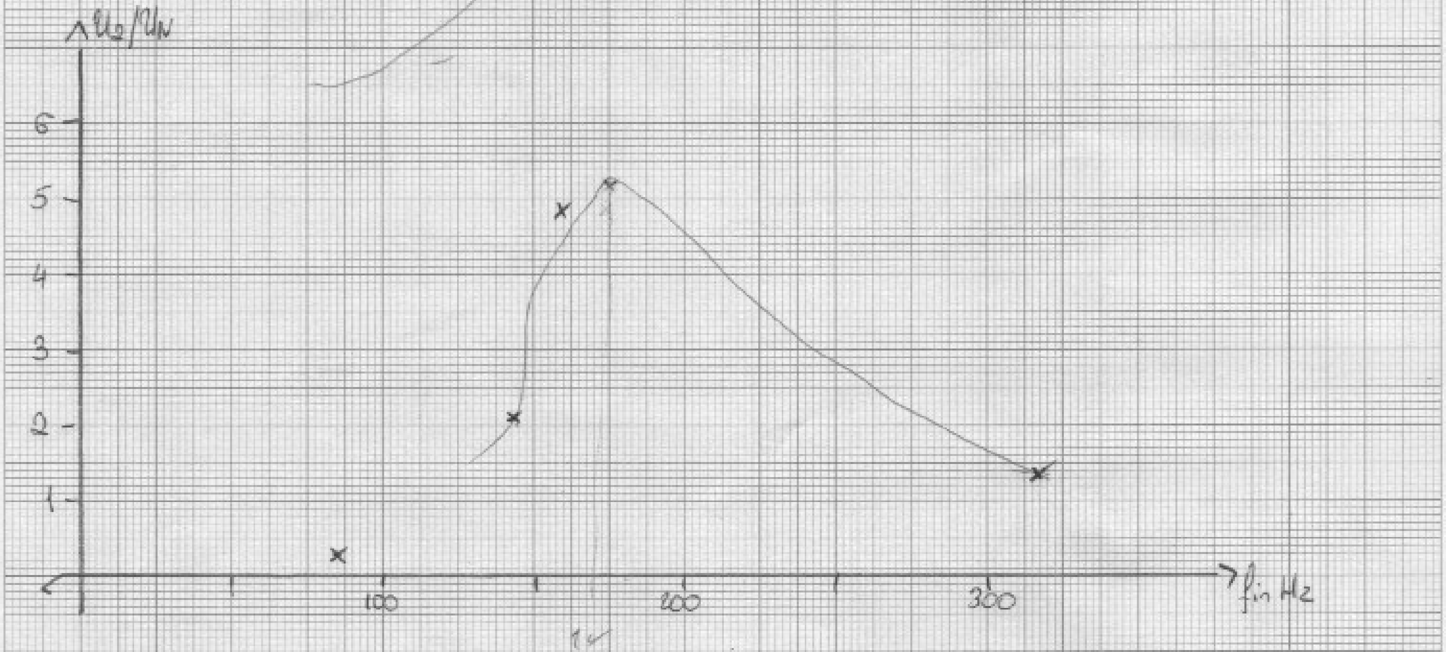

uN/uC
2,4
2,2
1,8
1,6
1,2
0,8
0,4
50
100
150
200
f in Hz

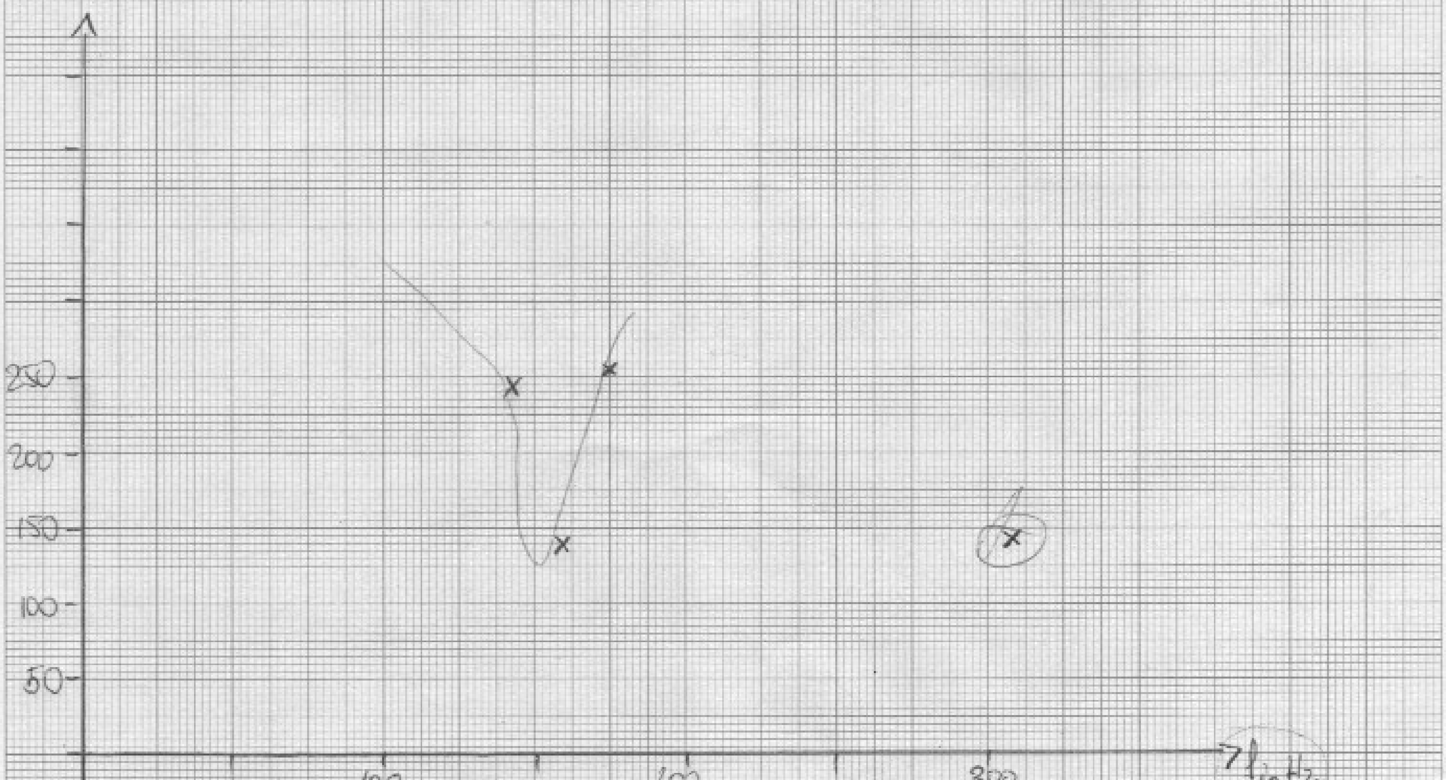
3.2


u in V
uN0
6
5
4
3
2
1
uN1
uN2
50
100
200
300
400
f in Hz

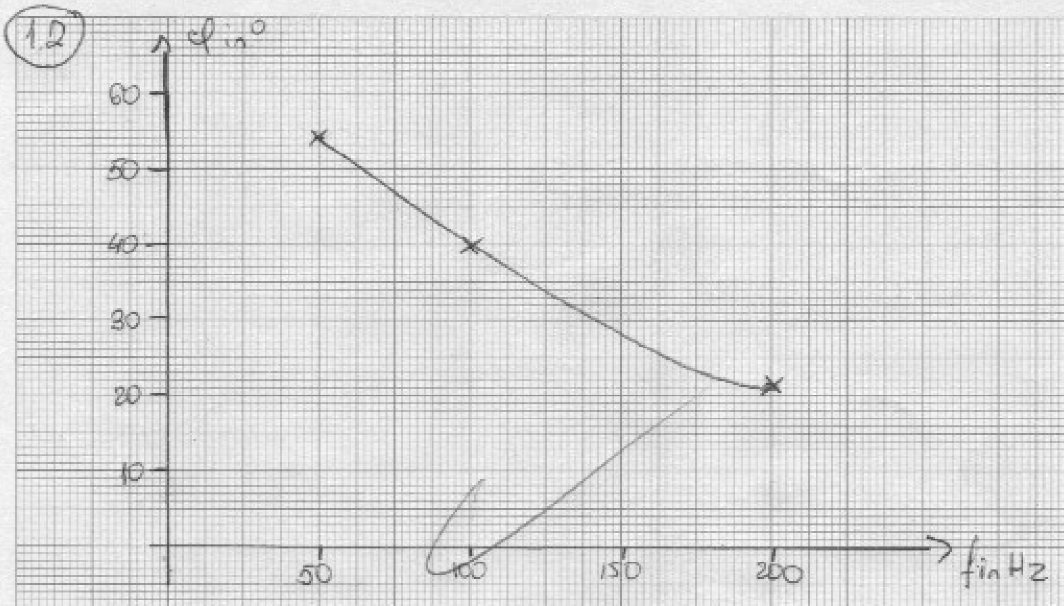
5.3

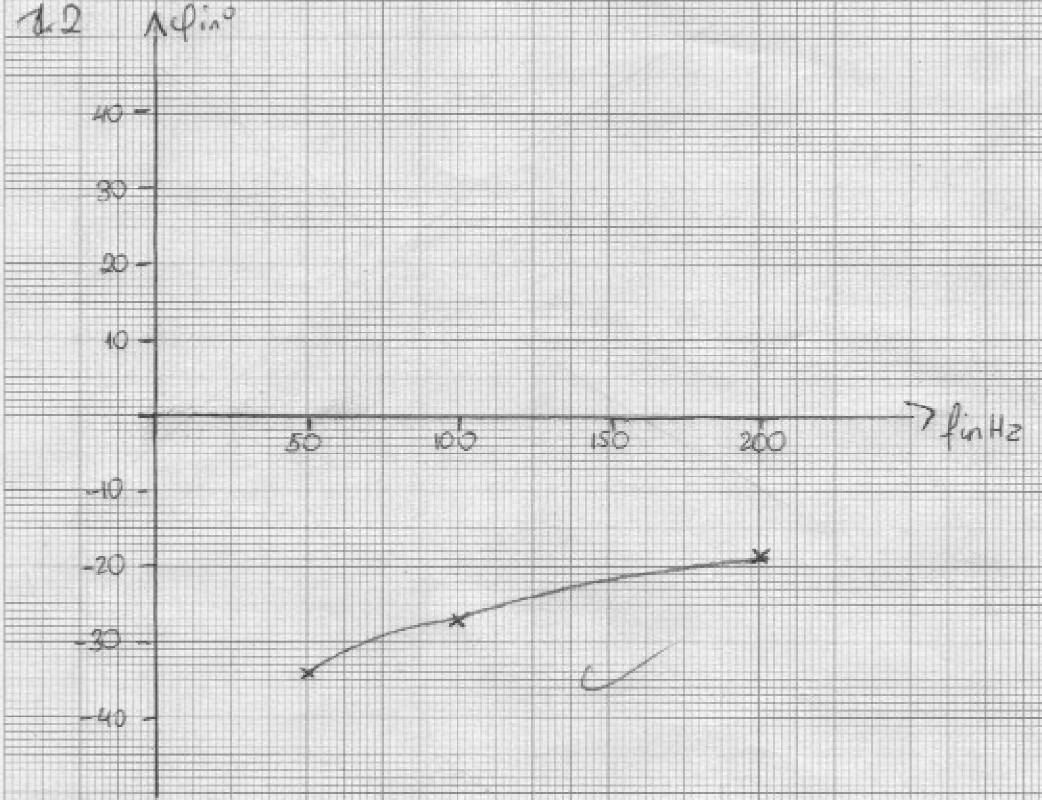

φ in °
120
100
80
60
40
20
0
50
100
200
300
320
f in Hz

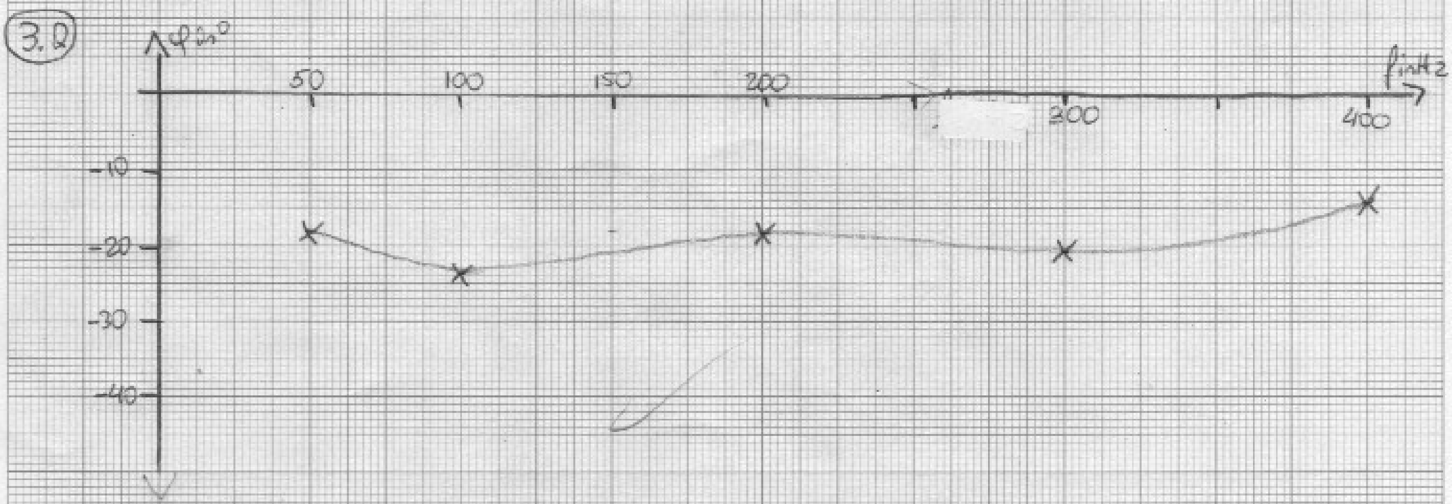

U2/UN
6
5
4
3
2
1
100
200
300
f in Hz


250
200
150
100
50
100
200
300
f in Hz

∅ 7


1.2
φ in °
60
50
40
30
20
10
50
100
150
200
f in Hz


2.2
φ in °
40
30
20
10
-10
-20
-30
-40
50
100
150
200
f in Hz


3.2
φ in °
50
100
150
200
300
400
f in Hz
-10
-20
-30
-40