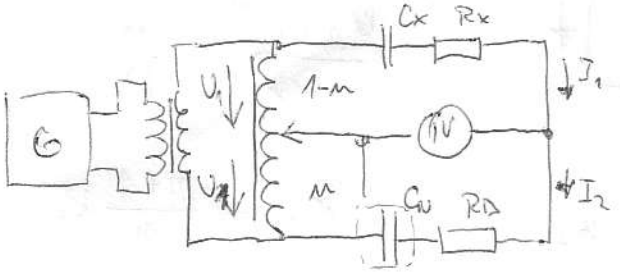
Měření impedance

(37) $C_x = ?$ $\lg\delta = ?$ $f = 2\,kHz$

$C_N = 1\,mF$ $R_D = 1\,k\Omega$ $n = 0{,}45$



$I_1 = I_2$

$$\frac{U_1(1-n)}{R_x + \frac{1}{j\omega C_x}} = \frac{U_1 n}{R_D + \frac{1}{j\omega C_N}}$$

$$C_x = \frac{n}{1-n} C_N \qquad R_x = \frac{1-n}{n} R_D$$

$$C_x = \frac{0{,}45}{1-0{,}45} \cdot 1\cdot 10^{-9} = 818\,nF$$

$$R_x = \frac{1-0{,}45}{0{,}45} \cdot 1\cdot 10^{3} = 1{,}22\,k\Omega$$

$$\lg\delta = \frac{1}{Q} = \frac{1}{\frac{1}{C_x\omega}{R_x}} = \frac{R_x}{C_x 2\pi f} =$$

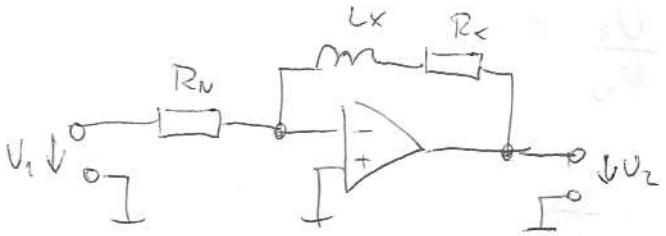
$$= \frac{1222}{818\cdot 10^{-12}\cdot 2\pi\cdot 2\cdot 10^{3}} =$$

$$= R_x C_x \omega = 1222 \cdot 818\cdot 10^{-12}\cdot 2\cdot\pi\cdot 2\cdot 10^{3} =$$

$$= 0{,}01256$$

ZÁK (38) $L_x = ?$ $R_x = ?$

$R_N = 1\,k\Omega$ $U_1 = 1V$ $Re\,U_2 = -0{,}2V$ $Im\,U_2 = 0{,}72V$ $f = 159{,}2\,Hz$



$$\frac{U_1}{R_N} = \frac{-U_2}{\omega L_x + R_x}$$

$$U_1 \frac{\omega L_x + R_x}{R_N} = -U_2$$

$$\omega L_x + R_x = \frac{-U_2}{U_1} R_N$$

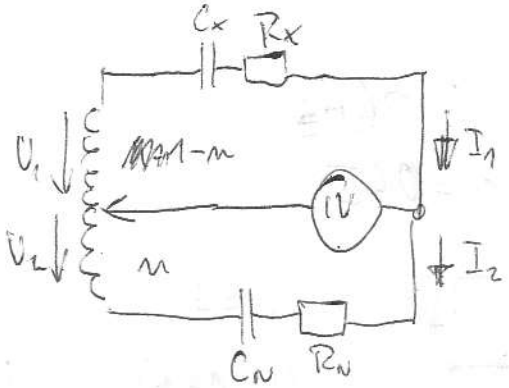
$$L_x = \frac{-Im\{U_2\}}{U_1} R_N \frac{1}{2\pi f}$$

$$R_x = \frac{-Re\{U_2\}}{U_1} R_N$$

$$\omega L_x = \frac{-U_2}{U_1} R_N \Rightarrow L_x = \frac{-Im\{U_2\}}{U_1} R_N \frac{1}{2\pi f} = \frac{+0{,}72}{1} \cdot 1\,10^{3} \frac{1}{2\pi\,159{,}2} = 0{,}721$$

$$R_x = \frac{-U_2}{U_1} R_N \Rightarrow R_x = \frac{-Re\{U_2\}}{U_1} R_N = \frac{+0{,}2}{1}\cdot 10^{3} = 200\,\Omega$$

(39) C_x a $\operatorname{tg}\delta_x$



$$\frac{U_1(1-n)}{\frac{1}{\omega C_x}+R_x} = \frac{U_2 n}{\frac{1}{\omega C_N}+R_N}$$

$$\frac{1-n}{R_x} = \frac{n}{R_N}$$

$C_N = 1\,\mu F$

$R_1 = 100\,k\Omega$

$f = 159{,}2\,Hz$

$n = 0{,}75$

$$R_x = \frac{1-n}{n} R_N$$

$$C_x = \frac{n}{1-n} C_N$$

$$R_x = \frac{1-0{,}75}{0{,}75} 100\cdot 10^3 = 33{,}3\,k\Omega$$

$$C_x = \frac{0{,}75}{1-0{,}75}\cdot 10^{-9} = 3\,nF$$

$$\operatorname{tg}\delta = R_x C_x \omega = 33{,}3\cdot 10^3 \cdot 3\cdot 10^{-9}\cdot 2\pi\, 159{,}2 = 0{,}1$$

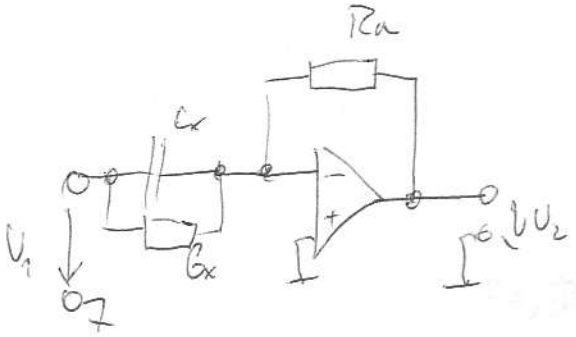
(40) $R_N = 10\,k\Omega$ $\quad \operatorname{tg}\delta = ?$

$U_1 = 10V$ $\quad C_x = ?$

$\operatorname{Re} U_2 = -0{,}4V$

$\operatorname{Im} U_2 = -5{,}2V$

$f = 10\,kHz$



$$\frac{U_1}{\frac{1}{\omega C_x + G_x}} = -\frac{U_2}{R_N}$$

$$U_1(\omega C_x + G_x) = -\frac{U_2}{R_N}$$

$$G_x = \frac{-\operatorname{Re}\{U_2\}}{R_N U_1} = \frac{0{,}4}{10\cdot 10^3\cdot 10} = 4\,\mu S \qquad C_x = \frac{-\operatorname{Im}\{U_2\}}{R_N\, 2\pi f\, U_1}$$

$$C_x = \frac{5{,}2}{10\cdot 10^3\cdot 2\pi\cdot 10\cdot 10^3\cdot 10} = 827{,}6\,nF$$

$$\operatorname{tg}\delta = \frac{1}{Q} = \frac{1}{\frac{Z}{X}} = \frac{1}{\frac{\omega C_x}{G_x}} = \frac{G_x}{\omega C_x} = \frac{4\cdot 10^{-6}}{2\pi\, 10\cdot 10^3\cdot 827{,}6\cdot 10^{-12}} =$$

$$= 0{,}0769$$

(41)

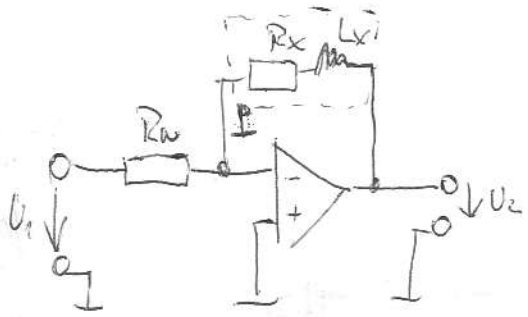
$R_N = 10\,k\Omega$

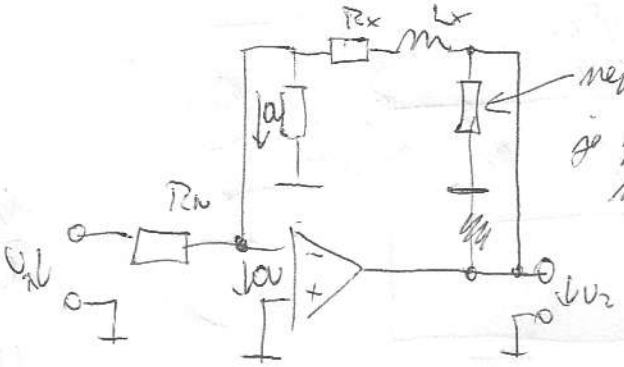
$U_1 = 1V$

$Re\,U_2 = -0{,}03V$

$Im\,U_2 = -0{,}6V$

$f = 1\,kHz$





nepřijmí se jiličkou je propojen na + svorku napětí

$$\frac{U_1}{R_N} = -\frac{U_2}{R_x + \omega L_x}$$

$$R_x + \omega L_x = -\frac{U_2}{U_1} R_N$$

$$R_x = -\frac{Re\,U_2}{U_1} R_N \qquad \omega L_x = -\frac{Im\,U_2\,R_N}{U_1}$$

$$R_x = +\frac{0{,}03}{1}\,10\cdot 10^3 = 300\,\Omega \qquad L_x = \frac{0{,}6\cdot 10\cdot 10^3}{1\cdot 2\pi\,10^3} = 0{,}955\,H$$

(42)

C_x

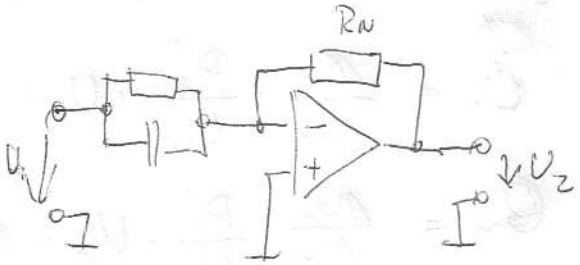
$R_N = 10\,k\Omega$

$U_1 = 10V$

$Re\,U_2 = -0{,}2V$

$Im\,U_2 = -6{,}3V$

$f = 1592$



$$\frac{U_1}{\frac{1}{G_x + \omega C_x}} = -\frac{U_2}{R_N}$$

$$(G_x + \omega C_x) U_1 = -\frac{U_2}{R_N}$$

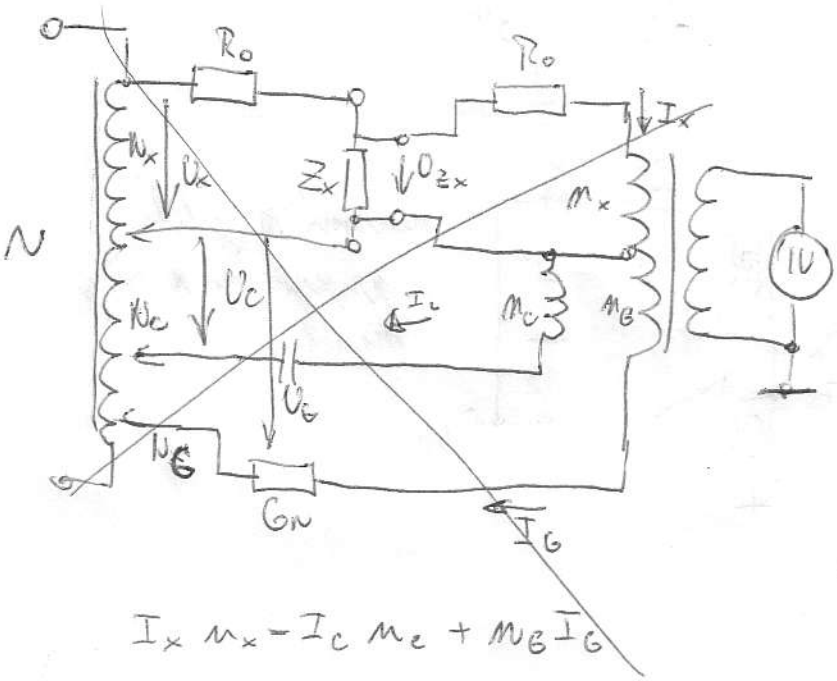
$$G_x = -\frac{Re\{U_2\}}{U_1 R_N} \qquad C_x = \frac{-Im\{U_2\}}{U_1 \omega R_N}$$

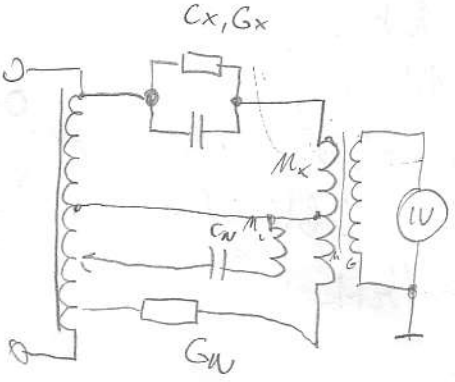
$$tg\,\delta = \frac{1}{Q} = \frac{1}{\frac{\omega C_x}{G_x}} = \frac{G_x}{\omega C_x} \qquad G_x = 2\,\mu S \qquad C_x = 6{,}29\,nF$$

$$= \frac{6{,}29\cdot 10^{-9}\cdot 2\cdot 10^{-6}}{2\pi\cdot 1592\cdot 6{,}29\cdot 10^{-9}} = 0{,}03178$$

(43) $C_x = ?$

$G_x = ?$





$$\frac{U_x}{U_c} = \frac{N_x}{N_c}$$

$$\frac{U_x}{U_G} = \frac{N_x}{N_G}$$

$$I_x m_x - I_c m_c + m_G I_G$$

$$\frac{U_x}{R_0 + Z_x} \cdot \frac{m_x Z_x}{R_0} = U_c j\omega C_N m_c + U_G G_N m_G$$

$$Z_x = \frac{1}{G_x} + \frac{1}{j\omega C_x}$$

$$U_x \frac{\frac{1}{G_x} + \frac{1}{j\omega C_x}}{R_0^2}$$

$$m_x \frac{U_x}{R_0^2 + R_0(R_x + j\omega L_x)}$$

pokud $\frac{R_0}{|Z_x|} \gg 2$ viz (232)

$$m_x \frac{U_x}{R_0^2} (G_x + j\omega C_x) = m_G U_G G_N + m_c U_c j\omega C_N$$

$$C_x = \frac{m_c}{m_x} \cdot \frac{R_0^2}{U_x} \cdot U_c = \frac{m_c}{m_x} \cdot \frac{N_c}{N_x} \cdot R_0^2 C_N$$

$$G_x = \frac{m_G}{m_x} \cdot \frac{R_0^2}{U_x} \cdot U_G = \frac{m_G}{m_x} \cdot \frac{N_G}{N_x} \cdot R_0^2 G_N$$

$C_N = 10\,mF$ $R_N = 1\,\Omega$ $m_x = 10$ z $m_c = m_G = 100$

$N_c/N_x = 0{,}4$ $N_G/N_x = 0{,}72$

$$R_x = \frac{100}{10} \cdot 0{,}72 \cdot \frac{(1\,\Omega)^2}{1\,\Omega} = 7{,}2\,\Omega$$

(53)

$\Delta U_2 = 1{,}2\,V$ $\quad N_2 = 100$

$B_m = ?$ $\quad S_{Fe} = 10\,120\,mm^2 = 0{,}00012\,m^2$

$K_{WB} = 10^{-2}\,Wb/V = 0{,}01\,\frac{Wb}{V}$

~~$U_2 = 4 f S_{Fe} N_2 B_m$~~

$$2B_{max} = \frac{K_{WB}\,\Delta U_{2max}}{S_{Fe}\,N_2} = \frac{0{,}01 \cdot 1{,}2}{0{,}00012 \cdot 100} = 1$$

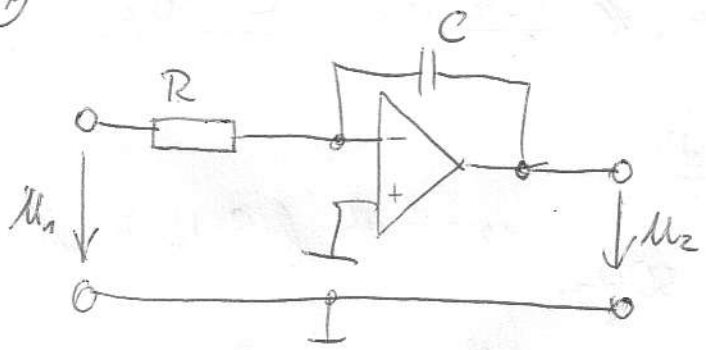
~~$1/2\ U_2 = 4 f S_{Fe} N_2 B_m$~~

$$B_{max} = 0{,}5\,T$$

~~$\Delta U_2 = 4 f S_{Fe} N_2 B_m$~~

~~$B_m = \frac{1{,}2}{4 \cdot 50 \cdot 0{,}00012 \cdot 100} = 0{,}5\,T$~~

(54)



$$C\frac{du_2}{dt} = -\frac{u_1}{R}$$

$$\int \frac{du_2}{dt} = \int -\frac{u_1}{RC}\,dt$$

$$u_2 = -\frac{1}{RC}\int u_1(t)\,dt$$

$K_{WB} = 0{,}001\,Wb/V$

$R = 10\,k\Omega$

$\tau = R \cdot C$ $\quad 0{,}001 = RC \quad 10 \cdot 10^3\,C$

$$\frac{0{,}001}{10 \cdot 10^3} = C = 100\,nF$$

(55) $H_{max} = 120\,\frac{A}{m}$ $\quad D_1 = 70\,mm$ $\quad D_2 = 50\,mm$

$N_1 = 40$ závitů

elektromagnet $\Rightarrow$ efektivní hodnota $\quad I_1 = ?$

$$l = \pi\,\frac{D_1 + D_2}{2} = \pi\,\frac{(0{,}07 + 0{,}05)}{2} =$$

$$= 0{,}06\,\pi$$

$$H = \frac{I_{max} N_1}{l}$$

$$I_{max} = \frac{H l}{N_1} = \frac{120 \cdot 0{,}06\,\pi}{40} = 0{,}5655\,A$$

$$I_1 = \frac{I_{max}}{\sqrt{2}} = 0{,}4\,A$$

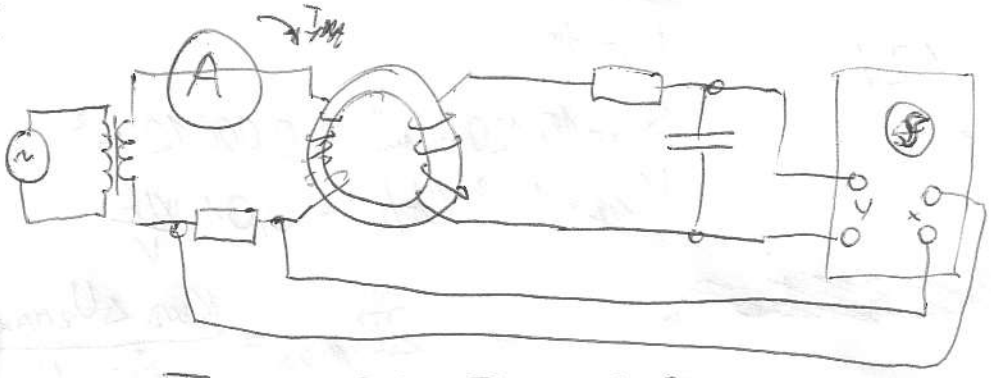
(56) $I_{ef} = 50\,mA = 0{,}05$

$B_{max} = 0{,}5\,T$

$N_1 = 20\,z$

$l_s = 0{,}15\,m$

$\mu_A = \frac{B_{Fe,m}}{\mu_0 H_{Fe,m}}$



$I_{max} = 0{,}05 \cdot \sqrt{2} = 0{,}0707\,A$

$H_{Fe,m} = \frac{I_{max} N_1}{l_s}$

$\mu_A = \frac{B_{Fe,m}}{4\pi \cdot 10^{-7} \cdot \frac{I_{max} N_1}{l_s}} = \frac{0{,}5}{4\pi \cdot 10^{-7} \cdot \frac{0{,}0707 \cdot 20}{0{,}15}} = 42\,202$

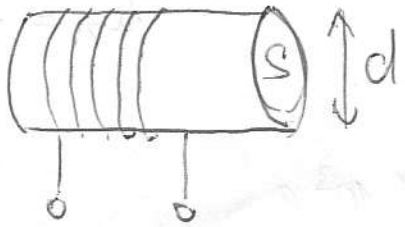
(57) $N = 100\,z$

$d = 100\,mm = 0{,}1\,m \Rightarrow S = \frac{\pi d^2}{4}$

$U = 250\,mV \quad T = 20\,ms \Rightarrow f = 50\,Hz$

$U_{ef} = 4{,}44 \cdot f \cdot S \cdot N \cdot B_{max}$

$B_{max} =$



$\frac{U_{ef}}{4{,}44 \cdot f S \cdot N} = B_{max}$

$\frac{U_{ef}}{4{,}44 \cdot f \cdot N \cdot \pi d^2} = B_{max}$

$\frac{0{,}25}{1{,}11 \cdot 50 \cdot 100 \cdot \pi \cdot 0{,}1^2} = 1{,}43\,mT$

(58) $B_n = ?$

$I_m = 0{,}5\,A \quad I_1 = 0\,A \quad N_2 = 100\,z \quad S_{v2} = 100\,mm^2$

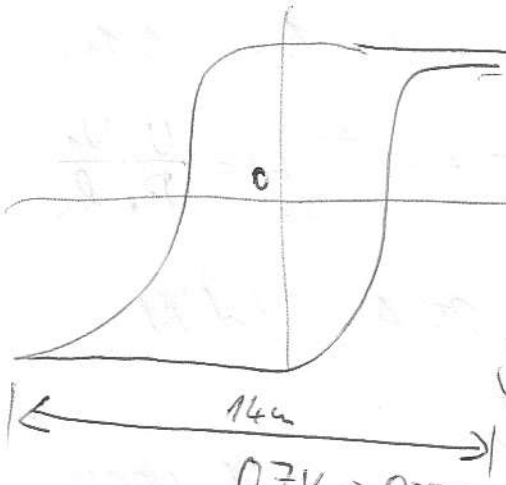
$U_{im1} = 2\,V \quad U_{m1} = -0{,}1\,V \quad K_{wb} = 0{,}01\,Wb/V$

$U_1 = U_{im1} \cdot K_{wb}$

$U_1 = 0{,}02\,V \quad U_1 = U_1 - 0{,}001\,V$

$B = \frac{U_1 K_{wb}}{S_{Fe} N}$

59



$K_x = K_y = 50\,V/cm$

$K_{UxIz} = 10^{-1}\,Wb/A$

$S_{Fe} = 100\,cm^2 = 0,0001$

$l_s = 0,14\,m$

$N_1 = 20z \quad N_2 = 200z$

$$H_{max} = \frac{N_1 I_1}{l_s} = \frac{20 \cdot \left(\frac{14}{3} \cdot 0,05 \cdot 1\right)}{0,14} = 50\,A/m$$

$$B_{max} = \frac{K_{UxIz} \cdot U_{max}}{S_{Fe} N_2} = \frac{0,1 \cdot \frac{8}{2} \cdot 0,05}{0,0001 \cdot 200} = 1\,T$$

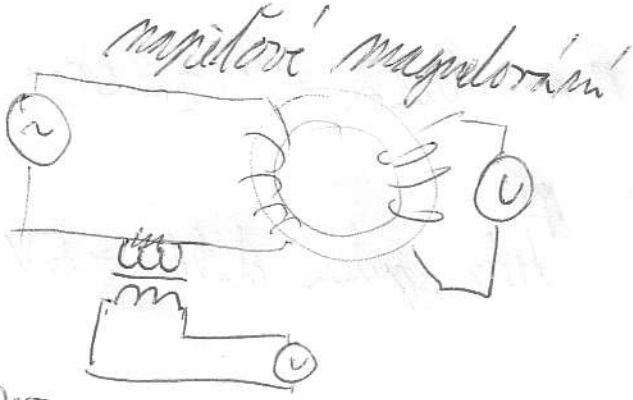
60

$H_{max} = 100\,\frac{A}{m}$ $\quad I_1 = ?$

$D_1 = 55\,mm$

$D_2 = 45\,mm$

$N_1 = 50$



$$l_s = \pi \frac{D_1 + D_2}{2} = \pi \frac{0,055 + 0,045}{2} = \pi\, 0,05$$

$$H_{max} = \frac{N_1 \cdot I_1}{l_s} \qquad I_1 = \frac{H_{max} l_s}{N_1} = \frac{100 \cdot 0,05\pi}{50} = \underline{0,314}$$

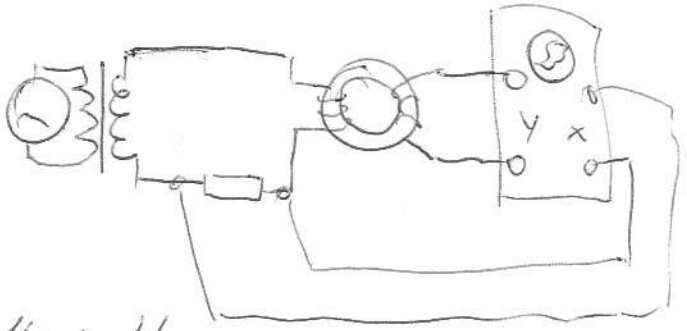
61 $I_{max} = 300\,mA = 0,3A$

$\mu_A = ?$

$B_{max} = 0,6\,T$

$N_1 = 30z$

$l_s = 0,15\,m$



$$B_{max} = \mu_0 \mu H_{max}$$

$$\mu_0 = \frac{I_{max} \cdot N_1}{l_s} = 4\pi \cdot 10^{-7} \frac{0,3 \cdot 30}{0,15} = \frac{0,6}{B_{max}}$$

$$\mu_{rel} = \frac{B_{max}}{\mu_0 \frac{I_{max} N_1}{l_s}} = \frac{0,6}{4\pi \cdot 10^{-7} \frac{0,3 \cdot 30}{0,15}} = 7957$$

(62) OBR. STEJNÝ JAKO U (61)

$l_s = 10\,cm = 0{,}1\,m$

$U_{Hmax} = R_N \cdot I_H = \dots$ ⟵ $H = \frac{I \cdot N_1}{l_s} \Rightarrow H = \frac{U N_1}{R_N l_s}$

$H = \frac{0{,}050 \cdot 50}{1 \cdot 0{,}10} = 25\,A\,m^{-1}/dílek$

(63) OBR. STEJNÝ JAKO U (61)

$f = 400\,Hz$
$N_2 = 100$
$S_{Fe} = 200\,mm^2 = 0{,}0002$

$U_{max} = 4 \cdot f \cdot N_2 \cdot B_{max} \cdot S_{Fe}$

$B_{max} = \frac{U_{max}}{4 f N_2 S_{Fe}} \left[\frac{\frac{U}{dílek}}{\frac{T}{dílek}}\right]$

$B_{max} = \frac{20 \cdot 2 \cdot}{4 \cdot 400 \cdot 100 \cdot 0{,}0002} = 1{,}25\,T$

při $U_{max} = 20 \cdot 2 = 40V$ je $B_{max} = 1{,}25\,T$ a to je 8 dílků

při 1 dílek, jeden dílek $= 5V$ je $B = 156{,}25\,mT$