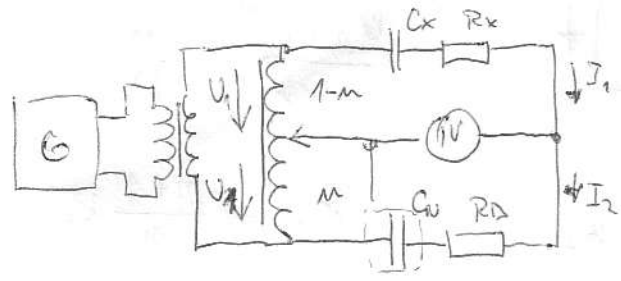


Měření impedanci

37) $C_x = ?$ $\lg \mathcal{D} = ?$ $f = 2 \text{ kHz}$
 $C_N = 1 \text{ nF}$ $R_D = 1 \text{ k}\Omega$ $m = 0,45$



$$I_1 = I_2$$

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

$$C_x = \frac{m}{1-m} C_n \quad R_x = \frac{1-m}{m} R_D$$

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

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

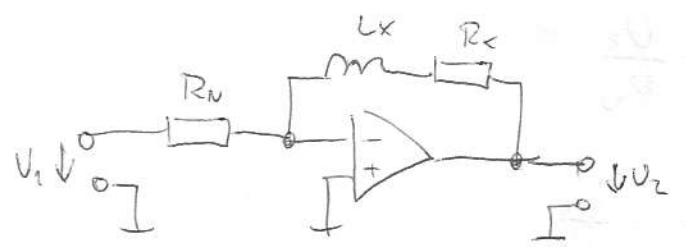
$$\lg \mathcal{D} = \frac{1}{Q} = \frac{1}{\frac{C_x \omega}{R_x} \cdot \frac{R_D}{C_n \omega}} = \frac{R_D}{R_x} \cdot \frac{C_n}{C_x}$$

$$= \frac{1,22 \text{ k}\Omega}{818 \cdot 10^{-9} \cdot 2\pi \cdot 2 \cdot 10^3} = \frac{1,22 \cdot 10^3}{818 \cdot 10^{-9} \cdot 2\pi \cdot 2 \cdot 10^3}$$

$$= R_x C_x \omega = 1,22 \cdot 818 \cdot 10^{-9} \cdot 2\pi \cdot 2 \cdot 10^3 = 0,01256$$

38) $L_x = ?$ $R_x = ?$

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



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

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

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

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

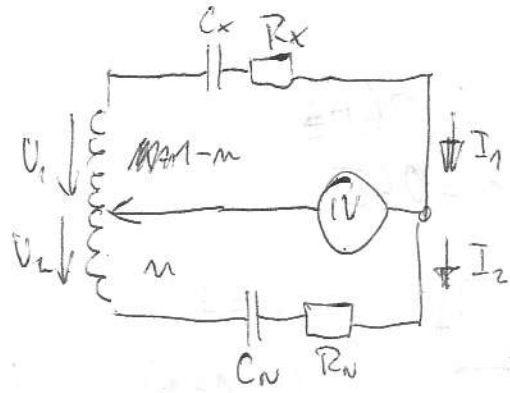
$$\omega L_x + R_x = -\frac{U_2}{U_1} R_N$$

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

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

39) C_x a $\lg \delta_x$

$C_N = 1 \mu F$
 $R_N = 100 k\Omega$
 $f = 159,2 \text{ Hz}$
 $m = 0,75$



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

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

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

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

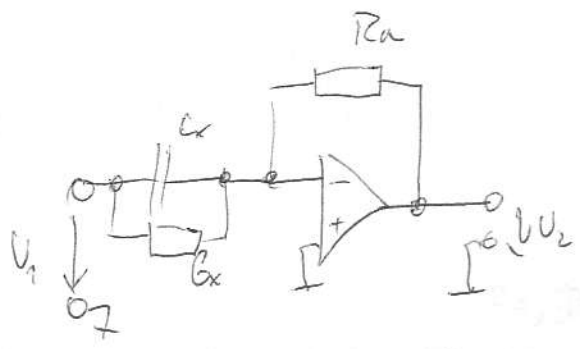
$$C_x = \frac{0,75}{1-0,75} \cdot 10^{-9} = 3 \mu F$$

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

$$\lg \delta = R_x C_x \omega = 333 \cdot 10^3 \cdot 3 \cdot 10^{-9} \cdot 2\pi \cdot 159,2 = 0,1$$

40

$R_N = 10 k\Omega$ $\lg \delta = ?$
 $U_1 = 10V$ $C_x = ?$
 $\text{Re } U_2 = -0,4V$
 $\text{Im } U_2 = -5,2V$
 $f = 10^2 \text{ Hz}$



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

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

$$G_x = \frac{-\text{Re}\{U_2\}}{R_N U_1} = \frac{0,4}{10 \cdot 10^3 \cdot 10} = 4 \mu S$$

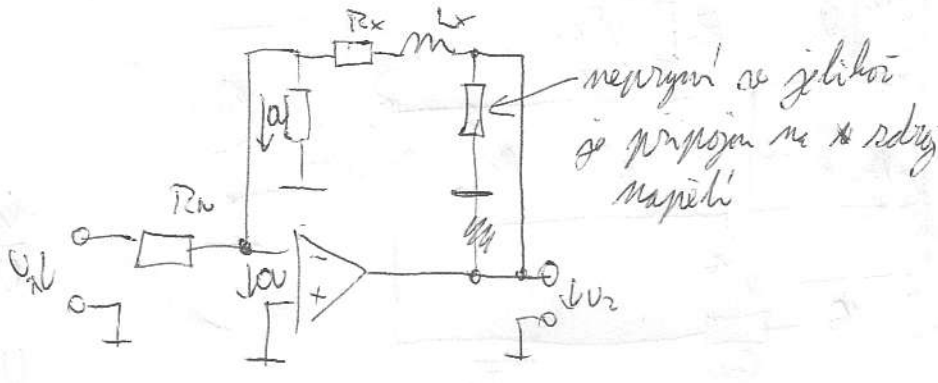
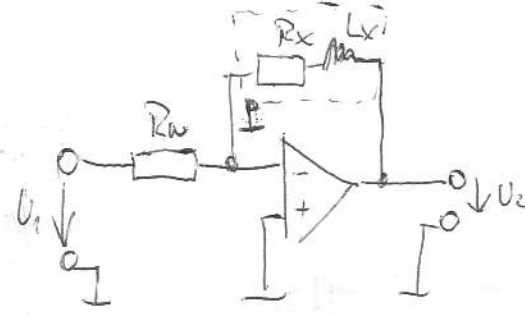
$$C_x = \frac{-\text{Im}\{U_2\}}{R_N 2\pi f U_1}$$

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

$$\lg \delta = \frac{1}{Q} = \frac{1}{\frac{1}{\omega C_x}} = \frac{1}{\frac{1}{G_x}} = \frac{G_x}{\omega C_x} = \frac{4 \cdot 10^{-6}}{2\pi \cdot 10 \cdot 10^3 \cdot 827,6 \cdot 10^{-12}} = 0,0769$$

41

$R_N = 10 \text{ k}\Omega$
 $U_1 = 1 \text{ V}$
 $\text{Re } U_2 = -0,03 \text{ V}$
 $\text{Im } U_2 = -0,6 \text{ V}$
 $f = 1 \text{ kHz}$



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

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

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

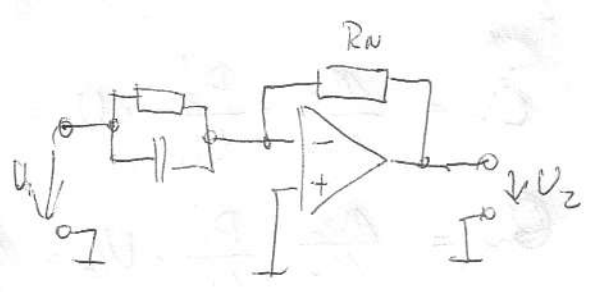
$$\omega L_x = - \frac{\text{Im } U_2 R_N}{U_1}$$

$$R_x = + \frac{0,03}{1} 10 \cdot 10^3 = 300 \Omega$$

$$L_x = \frac{0,6 \cdot 10^{-3}}{1 \cdot 2\pi \cdot 10^3} = 0,955 \text{ H}$$

42

C_x
 $R_N = 10 \text{ k}\Omega$
 $U_1 = 10 \text{ V}$
 $\text{Re } U_2 = -0,2 \text{ V}$
 $\text{Im } U_2 = -6,3 \text{ V}$
 $f = 1592$



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

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

$$G_x = - \frac{\text{Re } U_2}{U_1 R_N}$$

$$C_x = \frac{-\text{Im } U_2}{U_1 \omega R_N}$$

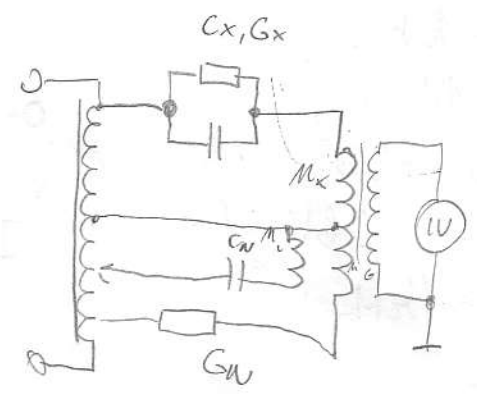
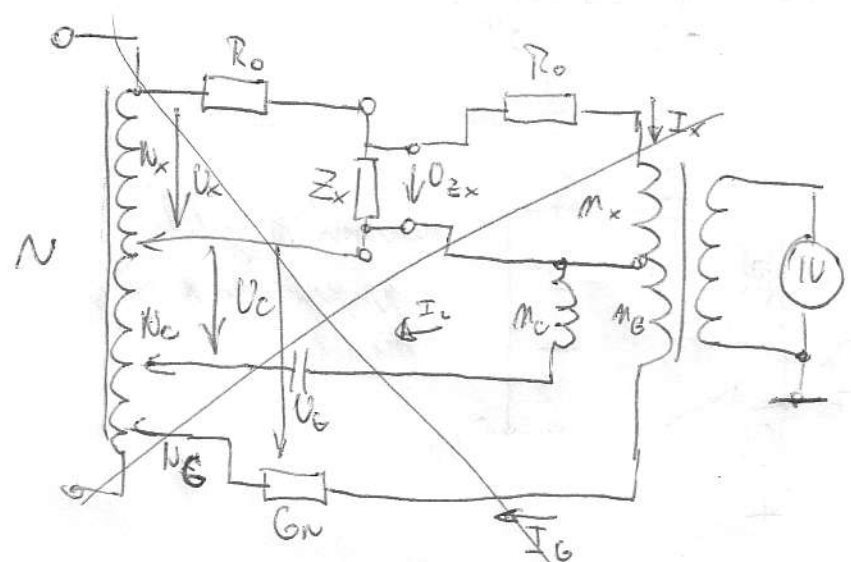
$$\text{tg } \phi = \frac{1}{Q} = \frac{1}{\frac{\omega C_x}{G_x}} = \frac{1}{\omega C_x} = \frac{G_x}{\omega C_x}$$

$$G_x = 2 \mu\text{S}$$

$$C_x = 6,29 \text{ nF}$$

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

43) $C_x = ?$
 $G_x = ?$



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

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

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

$$\frac{U_x}{R_0 + Z_x} m_x Z_x = \frac{U_c}{R_0} m_c Z_x + U_G G_w m_G$$

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

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

$$m_x \frac{U_x (R_0 + j\omega L_x)}{R_0^2 + R_0(R_x + j\omega L_x)} \approx \frac{R_0}{|Z_x|} \gg 2 \quad R_x = 282$$

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

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

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

$C_w = 10 \text{ nF}$ $R_w = 1 \text{ M}\Omega$ $m_x = 10$ $m_c = m_G = 100$

$N_c/N_x = 0.4$ $N_G/N_x = 0.72$

$$R_x = \frac{100}{10} \cdot 0.72 \cdot \frac{(1 \text{ M}\Omega)^2}{1 \text{ M}\Omega} = 7.2 \text{ M}\Omega$$

53

$$\Delta U_2 = 1,2V$$

$$B_m = ?$$

$$N_2 = 100$$

$$S_{V2} = 10 \cdot 120 \text{ mm}^2 = 0,0012 \text{ m}^2$$

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



~~$$U_2 = I \cdot S_{V2} \cdot N_2 \cdot B_m$$~~

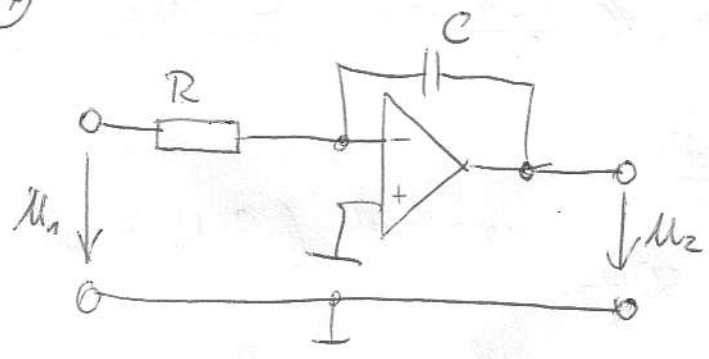
$$2B_{max} = \frac{K_{WB} \Delta U_{2max}}{S_{Fe} N_2} = \frac{0,01 \cdot 1,2}{0,0012 \cdot 100} = 1$$

~~$$1,2 = I \cdot S_{V2} \cdot N_2 \cdot B_m$$~~

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

~~$$\frac{\Delta U_2}{4 \cdot S_{V2} \cdot N_2} = B_m \Rightarrow \frac{1,2}{4 \cdot 10 \cdot 120 \cdot 100} = 0,5 T$$~~

54



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

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

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

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

$$R = 10 \text{ k}\Omega$$

$$T = R \cdot C$$

$$0,001 = 10 \cdot 10^3 \cdot C$$

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

55

$$H_{max} = 120 \frac{\text{A}}{\text{m}}$$

$$D_1 = 70 \text{ mm} \quad D_2 = 50 \text{ mm}$$

$$N_1 = 40 \text{ z}$$

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

elektromagnetijski ⇒ efektivni hodnik $I_1 = ?$

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

$$= 0,06 \pi$$

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

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

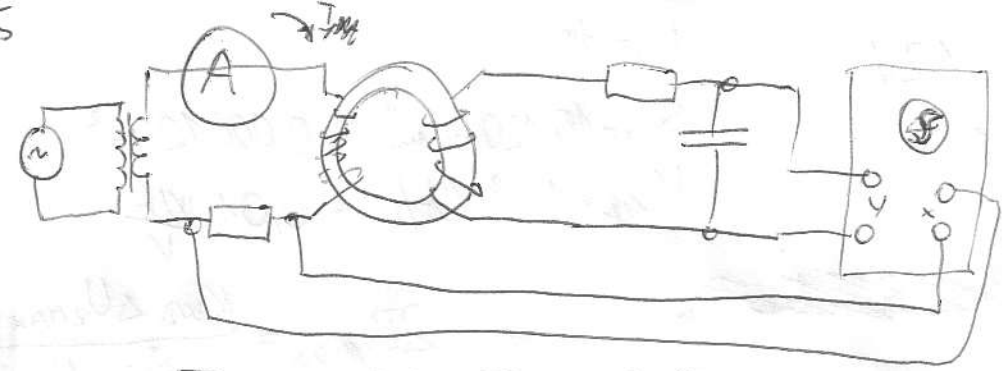
56) $I_{ef} = 50 \text{ mA} = 0,05$

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

$N_1 = 20$

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

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



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

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

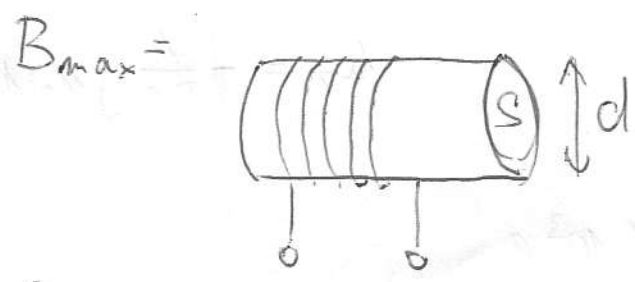
$\mu_A = \frac{B_{Fe,m}}{4\pi \cdot 10^{-7} \cdot \frac{I_{max} N_1}{l_s}} = \frac{0,5}{4\pi \cdot 10^{-7} \cdot \frac{0,0707 \cdot 20}{0,15}} = 42202$

57) $N = 100$

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

$U = 250 \text{ mV} \quad T = 20 \text{ ms} \Rightarrow f = 50 \text{ Hz}$

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



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

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

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

58) $B_n = ?$

$I_m = 0,5 \text{ A}$

$I_1 = 0 \text{ A}$

$N_2 = 100$

$S_{V2} = 100 \text{ mm}^2$

$U_{int} = 2 \text{ V}$

$U_{int} = -0,1 \text{ V}$

$K_{wb} = 0,01 \text{ Wb/V}$

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

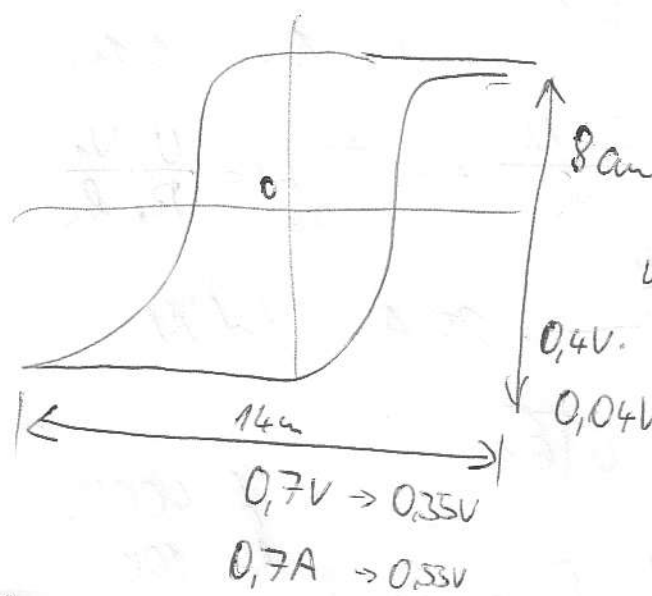
$U_1 = 0,02 \text{ V}$

$U_1 = -0,001 \text{ V}$

$B_n = ?$

$B = \frac{U_1 \cdot K_{wb}}{S_{V2} \cdot N}$

59



$k_x = k_y = 50 \text{ mV/cm}$

$K_{\text{WB}} = 10^{-7} \text{ Wb/N}$

$S_{\text{VZ}} = 100 \text{ mm}^2 = 0,0001$

$l_s = 0,14 \text{ m}$

$N_1 = 20 \text{ z} \quad N_2 = 200 \text{ z}$

$$H_{\text{max}} = \frac{N_1 \cdot I_1}{l_s} = \frac{20 \cdot \left(\frac{14}{2} \cdot 0,05 \cdot 1\right)}{0,14} = 50 \text{ A/m}$$

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

60

$H_{\text{max}} = 100 \frac{\text{A}}{\text{m}}$

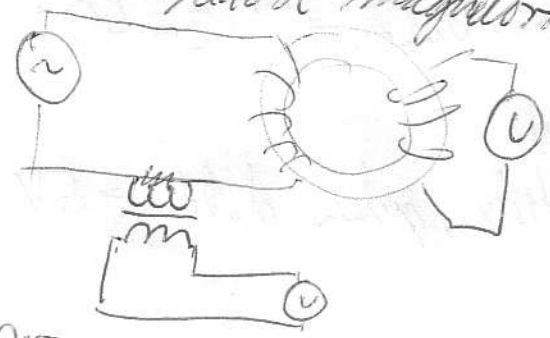
$I_1 = ?$

$D_1 = 55 \text{ mm}$

$D_2 = 45 \text{ mm}$

$N_1 = 50$

napitove mapelotanim



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

$$H_{\text{max}} = \frac{N_1 \cdot I_1}{l_s}$$

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

61

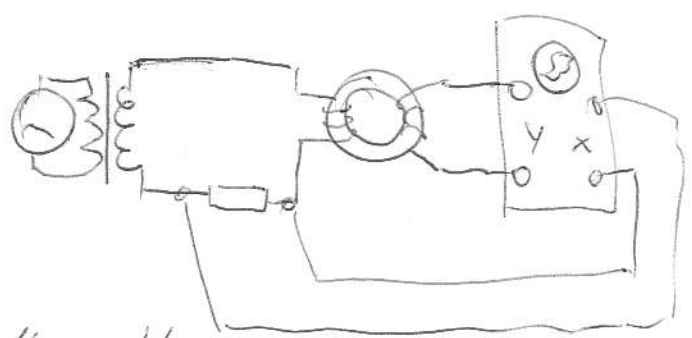
$I_{\text{max}} = 300 \text{ mA} = 0,3 \text{ A}$

$\mu_A = ?$

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

$N_1 = 30 \text{ z}$

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



$B_{\text{max}} = \mu_0 \mu_A H_{\text{max}}$

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

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

62) OBR. STEJNÍ JAKO U 61) $l_s = 10\text{m} = 0,1\text{m}$

$$U_{\text{max}} = R_N \cdot I_H = \dots \quad H = \frac{I \cdot N_1}{l_s} \Rightarrow H = \frac{U N_1}{R_N l_s}$$

$$H = \frac{0,050 \cdot 1050}{1 \cdot 0,10} = 25 \text{ A m}^{-1} / \text{dílek}$$

63) OBR. STEJNÍ JAKO U 61)

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

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

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

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

U při $U_{\text{max}} = 20 \cdot 2 = 40 \text{ V}$

$B_{\text{max}} = 1,25 \text{ T}$ a to je 8 dílek

pro každý, jeden dílek = 5V

$$B = 156,25 \text{ mT}$$