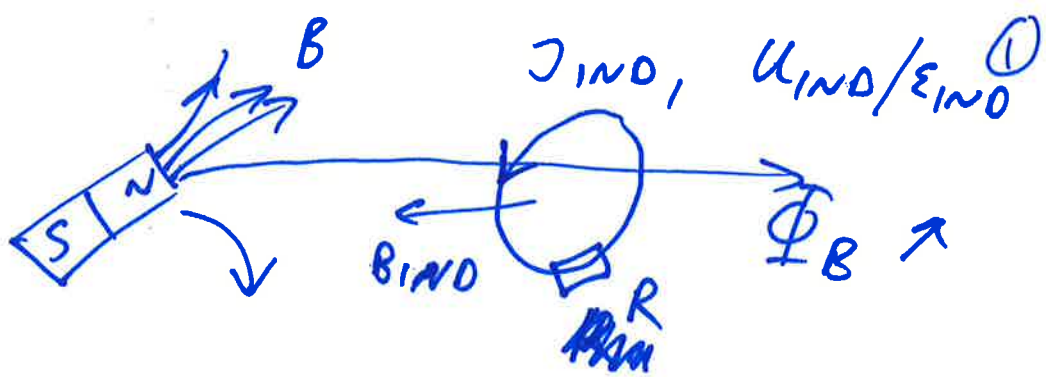
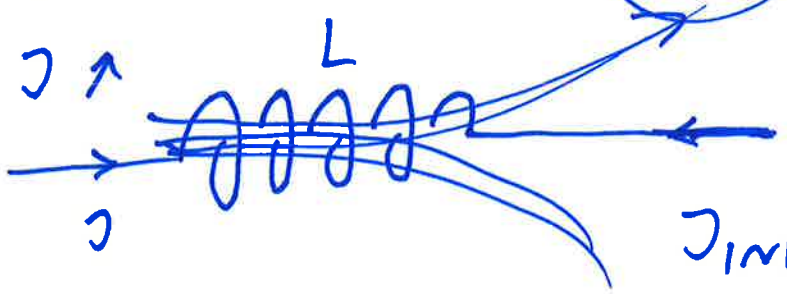


INDUKTIO:  
INTEGRALU



ITSEINDUKTANSI:



$[L] = H$  HENRY

$$J_{IND} = \frac{U_{IND}}{R} = -L \frac{\Delta J}{\Delta t}$$

$$= \frac{1}{R} \left( -L \frac{\Delta J}{\Delta t} \right)$$

$$U_{IND} = -L \frac{\Delta J}{\Delta t}$$

JOHTO: BIOT-SAVART

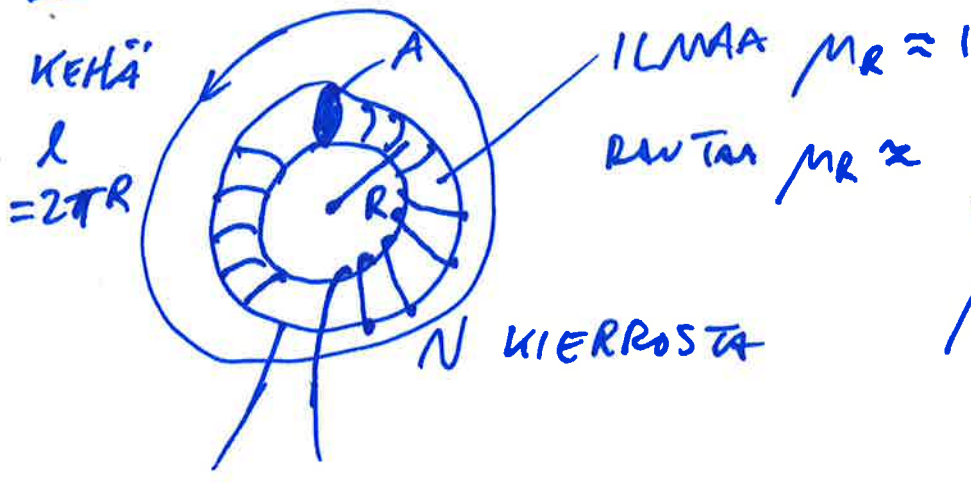
$$J = \frac{1}{L} \Phi \Rightarrow \frac{\Delta J}{\Delta t} = \frac{1}{L} \frac{\Delta \Phi}{\Delta t} = -L U_{IND}$$

$$\Rightarrow U_{IND} = -L \frac{\Delta J}{\Delta t}$$

INDUKTIOLAKI:  $U_{IND} = - \frac{\Delta \Phi}{\Delta t}$

ESIM. TOROIDI KÄÄMINNÄ L

(2)



$$\mu_0 = 4\pi \cdot 10^{-7} \frac{N}{A^2}$$

$$= 1.25 \frac{\mu N}{A^2}$$

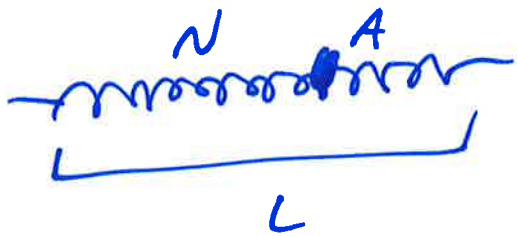
AMPERE (ESIM. 3.8)

$$B = \frac{\mu_0 N I}{2\pi R}$$

$$\Phi = N B A = \frac{\mu_0 N^2 I A}{2\pi R}$$

$$L = \frac{\Phi}{I} = \frac{\mu_0 N^2 A}{2\pi R} = \frac{\mu_0 N^2 A}{l}$$

SO LENOI DI

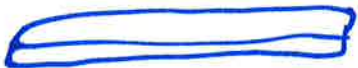


$$L \approx \frac{\mu_0 N^2 A}{l}$$

SÄMPYLÄ



SO DEKOIDI



LASKE 4.25

~~LASKE~~

4.30

(a) LOPULLINEN TASA VIRTA

(3)

$$I = 1.2 \text{ A}$$

$$U = RI \Rightarrow R = \frac{U}{I} = \frac{6.2 \text{ V}}{1.2 \text{ A}} \approx 5 \Omega$$

(b) INDUKTIIVINEN VIRTA KASVUA HIDASTEN LAAGA

$$U_{\text{IND}} = -L \frac{\Delta I}{\Delta t} = -L \frac{0.4 \text{ A}}{40 \text{ ms}} = \frac{0.1 \text{ A}}{1 \text{ ms}}$$

$$= \frac{0.4 \text{ A}}{40 \text{ ms}} = \frac{0.1 \text{ A}}{1 \text{ ms}} = 100 \frac{\text{A}}{\text{s}}$$

$$I(40 \text{ ms}) = 0.8 \text{ A}$$

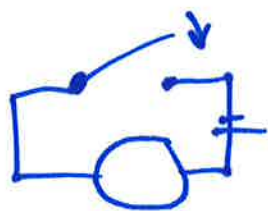
$$U_{\text{KOK}} = RI = 5 \Omega \cdot 0.8 \text{ A} = 4 \text{ V}$$

$$\Rightarrow E_{\text{IND}} = -2.2 \text{ V}$$

~~muutos~~

$$L = \frac{-U_{\text{IND}}}{\frac{\Delta I}{\Delta t}} = \frac{2.2 \text{ V}}{\frac{0.4 \text{ A}}{40 \text{ ms}}} = \frac{2.2 \text{ V}}{100 \frac{\text{A}}{\text{s}}} = 0.022 \text{ H}$$

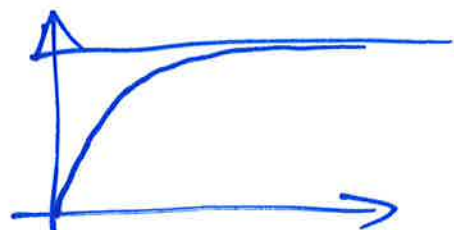
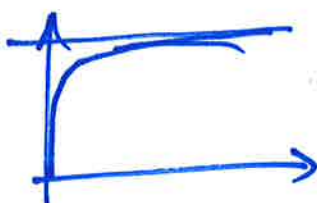
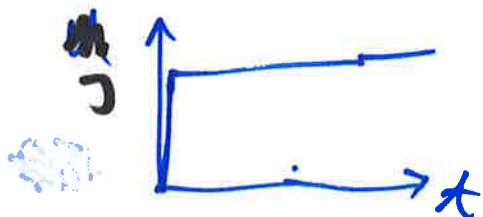
$$= \underline{\underline{22 \text{ mH}}}$$



VASTUS

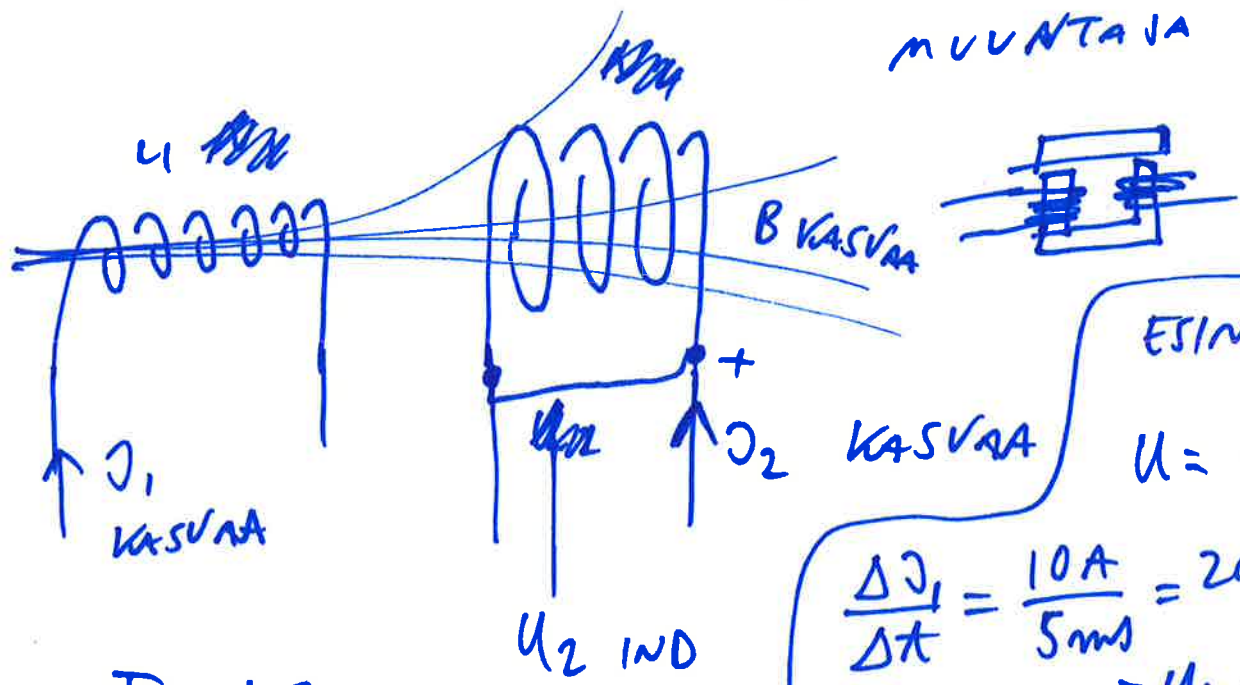
HEIKKO  
KA'Ä'Ä'Ä'

VÄHVA  
KA'Ä'Ä'Ä'



# KESKINÄÄIS INDUKTANSSI M

M MUTUAL  
MUUNTAJA



ESIM.  $M = 0.1 \text{ H}$

$U = -20 \text{ V}$

$$\frac{\Delta I_1}{\Delta t} = \frac{10 \text{ A}}{5 \text{ ms}} = 200 \frac{\text{A}}{\text{s}}$$

$$\Rightarrow U_{\text{IND}} = -20 \text{ V}$$

$$\Phi_1 = L_1 I_1$$

$$\frac{\Delta I_1}{\Delta t} \propto \frac{\Delta \Phi_1}{\Delta t} \propto \frac{\Delta \Phi_2}{\Delta t} \propto U_{2 \text{ IND}}$$

$$\Rightarrow U_{2 \text{ IND}} \propto \frac{\Delta I_1}{\Delta t} \quad \text{VERR. VAKIO M}$$

$$U_{2 \text{ IND}} = -M \frac{\Delta I_1}{\Delta t}$$

$$U_{1 \text{ IND}} = -M \frac{\Delta I_2}{\Delta t}$$

SAMA  
KÄÄM.  
 $1 = 2$

$$\rightarrow U_{\text{IND}} = -L \frac{\Delta I}{\Delta t}$$

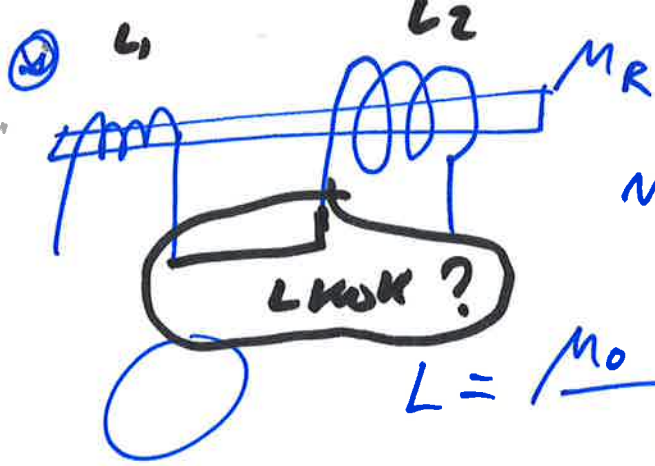
KÄÄMIN  
ITSEINDUKTANSSI

KESKINÄÄIS

ESIM.  $M = 0.1 \text{ H} \nearrow$



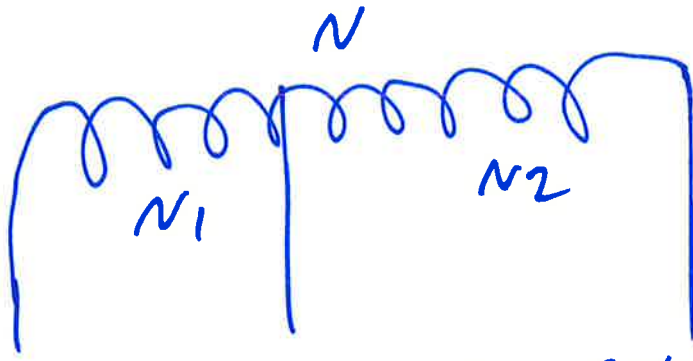
5



$n = ?$

$L_{KOK}$

$$L = \frac{\mu_0 N^2 A}{2\pi R}$$

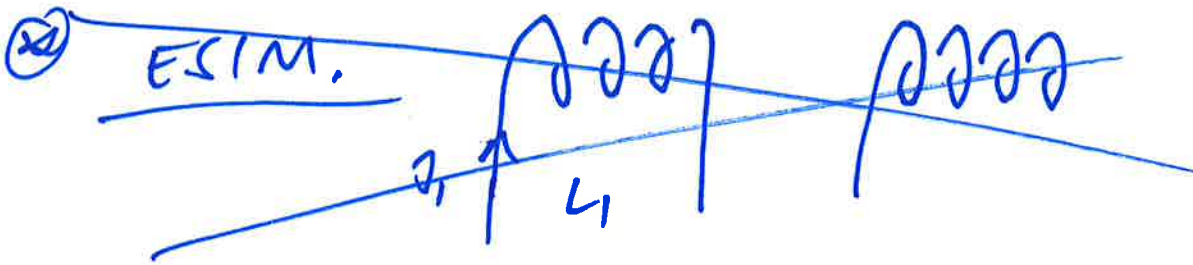


$L_{KOK} = \mu_0 CN^2$

$L_1 = CN_1^2$        $L_2 = CN_2^2$

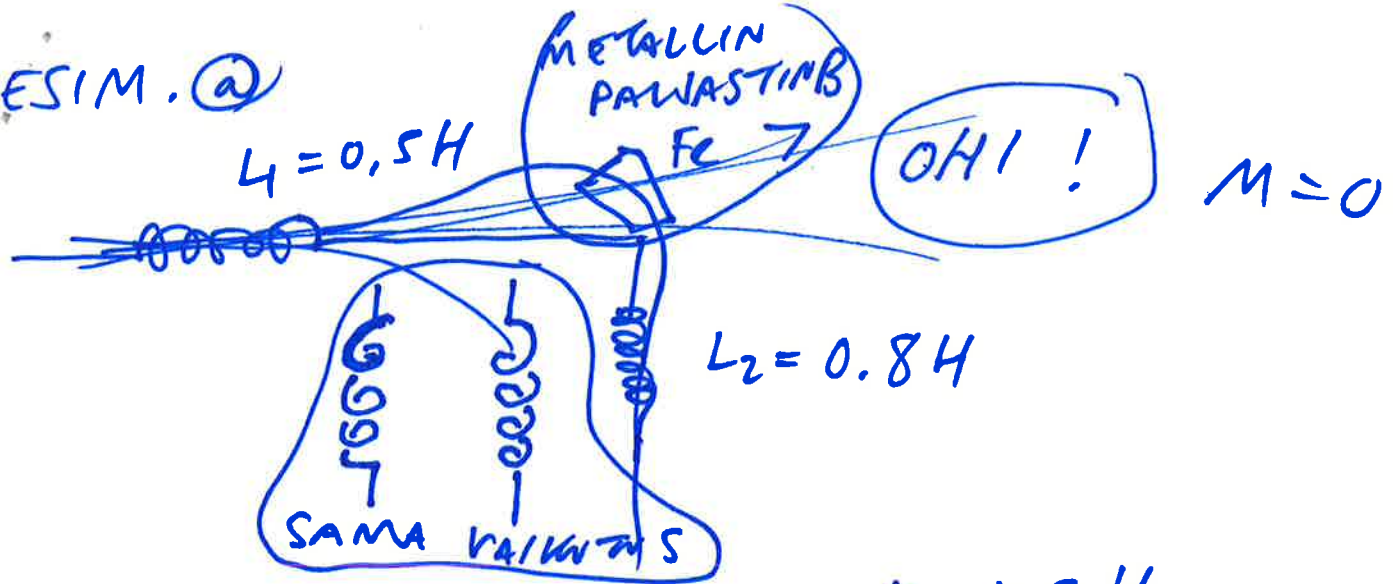
$L_{KOK} = C(N_1 + N_2)^2 = CN_1^2 + CN_2^2 + 2CN_1N_2$

$\Rightarrow \boxed{L_{KOK} = L_1 + L_2 + 2M}$



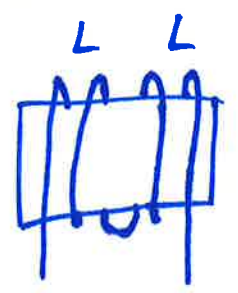
ESIM. @

(6)



$$L_{\text{kok}} = L_1 + L_2 + \underbrace{2M}_{=0} = \text{on } \underline{1.3 H}$$

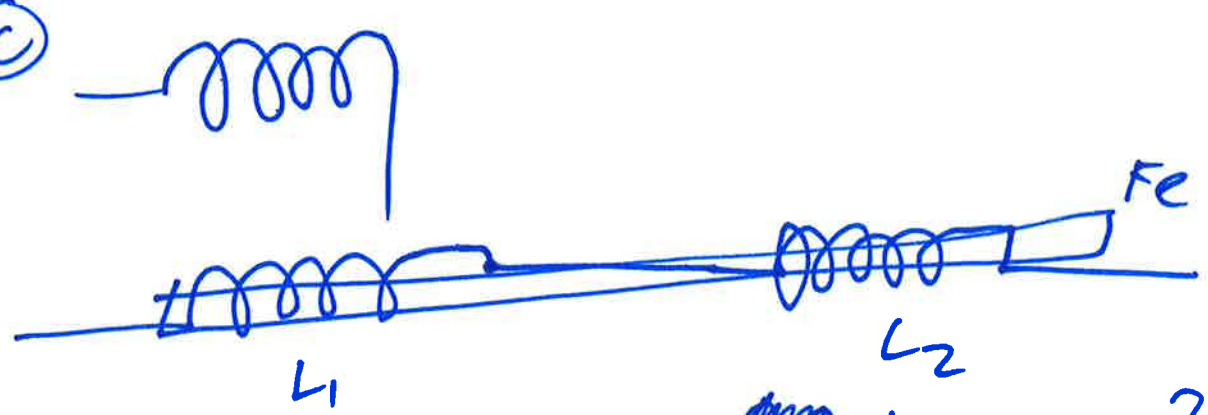
b) INDUKTANSI TAN RAS TUS ?



$$M = -L$$

$$L_{\text{kok}} = L + L + \underbrace{2M}_{-2L} = 0$$

c)



MITATTIIN  $L_{\text{kok}} = \frac{5}{2.5} H$ ,  $M = ?$

$$M = \frac{L_{\text{kok}} - L_1 - L_2}{2} = \frac{2.0 - 1.3}{2} = \frac{0.7}{2} = 0.35 H$$

JÄ'RKEVÄ TULOS  $L_1 = 95$   
 $L_2 = 0.8$   
 $M = 0.6 \leftarrow \sqrt{5} \sqrt{8} = 6.32$