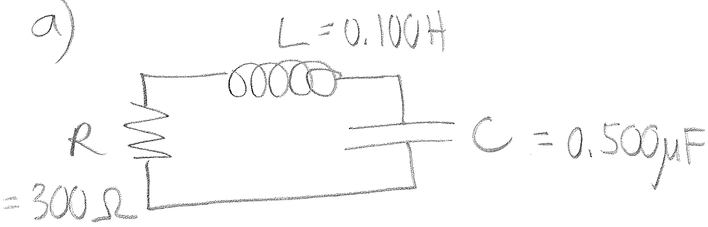
EKSAMEN 19 MAI 2006 Fysikkopgaver

a)



i) kretsens impedans $Z = \sqrt{R^2 + (X_L - X_C)^2}$, $f = 500 Hz$

$$X_L = \omega L = 2\pi\, 500Hz\, 0.100H = 314.16\,\Omega$$

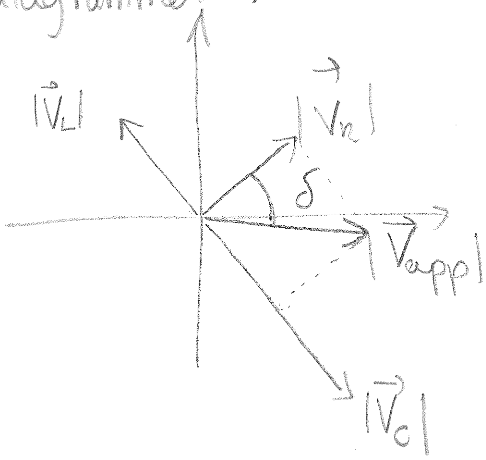
$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi\, 500Hz \cdot 0.500 \cdot 10^{-6}F} = 636.62\,\Omega$$

$$Z = \sqrt{300^2 + (314.16 - 632.62)^2} = \underline{\underline{440\,\Omega}}$$

fasevinklen δ: $\tan\delta = \frac{X_L - X_C}{R} = \frac{314.16 - 636.62}{300} = -1.074$

$$\underline{\underline{\delta = -47.1°}}$$

fasediagrammet :



spenningen ligger fasen 47.1° bak strømmen

ii) $f = 1000\ Hz$

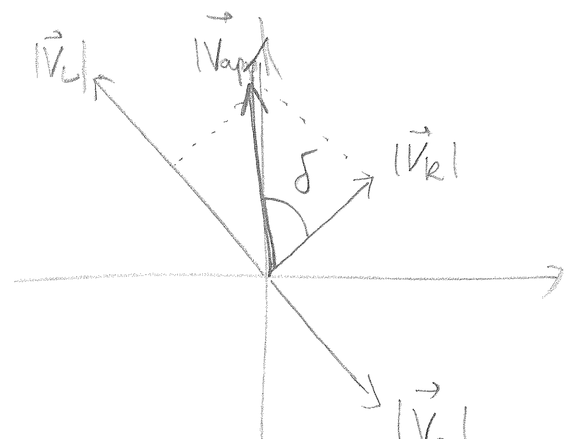
$X_L = 628.32\,\Omega$

$X_C = 318.31\,\Omega$

$\underline{\underline{Z = 431\,\Omega}}$

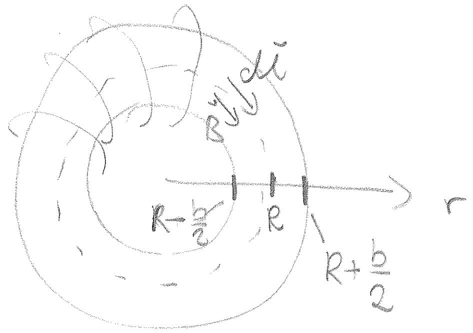
$\tan\delta = 1.033$

$\underline{\underline{\delta = 45.9°}}$



spenningen ligger fasen 45.9° foran strømmen.

b) Bruk Amperes lov $\oint_C \vec{B} \cdot d\vec{l} = \mu_0 I_C$



$\vec{B} \parallel d\vec{l}$, $I_C = N \cdot I$

$$B \int_{l=0}^{l=2\pi r} dl = \mu_0 N I$$

$\Updownarrow$

$$B \, 2\pi r = \mu_0 N I$$

$\Updownarrow$

$$B(r) = \frac{\mu_0 N I}{2\pi r}.$$

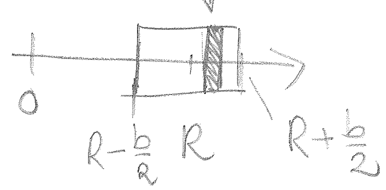
i) $B(R-\frac{b}{2}) = \frac{4\pi 10^{-7} N/A^2 \cdot 1000 \cdot 80 A}{2\pi (1.0m - \frac{0.20}{2} m)} = 0.0177 T \simeq \underline{0.018 T}$

ii) $B(R) = \underline{0.016 T}$

iii) $B(R+\frac{b}{2}) = 0.0145 T \simeq \underline{0.015 T}$

c) Fluksen er gitt ved $\phi_m = \int_S \vec{B} \cdot \hat{n} dA$, $dA = h \cdot dr$

$\vec{B} \parallel \hat{n}$



B(r) er konstant i høyden og konstant i den radiale avstand r.

$$\phi_m = \int_{r_{indre}}^{r_{ydre}} B(r) \cdot h \cdot dr = \int_{R-\frac{b}{2}}^{R+\frac{b}{2}} \frac{\mu_0 N I}{2\pi} h \frac{1}{r} dr = \frac{\mu_0 N I h}{2\pi} \ln\left(\frac{R+\frac{b}{2}}{R-\frac{b}{2}}\right)$$

d) Energien i toroiden er gitt ved $U_m = \frac{1}{2} L I^2$

Selvinduktansen er gitt ved $L = \frac{N \cdot \Phi_m}{I}$

(ses av $\mathcal{E} = -L \frac{dI}{dt} = -\frac{d\Phi_m}{dt}$, og gang med N)

$$U_m = \frac{1}{2} \frac{N \cdot \Phi_m}{I} I^2 = \frac{1}{2} N \cdot \left(\frac{\mu_0 N I h}{2\pi} \ln\left(\frac{R + b/2}{R - b/2}\right)\right) I$$

$$\underline{\underline{U_m = \frac{\mu_0 N^2 I^2 h}{4\pi} \ln\left(\frac{R + b/2}{R - b/2}\right)}}$$

Alternativt kan d) regnes:

$$U_m = \int u_m \, dV, \quad u_m = \frac{B^2}{2\mu_0} \quad dV = 2\pi r \cdot h \cdot dr$$

$$U_m = \int_{r_i = R - b/2}^{r_y = R + b/2} \frac{1}{2\mu_0} \cdot \left(\frac{\mu_0 N I}{2\pi r}\right)^2 2\pi r h \, dr$$

$$U_m = \frac{\mu_0 N^2 I^2 h}{4\pi} \int_{R - b/2}^{R + b/2} \frac{dr}{r}$$

$$\underline{\underline{U_m = \frac{\mu_0 N^2 I^2 h}{4\pi} \ln\left(\frac{R + b/2}{R - b/2}\right)}}$$

e) Gauss lov for $\vec{B}$-felter: $\oint_S \vec{B} \cdot \hat{n} \, dA = 0$ $\underline{\underline{\text{svar} = 3}}$

(Maxwell's 2. ligning)