Øving 7

Vserolod Karpov - vserolok

Oppgave 1

a) $\phi(t) = \int_0^t \frac{1}{N} v(\tau)\, d\tau = \frac{1}{N} \cdot 10 \cdot \frac{1}{100} \sin(100t)$

$= \frac{\sin(100t)}{40}$

$N \cdot I = \phi \cdot R \Rightarrow i(t) = \frac{\phi(t) \cdot R}{N} = \frac{100}{1600} \sin(100t)$

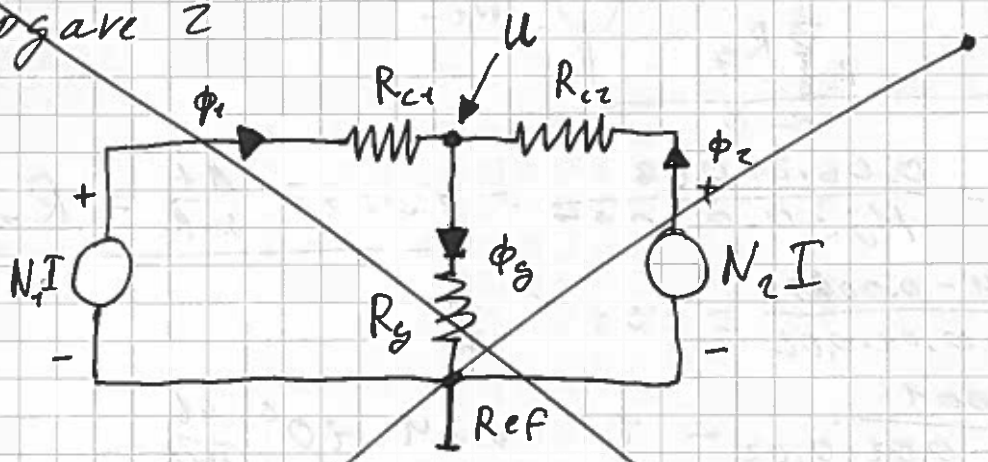
$= \frac{5}{8} \sin(100t)$

b) $V = L \cdot \frac{di}{dt} = \frac{R}{N} \cdot \frac{d\phi}{dt} \cdot L = N \frac{d\phi}{dt}$

$\Rightarrow \frac{R}{N} L = N \Rightarrow L = \frac{N^2}{R}$

Oppgave 2

a)



b) $B = \frac{\phi}{A}$, $R = \frac{l}{\mu A}$, $N_1 = N_2 = 400$, $\mu_j = 5000 \mu_0$

$\mu_0 = \mu_L = 4\pi \cdot 10^{-7}$

$R_{c1} = R_{c2} = \frac{2 \cdot 6\,cm + 2 \cdot 6\,cm + 4 \cdot 1mm}{\mu_j \cdot 4\,cm^2} = 111.01 \cdot 10^3 \frac{At}{Wb}$

$R_g = \frac{1mm}{\mu_0 \cdot 4cm^2} = 1,989 \cdot 10^6 \frac{At}{Wb}$

Setter $Ref = 0$, bruker nodespenning. 2

$$\Rightarrow \frac{N_1 I - U}{R_{c1}} + \frac{N_2 I - U}{R_{c2}} + \frac{U - 0}{R_g} = 0 \quad , N_1 = N_2, \; R_{c1} = R_{c2}$$

$$\Rightarrow U = -\frac{2 N_1 I}{R_c} \Big/ \left(\frac{1}{R_g} - \frac{2}{R_c}\right)$$

$$= \frac{-2 N_1 I}{\frac{R_c}{R_g} - 2} \quad , U = \phi \cdot R_g = B \cdot A \cdot R_g$$

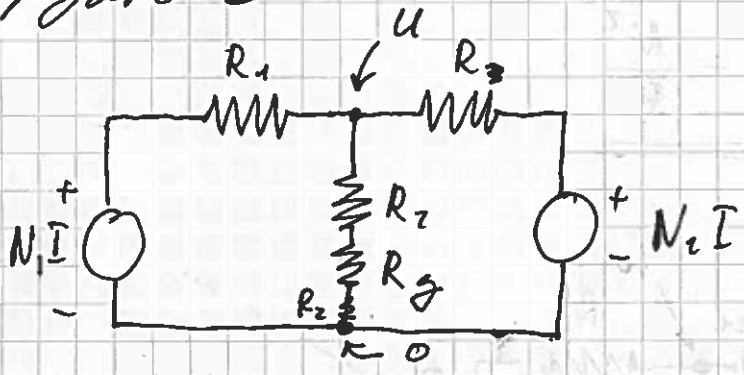
$$\Rightarrow B \cdot A \cdot (R_c - 2R_g) / (-2N_1) = I$$

$A = 1mm \cdot 2cm = 0.0002$, $B = 0.25\,T$

$\Rightarrow I = 9.66\,mA$

Oppgave 2

a)



b)

$$R_1 = \frac{l}{\mu A} = \frac{0.06 \cdot 2 + 0.08}{\mu_j \cdot 0.02 \cdot 0.02} = 79577 \frac{At}{mWb} = R_3$$

$$R_2 = \frac{0.04 - 0.00405}{\mu_j \cdot 0.02 \cdot 0.02} = 15717 \frac{At}{mWb}$$

$$R_g = \frac{0.001}{\mu_0 \cdot 0.02 \cdot 0.02} = 1.9894 \cdot 10^6 \frac{At}{mWb}$$

Node"spenning":

$$\frac{N_1 I - U}{R_1} + \frac{N_2 I - U}{R_3} + \frac{U - 0}{2R_2 + R_g} = 0 \quad \Rightarrow 2\frac{N_1 I}{R_1} - 2\frac{U}{R_1} + \frac{U}{2R_2 + R_g} = 0$$

$$I = \left(2\frac{U}{R_1} + \frac{U}{2R_2 + R_g}\right) \cdot \frac{R_1}{2N} = U\left(\frac{1}{N} + \frac{R_1}{2N(2R_2 + R_g)}\right)$$

$\mathcal{U} = \phi(R_s + R_z)$

$\phi = B \cdot A = 0.25 \cdot (0.02)^2$

$\Rightarrow I = 2.060605\ A$

Oppgave 3

a) $\frac{V_1}{N_1} = \frac{V_2}{N_2} \Rightarrow \frac{V_s}{N_1} = \frac{V_L}{N_2}$

Antagelse: $P = I_1 \cdot V_s = I_2^2 Z_L = I_2 \cdot V_L$

$\Rightarrow V_L = \frac{I_1}{I_2} V_s \Rightarrow \frac{V_s}{N_1} = \frac{V_s}{N_2} \cdot \frac{I_1}{I_2}$

$\Rightarrow N_2 I_2 = N_1 \cdot I_1$

b) $N_1 = 50,\ N_2 = 1$

$V_s = 1000V\ (RMS) \Rightarrow V_s = 1000 \cdot e^{j0}$

$Z_L = 0.5 + j0.5\ \Omega = \sqrt{\frac{1}{2}}\, e^{j45^\circ}$

$V_L = \frac{V_s}{N_1} = 20V$, $V_L = I_2 \cdot Z_L$

$\Rightarrow I_2 = \frac{V_L}{Z_L} = \frac{20}{\sqrt{\frac{1}{2}}} e^{-j45^\circ} = \frac{20\cdot\sqrt{2}}{\sqrt{2}} e^{-j45^\circ}$

$N_2 I_2 = N_1 I_1 \Rightarrow I_1 = \frac{1}{50} \cdot I_2 = \frac{2\sqrt{2}}{5\cdot\sqrt{\frac{1}{2}}} e^{-j45^\circ} = 2\frac{\sqrt{2}}{5} e^{-j45^\circ}$

c) $S = P \pm Qj = I^2 \cdot R \pm I^2 X j = I^2 \cdot Z_L^*$

$R_L = 0.5$, $X_L = 0,5$, $I_2^2 \cdot Z_L = 100 \cdot 8 \cdot e^{-j90^\circ} \cdot \frac{\sqrt{2}}{2} e^{j45^\circ}$

$= 400 \cdot \sqrt{2} \cdot e^{-j45^\circ} = 400(1 - j)$

$\Rightarrow P_L = 400\ W$, $Q_L = 400\ VAr$

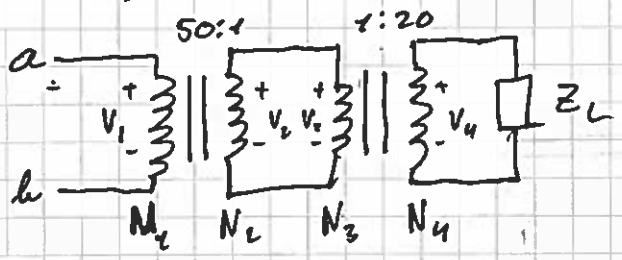
$S_s = V_s \cdot I_1 = \frac{1000}{5} \cdot \sqrt{2} \cdot e^{-j45^\circ} \cdot 2 = 400 - j400$

$\Rightarrow P_s = 400\ W$, $Q_L = 400\ VAr$

S_s skulle jeg bli litt S_L for en ideell trans.! Gir jo en eller annen tull tegn, men finner den ikke!

Οργαν 4

a) $Z_L = 200 \cdot e^{-45^\circ j}$



$\frac{V_1}{N_1} = \frac{V_2}{N_2}$, $\frac{V_3}{N_3} = \frac{V_4}{N_4}$, $I_1 N_1 = I_2 N_2$, $I_3 N_3 = I_4 N_4$

$I_2 = I_3 \Rightarrow N_2 = \frac{I_1}{I_2} N_1 = \frac{I_1}{I_3} N_1$, $I_3 = \frac{N_4}{N_3} I_4 \Rightarrow$

$N_2 = \frac{I_1}{I_4} \cdot \frac{N_3}{N_4} \cdot N_1$, $V_2 = V_3$, $V_3 = \frac{V_4}{N_4} \cdot N_3 \Rightarrow$

$V_2 = \frac{V_4}{N_4} \cdot N_3$, $V_4 = I_4 \cdot Z_L \Rightarrow V_2 = \frac{I_4 \cdot Z_L}{N_4} \cdot N_3$

$\Rightarrow \frac{V_1}{N_1} = \frac{V_2}{N_2} = \frac{\left(\frac{I_4 \cdot Z_L}{N_4} N_3\right)}{\left(\frac{I_1}{I_4} \cdot \frac{N_3}{N_4} \cdot N_1\right)} = \frac{I_4^2}{I_1} \cdot \frac{Z_L}{N_1}$

$\Rightarrow V_1 = \frac{I_4^2}{I_1} \cdot Z_L$, $I_4 = \frac{I_1}{N_2} \cdot \frac{N_3}{N_4} \cdot N_1$

$\Rightarrow V_1 = I_1 \cdot \left(\frac{N_1}{N_2} \cdot \frac{N_3}{N_4}\right)^2 \cdot Z_L = I_1 \cdot Z_{ab}$

$N_1 = 50$, $N_2 = 1$, $N_3 = 1$, $N_4 = 20 \Rightarrow$

$Z_{ab} = \left(\frac{50}{20}\right)^2 Z_L = \underline{1250 e^{-45^\circ j}}$

Oppgave 5a)

$$\frac{V_1}{N_1} = \frac{V_2}{N_2} \Rightarrow \frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{22 \cdot 10^3}{234.043} = \underline{\underline{94}}$$

b) $$I_2 = \frac{V_S\left(\frac{N_2}{N_1}\right)}{Z_R + Z_L} = 4.23 \cdot e^{-j5.19^\circ}$$

$$S_L = |I_2|^2 \cdot Z_L = (4.23)^2 \cdot 55 = \underline{948\,W}$$

$$\Rightarrow \underline{\underline{P_L = 948\,W,\ Q_L = 0}}$$

c) $$I_1 N_1 = I_2 N_2$$

$$\Rightarrow I_1 = I_2 \frac{N_2}{N_1} = \underline{\underline{0.045 e^{-j5.19^\circ}}}$$