Solutions:

$$\Delta B_{max} = 0{,}75 \cdot B_{sat} = 0{,}75 \cdot 0{,}3T \cong 0{,}225T$$

$$\left.\begin{matrix} P_o = 70W \\ V_o = 24V \end{matrix}\right\} I_o \approx 3A.$$

1/a: $V_o = D \cdot n \cdot V_{in}$; $V_o = 24$, $V_{in} = 400$, $D = 0{,}3$

$$\boxed{n = \frac{V_o}{D \cdot V_{in}} = \frac{24}{0{,}3 \cdot 400} = 0{,}2}$$

1/b: $\begin{cases} \Delta i_{pa} = 5\% \cdot I_o = 0{,}05 \cdot 3A = 0{,}15A \\ \Delta i_{pp} = 2 \cdot \Delta i_{pa} = 0{,}3A \quad (10\% \; I_o) \end{cases}$

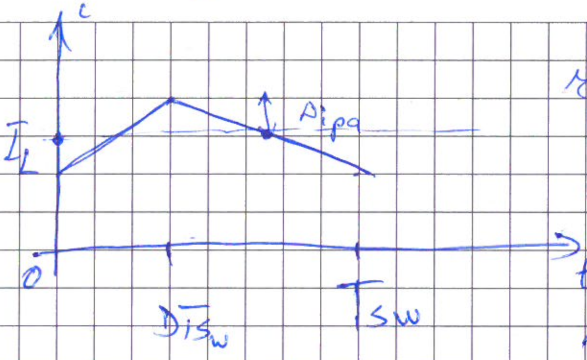
$f_{sw} = 100kHz \Rightarrow T_{sw} = 10\mu s$

$$\Delta i_{pp} = \frac{V_o}{L}(1-D) \cdot T_{sw} \Rightarrow L = \frac{V_o(1-D)T_{sw}}{\Delta i_{pp}} \Rightarrow$$

(Lecture 2.)

$$\boxed{L = \frac{24(1-0{,}3) \cdot 0{,}00001}{0{,}3} = 560\mu H}$$

1/C: rms i_L (inductor current)



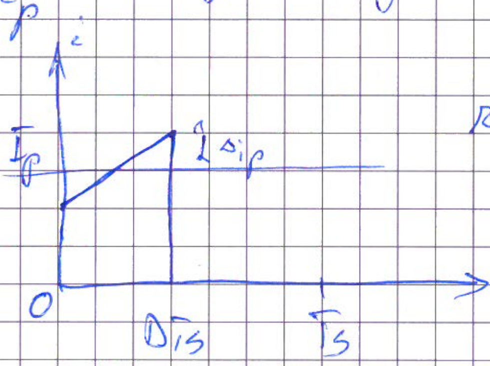
$$rms_{i_L} = I \cdot \sqrt{1 + \frac{1}{3}\left(\frac{\Delta i_{pa}}{I}\right)^2}$$

$$rms_{i_L} = 3 \cdot \sqrt{1 + \frac{1}{3}\left(\frac{0,15}{3}\right)^2}$$

$$rms_{i_L} = 3 \cdot \sqrt{1 + \frac{1}{3} \cdot 0,025}$$

$$\boxed{rms_{i_L} = 3,001249\,A}$$

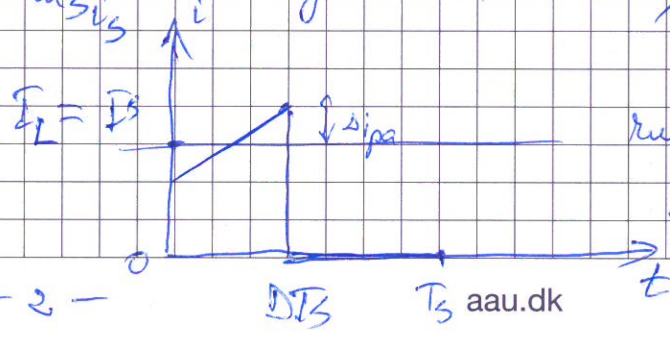
rms i_p (transformer primary)



$$rms_{i_p} = n \cdot rms_{i_s}$$

(transformer voltage and current eq.)

rms i_s (transformer secondary)



$$rms_{i_s} = I_s \sqrt{D} \sqrt{1 + \frac{1}{3}\left(\frac{\Delta i_{pa}}{I_s}\right)^2}$$

$$\boxed{rms_{i_s} = 1,6438\,A}$$

1/c: $\left[rms_{lp} = n \cdot rms_{is} = 0{,}2 \cdot 1{,}6438 = 0{,}32877 \right.$

2: $P_{Cu} = 1\,W \Leftrightarrow I_0^2 \cdot R = P_{Cu};\ R = \frac{1W}{9A} = 111\,m\Omega$

$$R = \rho \cdot \frac{n\,(MLT)}{A_W}$$

We know the design constraints:

ρ ; L ; I_{max} ; ΔB_{max} ; R ; K_u

$I_{max} = I_0 + \Delta i_{pa}$

$$\Downarrow$$

$$K_g \geq \frac{\rho \cdot L^2 \cdot I_{max}}{\Delta B_{max}^2 \cdot R \cdot K_u} \cdot 10^8 = 0{,}0108$$

Use Matlab to calculate and pay attention to the units.

$$K_g = \frac{A_c^2 W_A}{(MLT)}$$

See: Inductor_design.m

Transformer-design.m