



**NPTEL Online Certification Course**  
**<Design of Power Electronics converter>**  
**<Assignment Number 6>: Detailed Solution**  
**Indian Institute of Technology Guwahati**



An inductor  $L = 50 \mu H$  need to be designed for a buck converter. The current rating of the inductor is chosen as 20 A and ripple limit is 0.5 A. Following specifications are chosen for the design.

- $B_m = 0.2 \text{ T}$
- $J_m = 3 \text{ A/mm}^2$
- Window fill factor,  $K_u = 0.4$

Question 1. Find the area product  $A_p \dots \text{cm}^4$  Solution 1.

$$\begin{aligned} \text{Peak current} - I_{Lpk} &= I_L + \frac{\Delta I_L}{2} = 20 + \frac{0.5}{2} \\ &= 20.25 \text{ A} \end{aligned}$$

$$\begin{aligned} \text{Energy} - W_m &= \frac{1}{2} \times L \times I_{Lpk}^2 = \frac{1}{2} \times 100 \times 10^{-6} \times 20.25^2 \\ &= 10.25 \times 10^{-3} \text{ W} \end{aligned}$$

$$\begin{aligned} \text{Area product} \rightarrow A_p &= \frac{2 \times W_m}{K_u \times B_m \times J_m} = \frac{2 \times 10.25 \times 10^{-3}}{0.4 \times 3 \times 10^6 \times 0.2} \\ &= 8.54 \times 10^{-8} \text{ m}^4 = 8.54 \text{ cm}^4 \end{aligned}$$

Let EE ferrite core is chosen to design the inductor.

Question 2. Recall the design data given for EE ferrite cores in the lecture on magnetic cores. Write the part no. of the ferrite core you'll choose for the design. ...

Answer 2. EE-75, From the given design data we choose core having an area product ( $A_p$ ) close to or slightly higher than value of  $A_p$  calculated.

Question 3. What is the window area,  $W_a$  of the core. ...  $\text{cm}^2$

Answer 3.  $2.79 \text{ cm}^2$

Question 4. Cross-sectional area,  $A_c$  of the core ...  $\text{cm}^2$ .

Answer 4.  $3.37 \text{ cm}^2$

Question 5. Magnetic path length of the core ...  $\text{cm}$

Answer 5.  $10.70 \text{ cm}$

Question 6. Calculate  $I_{Lrms}$  ... (A)

Solution 6.

$$I_{Lrms} = \sqrt{(I_L)^2 + \frac{(\Delta I_L)^2}{12}} = \sqrt{(20)^2 + \frac{(0.5)^2}{12}}$$
$$= 20 \text{ A}$$

Question 7. Cross sectional area of conductor ...  $\text{mm}^2$  Solution

7.

$$A_W = \frac{I_{Lrms}}{J_m} = \frac{20}{3}$$
$$= 6.67 \text{ mm}^2$$

Question 8. AWG to be chosen for the conductor is ...

Answer 8. 8

Question 9. Calculate no. of turns N.

Solution 9.

$$N = \frac{K_u \times W_a}{A_w} = \frac{0.4 \times 2.79 \times 10^{-4}}{8.37 \times 10^{-6}}$$
$$= 13.33 = 14 \text{ turns}$$

Question 10. If relative permeability is 2300, calculate air gap length,  $l_g$  ...  $\text{mm}$ .

Solution 10.

$$l_g = \frac{\mu_o \times A_C \times N^2}{L} - \frac{l_c}{\mu_{rc}}$$
$$= \frac{4\pi \times 10^{-7} \times 3.37 \times 10^{-4} \times 14^2}{50 \times 10^{-6}} - \frac{10.70 \times 10^{-2}}{2300}$$
$$= 1.61 \times 10^{-3} \text{ m} = 1.61 \text{ mm}$$