

$$\textcircled{1} \quad H = n I$$

$$B_s \quad \mu H = \mu_0 \mu_r H = \mu_0 \mu_r n I$$

$$\text{Flux } \phi = BA = \mu_0 \mu_r n I A = \mu_0 \mu_r \left(\frac{N}{l}\right) A I$$

$$L = \frac{N\phi}{I} = \frac{N^2}{l} \frac{\mu_0 \mu_r A}{I} = n^2 \mu_0 \mu_r \underbrace{A l}_{\text{Volume}}$$

↳ inductance

$$\therefore L = n^2 \mu_0 \mu_r V_{\text{core}}$$

$$\therefore L = 4\pi \times 10^{-7} \times 1 \times \left(\frac{500}{0,2}\right)^2 \times (0,2) \times \pi \left(\frac{101}{2}\right)^2$$

$$= 1.23 \times 10^{-4} \text{ H}$$

$$B = 4\pi \times 10^{-7} \times 1 \times \left(\frac{500}{0,2}\right) \times \underbrace{1}_{\hookrightarrow I} = 3.14 \times 10^{-3} \text{ T}$$

when using core with  $\mu_r = 600$

$$L = 0,738 \text{ H} \quad \left. \begin{array}{l} \\ B_s \quad 1.88 \text{ T} \end{array} \right\} \text{ much Higher Total field!}$$

More energy is stored since Energy is  $E = \frac{B^2}{2\mu_0}$   
 where  $B$  is total field (external + induced)

$$(2) \quad H = n I_s = \frac{N}{l} I = \frac{200}{0,2} \times 2 = 2000 \text{ A/m}$$

$$B_{\text{applied (external)}} = \mu_0 H_{\text{sat}} = 4\pi \times 10^{-7} \times 2000$$

$$= 2.51 \times 10^{-3} \text{ T}$$

$$M_{\text{sat}} = \frac{\overset{\text{total}}{B_{\text{sat}}}}{\underset{\text{total field term}}{\mu_0}} - \underbrace{H_{\text{sat}}}_{\text{external source field term}}$$

$\downarrow$  ~~induced~~ induced field term

$$\therefore M_{\text{sat}} = \frac{1.5}{4\pi \times 10^{-7}} - 2000 = 1.19 \times 10^6 \text{ A/m}$$

$$\therefore I_{\text{surface}} = \underset{\text{L} \rightarrow M_{\text{sat}}}{I_{\text{ind}}} = M_{\text{sat}} l = 1.19 \times 10^6 \times 0,2 \text{ m}$$

$$= 2,38 \times 10^5 \text{ A}$$

$I_{\text{total in solenoid}} \ll I_{\text{surface induced in core}}$ 
  
 $\text{L} \rightarrow$  large surface current inside the magnetic core

$$d) \quad B = \mu_0 n I$$

$\hookrightarrow 1.5 \text{ T}$

$$\therefore I = \frac{1.5}{\mu_0 \frac{200}{0,2}} = 1194 \text{ A}$$

$\therefore$  not applicable to achieve large field with external source only  
 hence magnetic core needed.

$\text{L} \rightarrow$  very large external current needed to get same total field when using magnetic core