(1) A core with three legs is shown in Figure 1. Its depth is 5 cm, and there are 400 turns on the center leg. The remaining dimensions are shown in the figure. The core is composed of a steel having the magnetization curve shown in Figure 2. Answer the following questions about this core:

(a) What current is required to produce a flux density of 0.5 T in the central leg of the core?

(b) What current is required to produce a flux density of 1.0 T in the central leg of the core? Is it twice the current in part *(a)*?

(c) What are the reluctances of the central and right legs of the core under the conditions in part *(a)*?

(d) What are the reluctances of the central and right legs of the core under the conditions in part *(b)*?

(e) What conclusion can you make about reluctances in real magnetic cores?

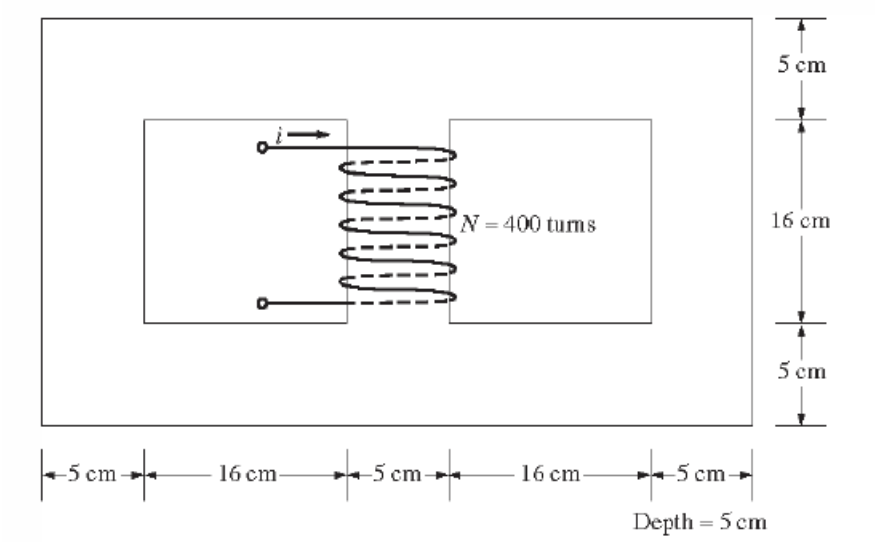


Figure 1

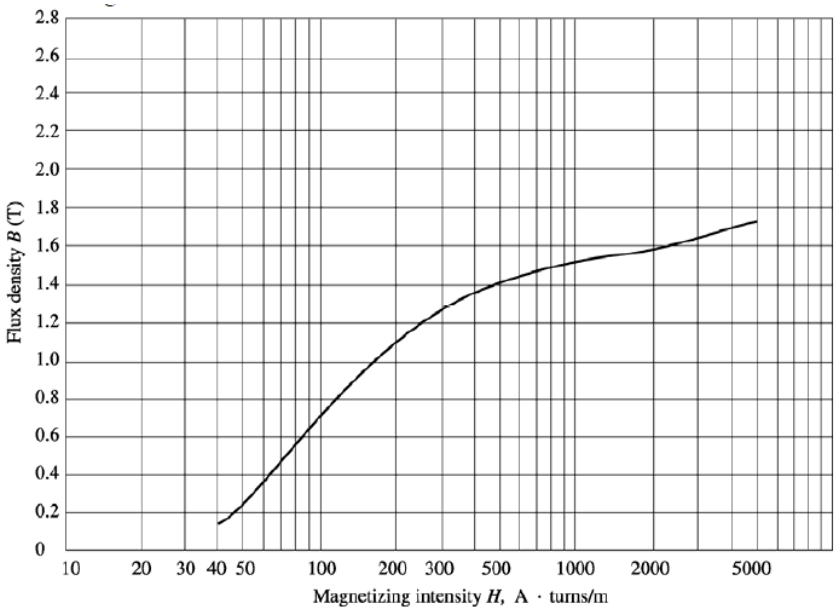
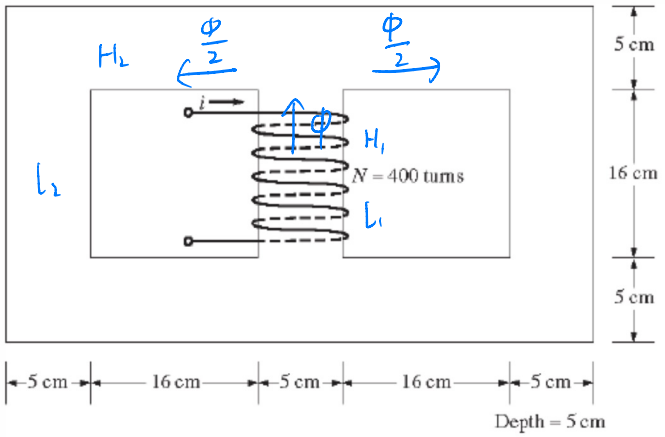


Figure 2

Homework 1

(a) $B_1 = 0.5\,T \rightarrow H_1 = 70\ A\cdot t/m$

$B_2 = \frac{\frac{\Phi}{2}}{A} = \frac{1}{2}\frac{\Phi}{A} = \frac{1}{2}B_1 = 0.25\,T \rightarrow H_2 = 50\ A\cdot t/m$



$l_1 = 16 + \frac{5}{2} + \frac{5}{2} = 21\,cm$

$l_2 = 21 \times 3 = 63\,cm$

$\mathcal{F} = H_1 l_1 + H_2 l_2$

$= 70 \times 0.21 + 50 \times 0.63$

$= 46.2\ (A\cdot t)$

$i_1 = \frac{\mathcal{F}}{N} = \frac{46.2}{400} = 0.1155\,(A)$

(b) $B_1' = 1.0\,T \rightarrow H_1' = 170\ A\cdot t/m$

$B_2' = \frac{1}{2}B_2' = 0.5\,T \rightarrow H_2' = 70\ A\cdot t/m$

$l_1 = 21\,cm$

$l_2 = 63\,cm$

$\mathcal{F} = H_1' l_1 + H_2' l_2$

$= 170 \times 0.21 + 70 \times 0.63$

$= 79.8\ (A\cdot t)$

$i_2 = \frac{\mathcal{F}}{N} = \frac{79.8}{400} = 0.1995\,(A)$

It is not twice the i_1 in (a)

(c) $\mu_1 = \frac{B_1}{H_1}$

$\mu_1 = \frac{0.5}{70}$

$\mu_1 = \frac{1}{140}$ (H/m)

$\mathcal{R}_{central} = \frac{l_1}{\mu_1 A}$

$= \frac{0.21}{\frac{1}{140} \cdot 0.05^2}$

$= 11760$ (A·t/wb)

$\mu_2 = \frac{B_2}{H_2}$

$\mu_2 = \frac{0.25}{50}$

$\mu_2 = 5 \times 10^{-3}$

$\mathcal{R}_{right} = \frac{l_2}{\mu_2 A}$

$= \frac{0.63}{5 \times 10^{-3} \times 0.05^2}$

$= 50400$ (A·t/wb)

(d) $\mu_1' = \frac{B_1'}{H_1'}$

$= \frac{1}{170}$

$\mathcal{R}'_{central} = \frac{l_1}{\mu_1' A}$

$= \frac{0.21}{\frac{1}{170} \times 0.05^2}$

$= 14280$ (A·t/wb)

$\mu_2' = \frac{B_2'}{H_2}$

$\mu_2' = \frac{0.5}{70}$

$\mu_2' = \frac{1}{140}$

$\mathcal{R}'_{right} = \frac{l_2}{\mu_2' A}$

$= \frac{0.63}{\frac{1}{140} \times 0.05^2}$

$= 35280$ (A·t/wb)

(e) $l \propto \mathcal{R}$

$B \propto \frac{1}{\mu}$