Physics 172-2,3
Winter Quarter 1985
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George Williams

FINAL EXAM

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Name (Print) Kao Name (Sign) AVE = 9.2

Discussion Instructor (CIRCLE ONE): Crelly Kao Luty McDonald Pollard

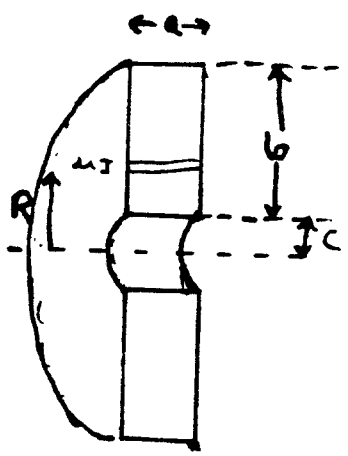
Discussion Section #: _____ Saffer Schweizer Smith

SHOW ALL WORK!! Report all numbers to three significant figures!
Use the conversion constants and data given on the front page.

(a) Given a rectangular toroid with the cross section shown, and N turns of wire, calculate its inductance. ← 12

(b) If N = 360, a = 2.75 cm, b = 7.25 cm, and c = 1.25 cm, calculate the numerical value for the inductance. ← 3

(c) When the current is 1.65 A, calculate the magnetic energy stored between R = 1.25 cm and R = 4.85 cm.



a. $B = \frac{\mu_0 I N}{2\pi r}$

$$\Phi_T = N \int_c^{c+b} \frac{\mu_0 I N}{2\pi r} a\, dr$$

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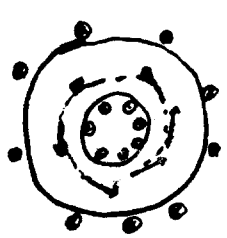
$$= \frac{\mu_0 I N^2 a}{2\pi} \ln\left|\frac{b+c}{c}\right|$$

$$\mathcal{E} = -\frac{d\Phi_T}{dt} = -L\frac{dI}{dt}$$

$$= -\frac{\mu_0 N^2 a}{2\pi} \ln\left|\frac{b+c}{c}\right| \frac{dI}{dt}$$

$$\boxed{L = \frac{\mu_0 N^2 a}{2\pi} \ln\left|\frac{b+c}{c}\right|}$$



$$\int \bar{B}\cdot d\bar{l} = \mu_0 N I$$

$$B 2\pi r = \mu_0 N I$$

$$B = \frac{\mu_0 N I}{2\pi r}$$

3 b.

$$L = \boxed{1.37 \times 10^{-3}\ H}$$

c. $u_B = \frac{1}{2\mu_0} B^2$ (energy density)

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$$= \frac{1}{2\mu_0} \frac{\mu_0^2 I^2 N^2}{4\pi^2 r^2}$$

$U = \int u_B\, dv$ $\quad dv = 2\pi r a\, dr$

$$= \int_{r_1}^{r_2} \frac{\mu_0 I^2 N^2 a}{4\pi r} dr$$

$$= \frac{\mu_0 I^2 N^2 a}{4\pi} \ln\left|\frac{r_2}{r_1}\right| = \boxed{1.31 \times 10^{-3} I}$$