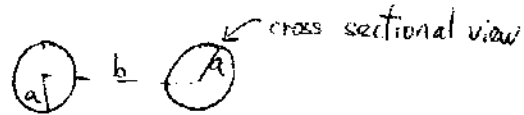
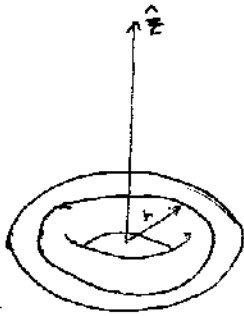


HW 10 official solutions.

1) Self induction of toroid.



$$\frac{1}{2} L I^2 = \frac{1}{2} \int d^3x B^2$$

$$\oint \vec{B} \cdot d\vec{\ell} = I N$$

$\uparrow$  total # of turns

$$B_\phi = \frac{I N}{2\pi r}$$

$\uparrow$  radius in cylindrical coordinates

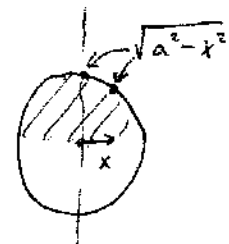
$$L = \frac{N^2}{(2\pi)^2} \int d^3x \frac{1}{r^2}$$

$$I_1 \equiv \int d^3x \frac{1}{r^2} = \int \frac{dz dr d\phi r}{r^2}$$

$$= 2\pi \int \frac{dz dr}{r}$$

$$= 2\pi \int_{-a}^a dx \int_0^{\sqrt{a^2-x^2}} \frac{2 dz}{\frac{b}{2} + x}$$

$$= 4\pi \int_{-a}^a dx \frac{\sqrt{a^2-x^2}}{\frac{b}{2} + x}$$



Let  $a\tilde{y} \equiv x$

$$I_1 = 4\pi a^2 \int_{-1}^1 d\tilde{y} \frac{\sqrt{1-\tilde{y}^2}}{\frac{b}{2} + a\tilde{y}}$$

$$= \frac{4\pi a^2}{b} \int_{-1}^1 d\tilde{y} \frac{\sqrt{1-\tilde{y}^2}}{1 + \frac{2a}{b}\tilde{y}}$$