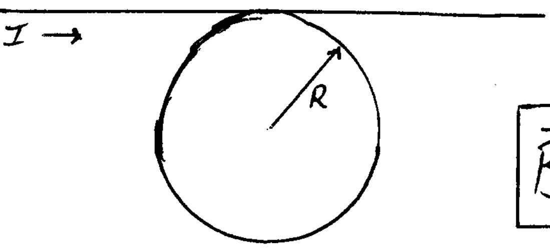
30-6) Using the results from Ex. 30.1 & 30. (learn these!), one finds the magnetic fields at the center of a circular current loop & around a thin straight conductor respectively:

$$B_{circle,center} = B_{cc} = \frac{\mu_0 I}{2R}$$

$$B_{wire} = \frac{\mu_0 I}{2\pi R}$$ ⇐ for an infinitely long straight wire!



By superposition,

$$\boxed{\vec{B}_{center} = \vec{B}_{cc} + \vec{B}_{wire} = \left(1 + \frac{1}{\pi}\right)\frac{\mu_0 I}{2R}(-\hat{z})}$$

$-\hat{z}$ = into page!

30-10) from Ex. 30.1:

$$B_{str} = \frac{\mu_0 I}{4\pi r}(\cos\theta_1 - \cos\theta_2)$$ for both straight wires

By observation, $\theta_1 = \frac{\pi}{2}$ & $\theta_2 = \pi \Rightarrow \vec{B}_{str} = \frac{-\mu_0 I}{4\pi r}\hat{z}$ 4 pts.

from Ex 30.2:

$$B_{curved} = \frac{\mu_0 I}{4\pi r}\theta \quad ; \theta = \frac{\pi}{2}$$ for a $\frac{1}{4}$-circle 4 pts.

$$\Rightarrow \vec{B}_{1/4\text{-circle}} = \frac{-\mu_0 I}{8r}\hat{z}$$

$$\vec{B}_{center} = 2\vec{B}_{str} + \vec{B}_{1/4\text{-circle}} = \boxed{\frac{-\mu_0 I \hat{z}}{2r}\left(\frac{1}{4} + \frac{1}{\pi}\right)}$$ 2 pts.

30-29) a) $I_{enc} = \int_0^{r_1} J\,dA$

Now $J = br$ & $dA = r\,dr\,d\theta$

$\Rightarrow I_{enc} = \int_0^{r_1} br^2 dr\,d\theta = \frac{2\pi b r_1^3}{3}$

$\oint_1 \vec{B}\cdot d\vec{s} = |\vec{B}|\,2\pi r_1 = \mu_0 I_{enc}$

$\Rightarrow \boxed{|\vec{B}|_{r_1<R} = \frac{\mu_0 b r_1^2}{3}}$

30-29) b) Now, $I_{enc} = \int_0^R J\,dA = \frac{2\pi b R^3}{3}$

$\oint_2 \vec{B}\cdot d\vec{s} = |\vec{B}|\,2\pi r_2 = \mu_0 I_{enc}$

$\Rightarrow \boxed{|\vec{B}|_{r_2>R} = \frac{\mu_0 b R^3}{3 r_2}}$

30-38) a) $\Phi_E = EA = \frac{q}{\varepsilon_0} \Rightarrow \frac{dE}{dt} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{4\pi I}{A} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{4I}{r^2}$

$I = 0.20\,A$ & $r = 0.1\,m \Rightarrow \frac{dE}{dt} = \left(8.99\times10^9 \frac{N\cdot m^2}{C^2}\right)\cdot\frac{4(0.20A)}{(0.10m)^2} \simeq \boxed{7.192\times10^{11}\,\frac{V}{m\cdot s}}$

30-38) b) Inbetween the plates, the current is equal to the displacement current, so: $\oint \vec{B}\cdot d\vec{s} = B\cdot 2\pi r = \mu_0\varepsilon_0\frac{d\Phi_E}{dt} = \mu_0 I_s$

where $I_s = I\cdot\frac{r^2}{r_{plate}^2} = \frac{I}{4} = 0.05\,A$ Here, we have found the current going through the 5 cm radius loop.

$\Rightarrow B = \frac{\mu_0 I_s}{2\pi r} = \frac{\left(4\pi\times10^{-7}\,\frac{T\cdot m}{A}\right)(0.05\,A)}{2\pi\,(0.05\,m)} = \boxed{2\times10^{-7}\,T = 0.2\,\mu T}$

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30-40) $B = \dfrac{\mu_m N I}{2\pi r}$, where $\mu_m = 5000\,\mu_0$, $r = 0.1\text{m}$, $N = 470$
& $B = 1.3\text{T}$

$$\Rightarrow \boxed{I = \frac{2\pi r B}{5000\mu_0 N} \simeq 0.277\text{A}}$$

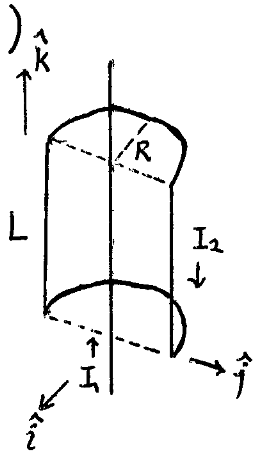
30-56) The magnetic field at a pt. on the common axis of the coils is given by (& derived in discussion section):

$$B = \frac{N\mu_0 I R^2}{2}\left[\frac{1}{(R^2+x^2)^{3/2}} + \frac{1}{(2R^2+x^2 \quad 2Rx)^{3/2}}\right]$$

at the midway pt: $\boxed{B\left(x=\frac{R}{2}\right) = \frac{8 N \mu_0 I}{5\sqrt{5}\,R}}$

plugging in given values yields: $B\left(x = \frac{0.5\text{m}}{2}\right) = \dfrac{8(100)\,\mu_0\,(10.0\text{A})}{5\sqrt{5}\,(0.5\text{m})} \simeq \boxed{0.018\text{T}}$

30-65)



Magnetic Field for Semi-Circular Segments:

As derived in previous examples, the magnetic field at a distance R away from a semi-circular wire segment is:

$$\vec{B}_{semi} = \frac{\mu_0 I_2}{4R}\hat{k}$$

Now, since the current in each semi-circle travels in the opposite direction ($\hat{i}$ has the same magnitude), then: $\vec{B}_{semi,net} = 0 \Rightarrow \vec{F}_{semi,net} = 0$

Force for the Straight Line Segments:

from section 30.2:

$$\vec{F}_B = \frac{\mu_0 I_1 I_2 L}{2\pi R}\hat{j} \text{ ; force for 2 } \parallel \text{ conductors}$$

$$\Rightarrow \boxed{\vec{F}_{net} = 2\vec{F}_B = \frac{\mu_0 I_1 I_2 L}{\pi R}\hat{j}}$$

In left segment, I_2 is $\parallel$ $\hat{i}$ in same direction as I_1 $\Rightarrow$ this produces a force in the $+\hat{j}$-direction. In the rt. segment I_2 is anti-$\parallel$ to I_1 $\Rightarrow$ this also produces a force in the $+\hat{j}$-direction!