28-64. The right and left sides of the rectangle experience exactly the same magnetic fields, but with reversed current; the forces on these two sides are equal but opposite. The magnetic field due to the current in the AB wire is into-the-page where the rectangular loop is located. For the top of the loop $d\vec{\boldsymbol{\ell}} \times \vec{\mathbf{B}}$ is up-page ($\hat{\mathbf{j}}$) whereas for the bottom of the loop $d\vec{\boldsymbol{\ell}} \times \vec{\mathbf{B}}$ is down-page ($-\hat{\mathbf{j}}$) and weaker due to the reduced B. The net magnetic force is then:

$$F = \frac{\mu_0 I_{AB}}{2\pi}\,\ell I_{\text{loop}}\left(\frac{1}{r_{\text{top}}} - \frac{1}{r_{\text{bottom}}}\right) = \frac{4\pi\times10^{-7}\cdot 14}{2\pi}\,.2\cdot 5\left(\frac{1}{.026} - \frac{1}{.1}\right) = 7.97{\times}10^{-5}\ \text{N}$$

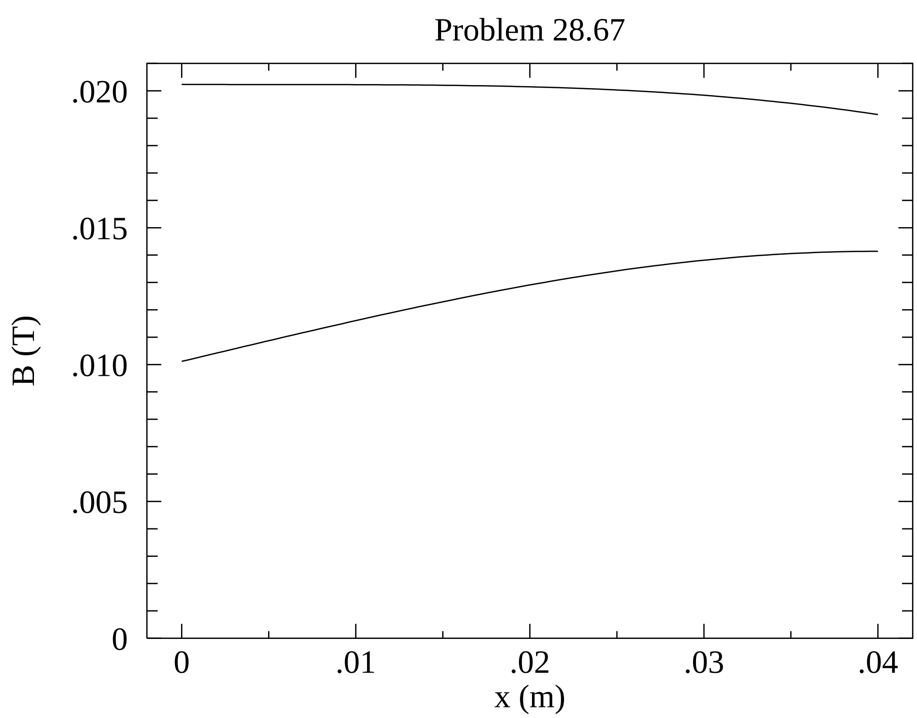
28-67. (a) According to Eq. 28-16 the magnetic field due to a single coil-set is:

$$B_x = \frac{\mu_0 N I a^2}{2(x^2+a^2)^{3/2}}$$

For the left hand coil: $x \rightarrow a/2 + x$ for the right hand coil: $x \rightarrow a/2 - x$. Combining these magnetic fields yields:

$$B_x = \frac{\mu_0 N I a^2}{2}\left[\left((a/2+x)^2 + a^2\right)^{-3/2} + \left((a/2-x)^2 + a^2\right)^{-3/2}\right]$$

(b) Plotted for the data of part (d).



(c) At $x = 0$ we have:

$$B_x = \mu_0 N I a^2\left[\left(\frac{5a^2}{4}\right)^{-3/2}\right] = \frac{\mu_0 N I}{a}\left(\frac{4}{5}\right)^{3/2}$$

(d)

$$B_x = \frac{\mu_0 NI}{a}\left(\frac{4}{5}\right)^{3/2} = \frac{4\pi\times 10^{-7}\cdot 300\cdot 6}{.08}\left(\frac{4}{5}\right)^{3/2} = 0.0202 \text{ T}$$

(e)

$$\frac{dB}{dx} = -3\,\frac{\mu_0 NIa^2}{2}\left[(a/2+x)\left((a/2+x)^2+a^2\right)^{-5/2} - (a/2-x)\left((a/2-x)^2+a^2\right)^{-5/2}\right]$$

At $x = 0$ this is zero.

$$\begin{aligned}\frac{d^2B}{dx^2} &= -3\,\frac{\mu_0 NIa^2}{2}\left\{\left[\left((a/2+x)^2+a^2\right)^{-5/2} + \left((a/2-x)^2+a^2\right)^{-5/2}\right]\right.\\ &\quad \left. -5\left[(a/2+x)^2\left((a/2+x)^2+a^2\right)^{-7/2} + (a/2-x)^2\left((a/2-x)^2+a^2\right)^{-7/2}\right]\right\}\end{aligned}$$

Plugging in $x = 0$ yields:

$$\frac{d^2B}{dx^2} = -3\,\frac{\mu_0 NIa^2}{2}\left[2\left(5a^2/4\right)^{-5/2}\right]\left\{1-5\,\frac{(a/2)^2}{(5a^2/4)}\right\} = 0$$

The results $dB/dx = 0$ and $d^2B/dx^2 = 0$ say the slope is zero and the change in slope is zero: clearly this means flat.

28-79. The suggested integral is essentially $\oint \vec{\mathbf{B}}\cdot d\vec{\boldsymbol{\ell}} = \mu_0 I_{\text{encl}}$, as the 'loop-return' integral from $x = +\infty$ to $x = -\infty$ at $r = \infty$ is zero as $B \sim 1/r^3$ through path length πr yields an integral $\sim 1/r^2 \to 0$ if $r \to \infty$.

$$\int_{-\infty}^{+\infty} B_x\, dx = \frac{\mu_0 I a^2}{2}\int_{-\infty}^{+\infty}\frac{dx}{(x^2+a^2)^{3/2}} = \frac{\mu_0 I}{2}\left[\frac{x}{\sqrt{x^2+a^2}}\right]_{-\infty}^{+\infty} = \frac{\mu_0 I}{2}\left[1--1\right] = \mu_0 I$$

28-82. In the context of the current sheet problem (assigned 8-3), $K = nI$, so the magnetic filed due to one alone sheet is $B = \mu_0 nI/2$ directed either to the right or left. At P and S the magnetic fields due to the bisheet cancel: $B = 0$. At R the fields add with result: $B = \mu_0 nI$ with direction to the right.