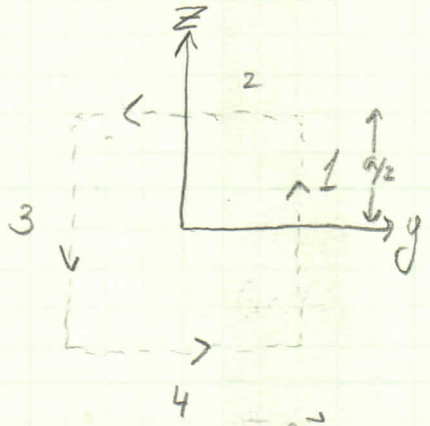
5.4

$$F = I\int_C (d\vec{l}\times\vec{B})$$



$$d\vec{l}_1 = dz\hat{z}\;;\; d\vec{l}_2 = dy\hat{y}\;;\; d\vec{l}_3 = dz\hat{z}\;;\; d\vec{l}_4 = dy\hat{y}\;;\; \vec{B} = kz\hat{x}$$

$$\frac{F}{I} = \int(d\vec{l}_1\times\vec{B}) + \int d\vec{l}_2\times\vec{B} + \int d\vec{l}_3\times\vec{B} + \int d\vec{l}_4\times\vec{B}$$

$$d\vec{l}_1\times\vec{B} = kz\,dz(\hat{z}\times\hat{x}) = kz\,dz\,\hat{y}$$

$$d\vec{l}_2\times\vec{B} = kz\,dy(\hat{y}\times\hat{x}) = -kz\,dy\,\hat{z}$$

$$d\vec{l}_3\times\vec{B} = -kz\,dz(\hat{z}\times\hat{x}) = kz\,dz\,\hat{y}$$

$$d\vec{l}_4\times\vec{B} = kz\,dy(\hat{y}\times\hat{x}) = -kz\,dy\,\hat{z}$$

$$\frac{F}{Ik} = \int_{(0,a/2,-a/2)}^{(0,a/2,a/2)} z\,dz\,\hat{y} + \int_{(0,a/2,a/2)}^{(0,-a/2,a/2)} z\,dy\,\hat{z} - \int_{(0,-a/2,a/2)}^{(0,-a/2,-a/2)} z\,dz\,\hat{y} - \int_{(0,-a/2,-a/2)}^{(0,a/2,-a/2)} z\,dy\,\hat{z}$$

$$\frac{F}{Ik} = \frac{1}{2}z^2\Big|_{-a/2}^{a/2}\hat{y} - yz\Big|_{(0,a/2,a/2)}^{(0,-a/2,a/2)}\hat{z} + \frac{1}{2}z^2\Big|_{a/2}^{-a/2}\hat{y} - yz\Big|_{(0,-a/2,-a/2)}^{(0,a/2,-a/2)}\hat{z}$$

$$\frac{F}{Ik} = 0\hat{y} - \left[\frac{-a^2}{4} - \frac{a^2}{4}\right]\hat{z} + 0\hat{y} - \left[\frac{a^2}{4} - \frac{a^2}{4}\right]\hat{z} = a^2$$

$$F = Ika^2\hat{z}$$