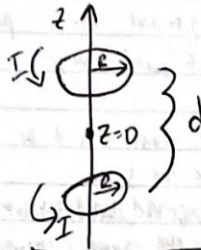


Problem 1

S.47



$$B(z) = \frac{\mu_0 I}{4\pi} \int \frac{dl'}{r^2} \cos\theta$$

$$B(z) = \frac{\mu_0 I}{4\pi} \left(\frac{\cos\theta}{r^2} \right) 2\pi R$$

$$= \frac{\mu_0 I}{2} \frac{R^2}{(R^2 + z^2)^{3/2}}$$

$$a). \vec{B} = \frac{\mu_0 I R^2}{2} \left\{ \frac{1}{[R^2 + (d/2 + z)^2]^{3/2}} + \frac{1}{[R^2 + (d/2 - z)^2]^{3/2}} \right\} \hat{z}$$

$$\frac{\partial B}{\partial z} = \frac{\mu_0 I R^2}{2} \left\{ \frac{(-3/2)(d/2 + z)}{[R^2 + (d/2 + z)^2]^{5/2}} + \frac{(-3/2)(d/2 - z)(-1)}{[R^2 + (d/2 - z)^2]^{5/2}} \right\}$$

$$= \frac{3\mu_0 I R^2}{2} \left\{ \frac{-(d/2 + z)}{[R^2 + (d/2 + z)^2]^{5/2}} + \frac{(d/2 - z)}{[R^2 + (d/2 - z)^2]^{5/2}} \right\}$$

$$\frac{\partial B}{\partial z} \Big|_{z=0} = \frac{3\mu_0 I R^2}{2} \left\{ \frac{-d/2}{[R^2 + (d/2)^2]^{5/2}} + \frac{d/2}{[R^2 + (d/2)^2]^{5/2}} \right\} = 0$$

$$\frac{\partial B}{\partial z} \Big|_{z=0} = 0$$

$$b). \frac{\partial^2 B}{\partial z^2} = \frac{3\mu_0 I R^2}{2} \left\{ \frac{-1}{[R^2 + (d/2 + z)^2]^{5/2}} + \frac{-(d/2 + z)(-3/2)(d/2 + z)}{[R^2 + (d/2 + z)^2]^{7/2}} \right.$$

$$\left. + \frac{-1}{[R^2 + (d/2 - z)^2]^{5/2}} + \frac{(d/2 - z)(-3/2)(d/2 - z)(-1)}{[R^2 + (d/2 - z)^2]^{7/2}} \right\}$$

$$\frac{\partial^2 B}{\partial z^2} \Big|_{z=0} = \frac{3\mu_0 I R^2}{2} \left\{ \frac{-2}{[R^2 + (d/2)^2]^{5/2}} + \frac{2(d/2)^2}{[R^2 + (d/2)^2]^{7/2}} \right\}$$

$$= \frac{3\mu_0 I R^2}{[R^2 + (d/2)^2]^{7/2}} \left(-R^2 - \frac{d^2}{4} + \frac{d^2}{4} \right) = \frac{3\mu_0 I R^2}{[R^2 + (d/2)^2]^{7/2}} (d^2 - R^2)$$

$$d = R$$

$$B(0) = \frac{\mu_0 I R^2}{2} \left\{ \frac{1}{[R^2 + (R/2)^2]^{3/2}} + \frac{1}{[R^2 + (R/2)^2]^{3/2}} \right\} = \frac{\mu_0 I R^2}{[R^2 + (R/2)^2]^{3/2}}$$

$$= \frac{8\mu_0 I}{5^{3/2} R} \rightarrow \boxed{\frac{8\mu_0 I}{5^{3/2} R}}$$

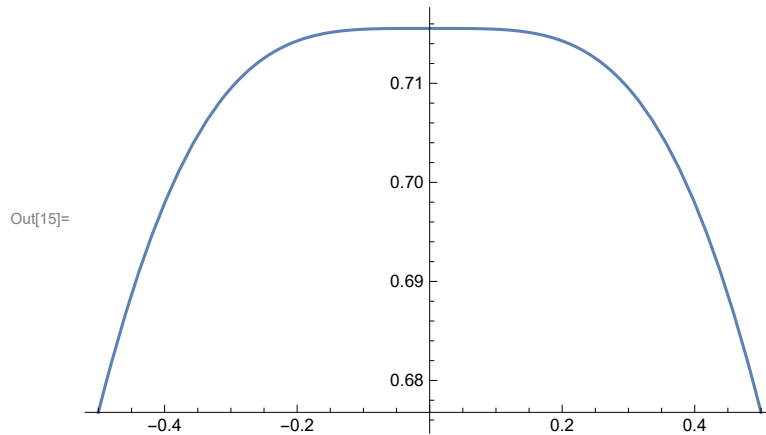
Part c

In[10]: $R = 1;$
 $I_c = 1;$
 $u_0 = 1;$

$$\text{In[13]:= MagField} = \frac{(u0 * Ic * R^2)}{2} * \left(\frac{1}{\left(R^2 + \left(\frac{R}{2} + z\right)^2\right)^{\frac{3}{2}}} + \frac{1}{\left(R^2 + \left(\frac{R}{2} - z\right)^2\right)^{\frac{3}{2}}} \right)$$

$$\text{Out[13]=} \frac{1}{2} \left(\frac{1}{\left(1 + \left(\frac{1}{2} - z\right)^2\right)^{\frac{3}{2}}} + \frac{1}{\left(1 + \left(\frac{1}{2} + z\right)^2\right)^{\frac{3}{2}}} \right)$$

$$\text{In[15]:= Plot[MagField, \{z, -\frac{R}{2}, \frac{R}{2}\}]$$



Problem 2

```

deltatau =  $\frac{(40 * \text{Pi})}{200}$ ;

deltalx = -Sin[u] * deltau;
deltaly = Cos[u] * deltau;
deltalz =  $\left(\frac{0.05}{\text{Pi}}\right) * \text{deltau}$ ;
deltal = {deltalx, deltaly, deltalz};
rx = x - Cos[u];
ry = y - Sin[u];
rz = z -  $\frac{0.05}{\text{Pi}} * u$ ;
r = {rx, ry, rz};

```

In[8]:=
$$\mathbf{B} = \text{Sum}\left[\mathbf{u0} * \frac{\mathbf{Ic}}{4 * \text{Pi}} * \left(\text{Cross}\left[\{-\text{Sin}[u] * \text{deltau}, \text{Cos}[u] * \text{deltau}, \left(\frac{0.05}{\text{Pi}}\right) * \text{deltau}\}, \right.\right.\right.$$

$$\left.\left.\left\{x - \text{Cos}[u], y - \text{Sin}[u], z - \frac{0.05}{\text{Pi}} * u\right\}\right] / \right.$$

$$\left.\left.\left(\text{Norm}\left[\left\{x - \text{Cos}[u], y - \text{Sin}[u], z - \frac{0.05}{\text{Pi}} * u\right\}\right]\right)^3\right), \{u, -20 * \text{Pi}, 20 * \text{Pi}, \text{deltau}\}\right]$$

Out[8]=
$$\left\{ \frac{-0.628319 - 0.01 y + \frac{\pi z}{5}}{4 \pi \left(\text{Abs}[-1+x]^2 + \text{Abs}[y]^2 + \text{Abs}[-1+z]^2\right)^{3/2}} + \dots 199 \dots + \frac{0.628319 - 0.01 y + \frac{\pi z}{5}}{4 \pi \left(\text{Abs}[-1+x]^2 + \text{Abs}[y]^2 + \text{Abs}[1+z]^2\right)^{3/2}}, \right.$$

$$\dots 1 \dots, \frac{\frac{\pi}{5} - \frac{\pi x}{5}}{4 \pi \left(\text{Abs}[-1+x]^2 + \text{Abs}[y]^2 + \text{Abs}[\dots 1 \dots]^2\right)^{3/2}} + \frac{\frac{\pi}{5} - \frac{\pi x}{20} - \frac{\pi x}{4 \sqrt{5}} + \frac{1}{5} \sqrt{\frac{5}{8} - \frac{\sqrt{5}}{8}} \pi y}{4 \pi \left(\text{Abs}[\dots 1 \dots]^2 + \dots 1 \dots^2 + \dots 1 \dots^2\right)^{3/2}} +$$

$$\frac{\frac{\pi}{5} + \frac{\dots 1 \dots}{20} - \frac{\dots 1 \dots}{5} \sqrt{\frac{5}{8} + \dots 1 \dots}}{4 \pi \left(\dots 1 \dots\right)^{3/2}} + \dots 195 \dots + \frac{\dots 1 \dots}{\dots 1 \dots} +$$

$$\left. \frac{\frac{\pi}{5} - \frac{\pi x}{20} - \frac{\pi x}{4 \sqrt{5}} - \frac{1}{5} \sqrt{\frac{5}{8} - \frac{\sqrt{5}}{8}} \pi y}{4 \pi \left(\dots 1 \dots\right)^{3/2}} + \frac{\frac{\pi}{5} - \frac{\pi x}{5}}{4 \pi \left(\text{Abs}[\dots 1 \dots]^2 + \dots 1 \dots^2 + \text{Abs}[\dots 1 \dots]^2\right)^{3/2}} \right\}$$

large output

show less

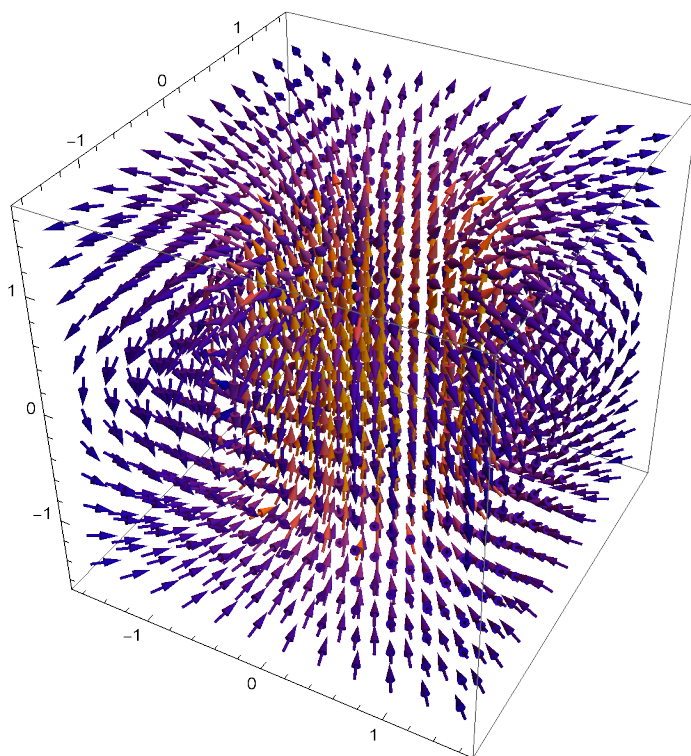
show more

show all

set size limit...

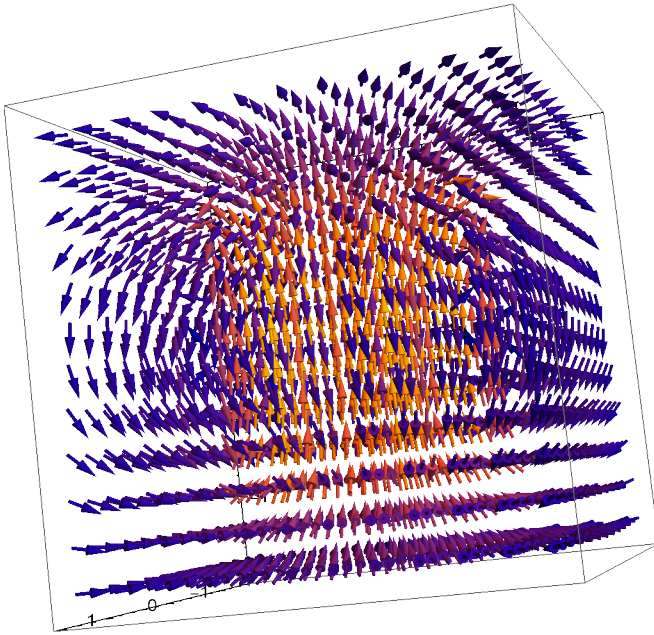
In[9]:= `VectorPlot3D[B, {x, -1.5, 1.5}, {y, -1.5, 1.5}, {z, -1.5, 1.5}, VectorPoints -> {12, 12, 12}]`

Out[9]=



```
In[6]:= VectorPlot3D[B, {x, -1.5, 1.5}, {y, -1.5, 1.5}, {z, -1.5, 1.5}, VectorPoints -> {12, 12, 12}]
```

Out[6]=



```
In[7]:= VectorPlot3D[B, {x, -1.5, 1.5}, {y, -1.5, 1.5}, {z, -1.5, 1.5}, VectorPoints -> {12, 12, 12}]
```

Out[7]=

