MAGNETOSTATICS

$\bar{B}$ MAGN. FLUX DENSITY

$\bar{H}$ MAGN. FIELD

$$\bar{B} = \mu_0 \bar{H}$$

$\mu_0 = 4\pi \cdot 10^{-7} \frac{Vs}{Am}$

FREE-SPACE PERMEABILITY

$$[\bar{H}] = \frac{A}{m}$$

$$[\bar{B}] = \frac{Vs}{m^2} = T$$

$\bar{D}$

$\bar{E}$

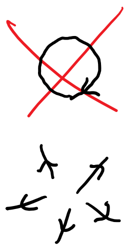
$$\bar{D} = \varepsilon_0 \bar{E}$$

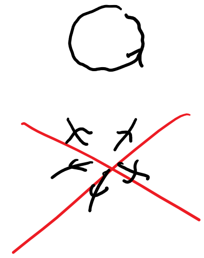
$$[\bar{E}] = \frac{V}{m}$$

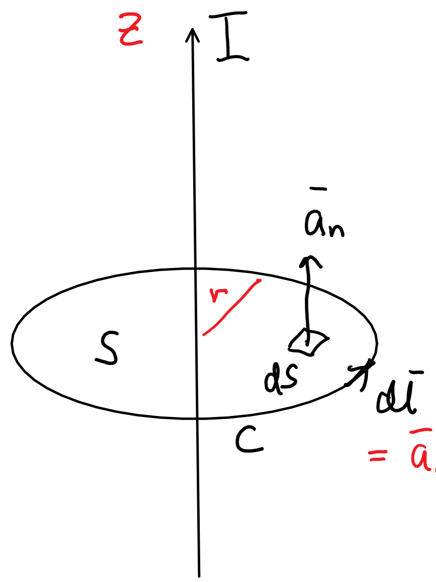
$$[\bar{D}] = \frac{As}{m^2}$$

$$\nabla \times \bar{E} = 0 \qquad \nabla \times \bar{H} = \bar{J} \quad \text{(Ampère)}$$

$$\nabla \cdot \bar{D} = \rho_s \qquad \nabla \cdot \bar{B} = 0$$







$$= \bar a_\phi \, r \, d\phi$$

$$\bar H(\underset{x,y,z}{\bar R}) = ?$$

$$\nabla \times \bar H = \bar J$$

$$\bar H(\bar R) = \bar H(r, \cancel{\phi}, \cancel{z})$$

STOKES: $$\underbrace{\int_S \underbrace{\nabla \times \bar H}_{\bar J} \cdot d\bar S}_{= I} = \oint_C \bar H \cdot d\bar l$$

$$\oint_C \bar H \cdot d\bar l = \int_0^{2\pi} \underbrace{\bar H(r) \cdot \bar a_\phi}_{H_\phi(r)} \, r \, d\phi$$

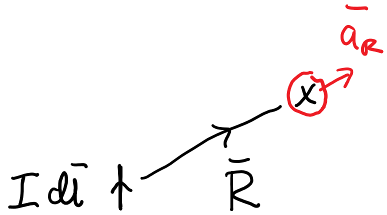
$$= r \, H_\phi(r) \, 2\pi$$

$$\bar R = R \bar a_R = \bar a_x x + \bar a_y y + \bar a_z z$$

$$= \bar a_r r + \bar a_z z$$

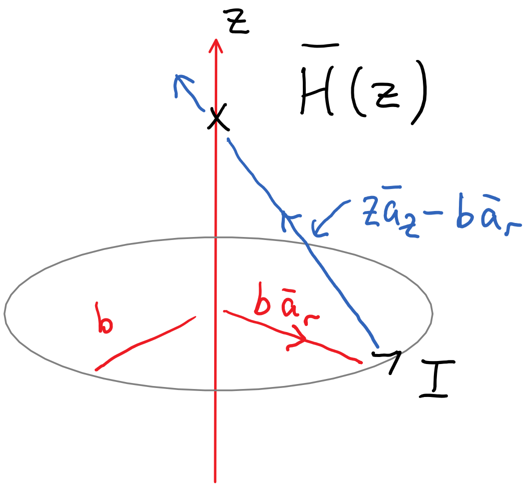
$$\underset{(r)}{\bar H(\bar R)} = \bar a_\phi \frac{I}{2\pi r}$$

BIOT-SAVART'S LAW



$$\bar H(\bar R) = \frac{I \; d\bar l \times \bar a_r}{4\pi R^2}$$

$$\bar R = z\,\bar a_z$$



$$\bar H(z) = \oint \frac{I \; \overbrace{d\bar l}^{\bar a_\phi\, b\, d\phi} \times (z\,\bar a_z - b\,\bar a_r)}{4\pi \sqrt{z^2+b^2}^{\,3}}$$

$$\bar a_\phi \times \bar a_z = \bar a_r$$

$$\bar a_\phi \times (-\bar a_r) = \bar a_z$$

$$\bar H(z) = \frac{I\, b^2\, \bar a_z}{4\pi\,(z^2+b^2)^{3/2}} \overbrace{\int_0^{2\pi} d\phi}^{2\pi}$$

$$= \frac{I \pi b^2}{4\pi\,(z^2+b^2)^{3/2}}\; \bar a_z\; 2$$

$z >> b$

$$\bar H(z) = \frac{\overbrace{\mu_0 I \pi b^2}^{p_m}}{4\pi \mu_0 z^3}\; 2\,\bar a_z$$

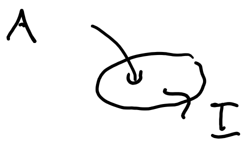
ELECTRIC DIPOLE

$\left.\begin{array}{l} R = z \\ \theta = 0 \end{array}\right\} +z\text{-axis}$

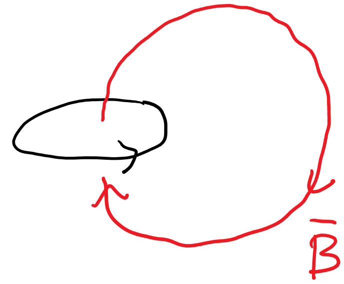
$$\bar E = \frac{p_e}{4\pi\varepsilon_0 \underbrace{R^3}_{z^3}} \left(2\underbrace{\bar a_R}_{\bar a_z} \underbrace{\cos\theta}_{1} + \underbrace{\sin\theta}_{0}\, \bar a_\theta\right)$$

+z-axis

$$\bar{E}(z) = \frac{p_e}{4\pi\varepsilon_0 z^3} 2\bar{a}_z$$



$$p_m = \mu_0 \underbrace{IA}_{m}$$



$[m] = Am^2$

$$[p_m] = Am^2 \frac{Vs}{Am} = Vsm$$

$[p_e] = Asm$