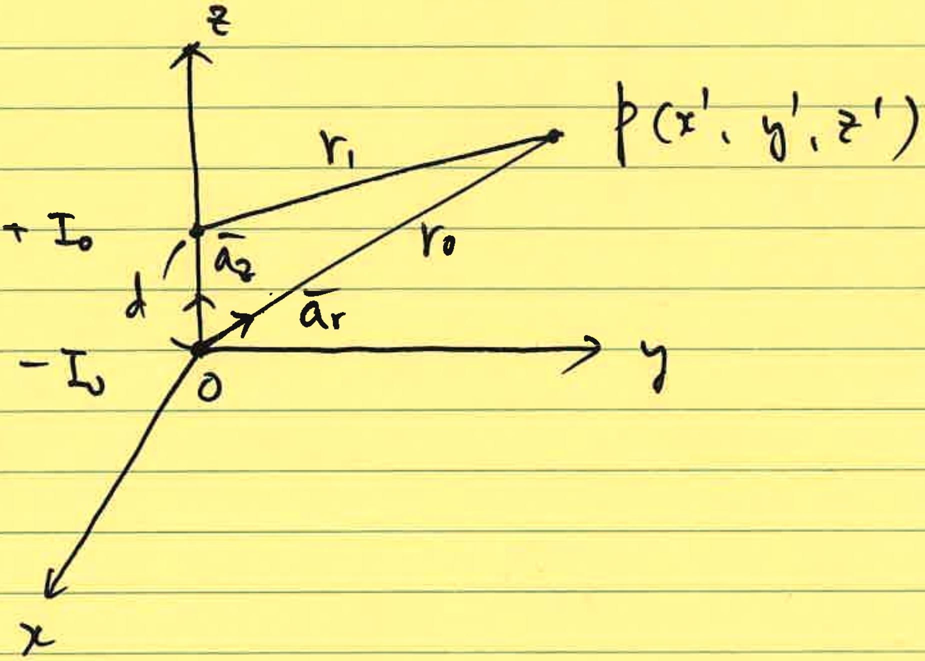
Dipole field



$$\phi(x', y', z') = -\frac{I_0}{4\pi\sigma}\frac{1}{r_0} + \frac{I_0}{4\pi\sigma}\frac{1}{r_1}$$

$$\frac{1}{r_1} = \frac{1}{r_0} + \frac{\partial}{\partial z}\left(\frac{1}{r}\right)\cdot d$$: Taylor series expansion of $\frac{1}{r_1}$

$$\phi = \frac{I_0}{4\pi\sigma}\frac{\partial}{\partial z}\left(\frac{1}{r}\right) d$$

$$= \frac{I_0}{4\pi\sigma}\left[\nabla\left(\frac{1}{r}\right)\cdot\bar{a}_z\right] d$$

$$= \frac{I_0}{4\pi\sigma}\nabla\left(\frac{1}{r}\right)\cdot\bar{d}$$

$I_0 d = p \quad , \quad I_0 \bar{d} = \bar{p}$

$\Rightarrow$ dipole moment

$$\phi = \frac{1}{4\pi\sigma} \nabla\left(\frac{1}{r}\right) \cdot \bar{p}$$

$$= \frac{1}{4\pi\sigma} \frac{\bar{a}_r}{r^2} \cdot \bar{p}$$

$$= \frac{p}{4\pi\sigma} \cdot \frac{\cos\theta}{r^2}$$