EE468G NOTES (5B)

Reading assignment:

Contents: Magnetic fields (Part I)

Maxwell's equations for magnetostatics in free-space

Differential format:

$$\nabla \times \vec{B} = \mu_0 \vec{J} \qquad \text{(Ampere's Law)}$$

$$\nabla \cdot \vec{B} = 0 \qquad \text{(Gauss' Law for magnetic)}$$

Integral form:

$$\oint_S \vec{B} \cdot d\vec{S} = 0$$

$$\oint_C \vec{B} \cdot d\vec{l} = \mu_0 I$$

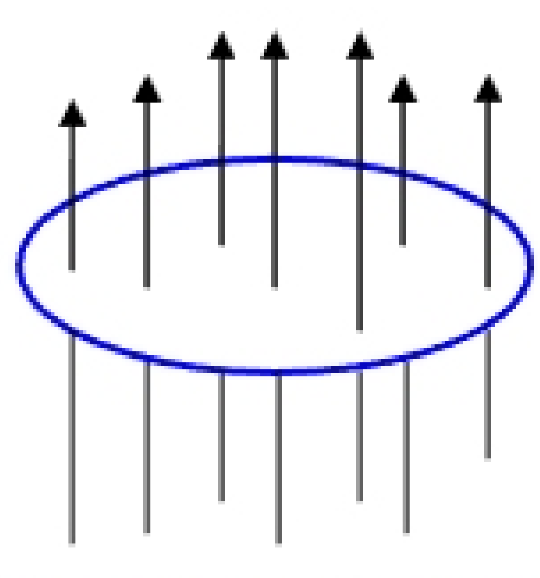
$\vec{B}$: Magnetic flux density, tesla (T) or [weber/m^2]

$\mu_0 = 4\pi \times 10^{-7}$ [H/m]: Free-space permeability

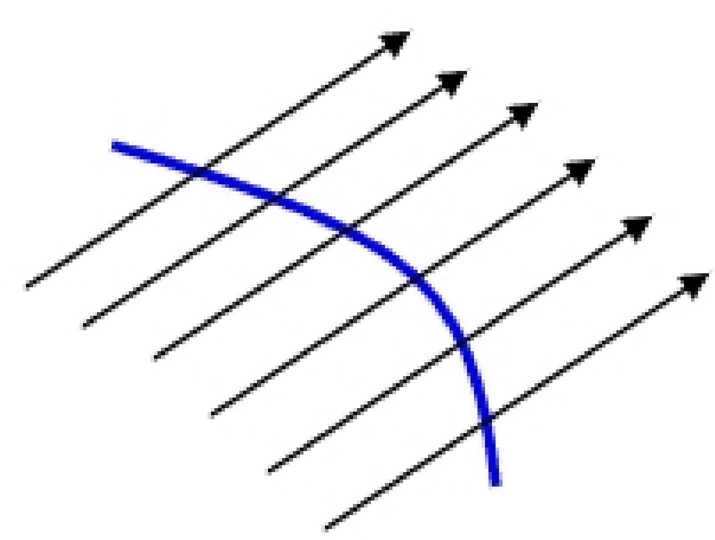
$\vec{J}$: Volume current density [A/m^2]

or surface current density [A/m]

I: Total current flow [A]



Use surface integral to calculate the total current from volume current density.



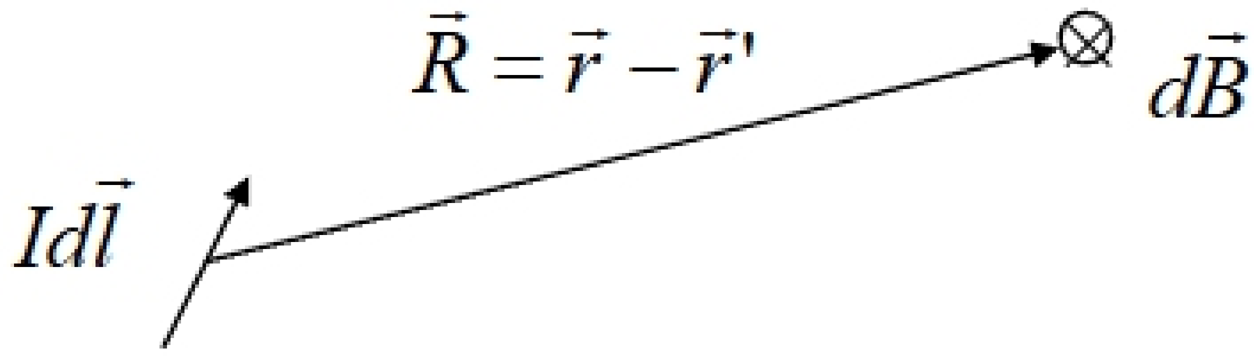
Use line integral to calculate the total current from surface current density.

Magnetic flux density calculation

Biot-Savart Law: the magnetic flux density generated by a current element is given by

$$d\vec{B} = \frac{\mu_0}{4\pi} \frac{Id\vec{l} \times (\vec{r} - \vec{r}')}{|\vec{r} - \vec{r}'|^3}, \qquad [T]$$

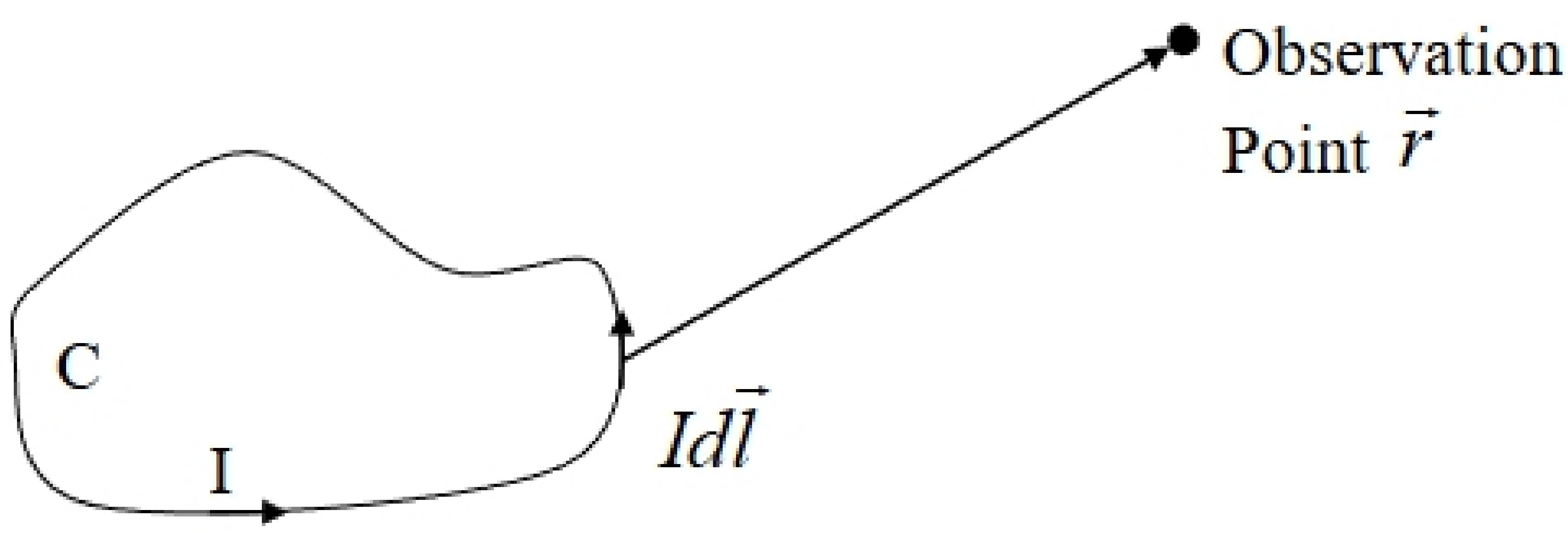
The unit of magnetic flux density is T, which stands for Tasla.



Property: $d\vec{B} \perp d\vec{l}$, $\qquad d\vec{B} \perp \vec{R}$

The magnetic flux density generated by a current loop is given by

$$\vec{B} = \frac{\mu_0 I}{4\pi} \oint_C \frac{d\vec{l} \times (\vec{r} - \vec{r}')}{|\vec{r} - \vec{r}'|^3}, \quad [T]$$



This formula can be extended to the surface current and volume current. Simply change the domain of integration.