ECE 30
Day 16 Notes

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Agenda

- Sinusoidal Traveling Waves - Complete
- Magnitism Introduction
- Magnetic Force

Sinusoidal Traveling Waves

By definition:

$$v = \frac{\lambda}{T}$$

therefore:

$$y(x,t) = Asin(2\pi(\frac{x}{\lambda} - \frac{t}{T})$$

The Wave number $k \triangleq \frac{2\pi}{\lambda}$:
We know $\omega = \frac{2\pi}{T}$:

$$y(x,t) = Asin(kx - \omega t)$$

In general:

$$y(x,t) = Asin(kx - \omega t + \phi)$$

Magnetism

There exists a magnetic field, written with $\vec{B}$ which is measured in Teslas (T).

The direction of $\vec{B}$ is the direction of a compass needle held at that point.

Magnetic fields always flow from North poles to South poles. Similar to Electric fields which always flow from Positive to Negative.

We can define $\vec{B}$ at any point in space by the magnetic force exerted on a charged particle moving ad $\vec{v}$
Magnetic force is written $\vec{F_B}$

Magnetic Forces

We can empirically determine:

1. $|\vec{F_B}| \propto q_1|\vec{v}|$
2. If $\vec{v}$ is parallel to $\vec{B}$ then $\vec{F_B} = 0$
3. The direction of $\vec{F_B}$ is perpendicular to both $\vec{v}$ and $\vec{B}$
4. $\vec{F_B}$ on a positive charge is opposite $\vec{F_B}$ on a negative charge.
5. $|\vec{F_B}| \propto |\vec{v} \times \vec{B}|$

These properties imply that:

$$\vec{F_B} = k(\vec{v} \times \vec{B})$$

Magnetic fields use the right hand rule. We curl our right hand from $\vec{v}$ to $\vec{B}$, and our thumb points in the direction of $\vec{F_B}$. The standard cross product uses this rule. This only applies if q is positive.

Therefore:

$$\vec{F_B} = q(\vec{v} \times \vec{B})$$

This is one of the cases which motivated the creation of the cross product.

We also get the identity:

$$|\vec{F_B}| = q|\vec{v}||\vec{B}|sin(\theta)$$

This comes from the definition of the cross product.

$\vec{B}$ on a current carrying conductor can has the following properties according to experiments

1. $d\vec{B} \propto \vec{r}, d\vec{s}$