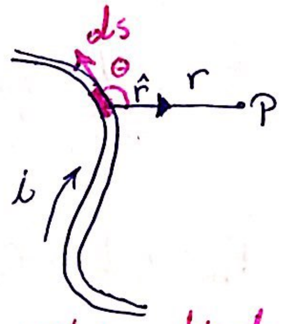
Chapter 29: Magnetic fields due to Currents



- If we take a piece of the wire (ds)

Then $dB = \dfrac{\mu_0 i}{4\pi} \dfrac{ds \times \hat{r}}{r^2}$ → a vector that points from ds to P

dB: magnetic field

ds: in the direction of i in ds

- This is called the Biot_Savart law

* Now, to Calculate B you need to integrate

As a result :-

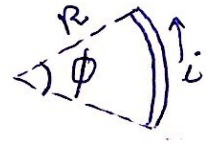
Magnetic field of a long straight wire

$B = \dfrac{\mu_0 i}{2\pi R}$

Magnetic field of a Circular Arc

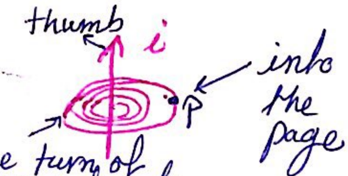
$B = \dfrac{\mu_0 i \phi}{4\pi R}$ → ϕ in Radians

B: in the center



- Note: R is the perpendicular distance of the point from the wire

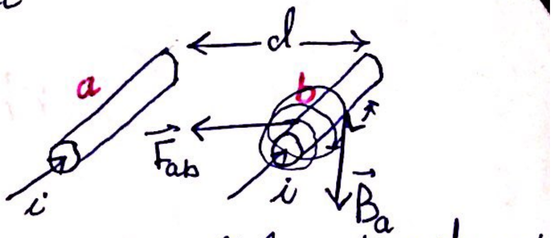
- Direction of B



Alaa Etarini

• Force between two parallel currents

• Direction of B on wire b due to wire a



$$B_a = \frac{\mu_0 i_a}{2\pi d}$$

$d \rightarrow$ distance between wires

• parallel :- attract each other

• Remember: $F = i\vec{L} \times \vec{B}$

→ antiparallel : repel each other

So $F_{ba} = i_b L_b \times B_a$

$$= i_b L_b \frac{\mu_0 i_a}{2\pi d}$$

$$\boxed{F_{ba} = \frac{\mu_0 i_a i_b L_b}{2\pi d}}$$

• Ampere's law

$$\oint B \cdot d\vec{s} = \mu_0 i_{enc}$$

• to use it, you create a closed loop called **Amperian loop**

If i is in the same direction your thumb then it's positive if not it's negative

Explanation :-

So $i_{enc} = i_1 - i_2$

(كَتِلوها :p)

The thumb is pointing out of the page when your fingers are pointing in the **Direction of integration** (The arrow)

← تفرجنة ع ترتيب

In the book page 772 fig 29-12 is really useful to understand

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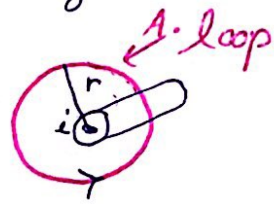
Applications on Ampere's law

↳ Magnetic field **outside** a long straight wire



$$\oint B \cdot ds = B \oint ds = B(2\pi r)$$

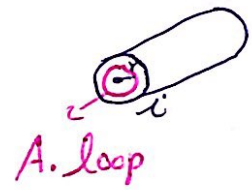
es.

summation of all line segments with lengths ds around the loop

$$B\, 2\pi r = i_{enc}\, \mu_0$$

$$B = \frac{\mu_0 i}{2\pi r}$$

↳ Magnetic field **inside** a long straight wire



$$\oint B \cdot ds = B\, 2\pi r$$

density

But here $i_{enc} = i\, J$

$$= i\, \frac{\pi r^2}{\pi R^2}$$ → radius

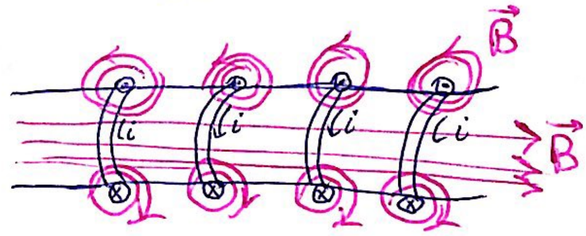
So $B = \left(\frac{\mu_0 i}{2\pi R^2}\right) r$

Solenoids

B outside is zero

$B = \mu_0\, i\, n$

- number of Turns per unit length



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