

Class XII Academic Program-2020

PHYSICS 2ND PAPER

Lecture : P-12

Chapter 04 : Magnetic effects of current and magnetism



Today's Topics:

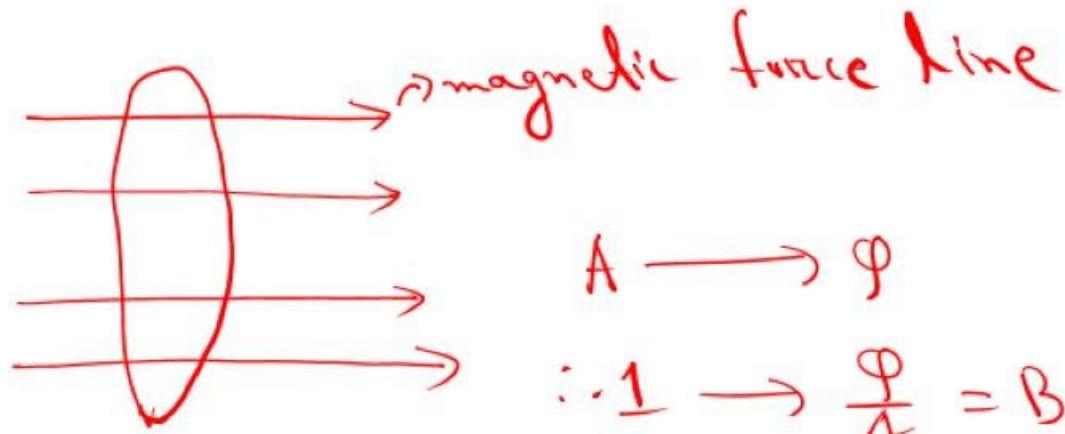
- Magnetism
- Classification of magnetic materials
- Magnetic domain
- Electromagnet and permanent magnet
- Hysteresis
- Mathematical example

Magnetism

- Curie Point/Temp
- Magnetic flux density (\vec{B})
- Magnetic permeability (μ)
- Magnetic field intensity (\vec{H})
- Magnetic dipole moment (\vec{m})

- Magnetic Induction (\vec{B})
- Magnetic susceptibility (χ)
- Magnetic retentivity \rightarrow no symbol (*just property*)
- Magnetization Intensity (\vec{I})

Curie point: With increase in Temp., magnetic properties of ferromagnetic materials generally degrades. The temperature after which magnetic properties vanished totally is called Curie point, i.e. 770°C / 1043K for Iron.

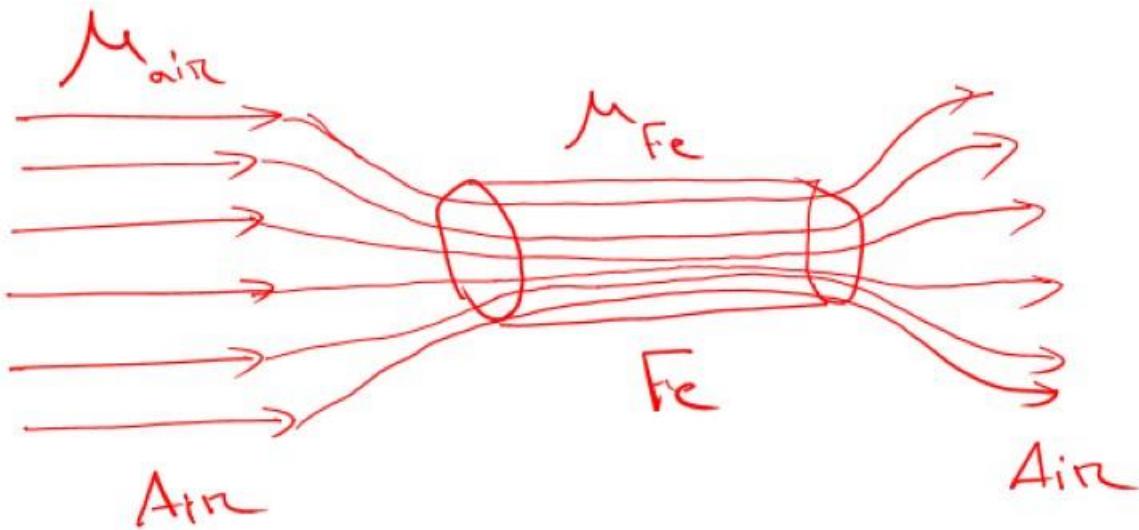


A, Φ

$$A \longrightarrow \Phi$$

$$\therefore 1 \rightarrow \frac{\Phi}{A} = B = \frac{wb}{m^2} = T$$

(Flux per unit Area)



$$\mu_{Fe} > \mu_{air}$$

$\mu \uparrow \longrightarrow$ magnetic force line density \uparrow

So, the more B
So, $B \propto \mu$

\vec{H} (magnetic Intensity)

H increases with increase in magnetic force line density

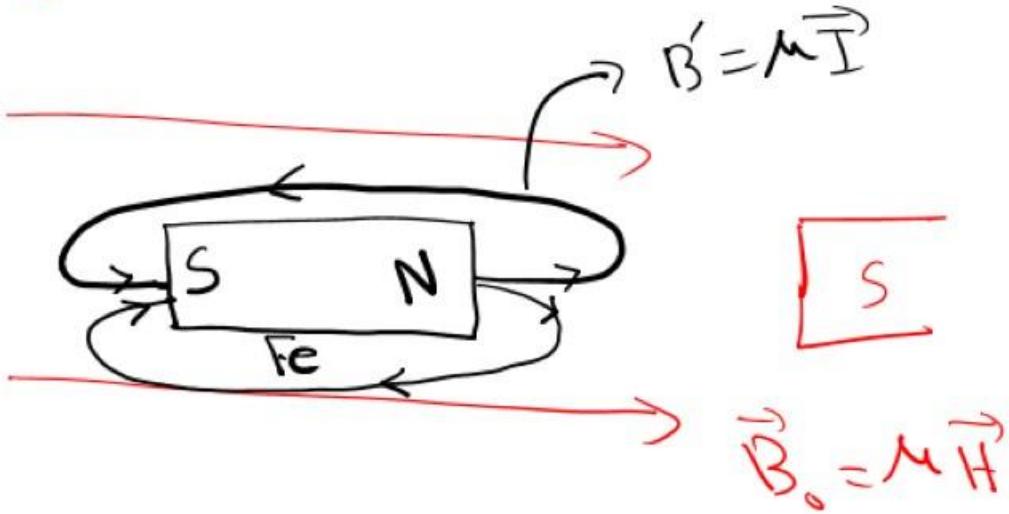
and, $B \propto H$

$$B \propto M$$

So,
$$\boxed{B = \mu H}$$

T Am^{-1}

Magnetization Intensity (\vec{I}):

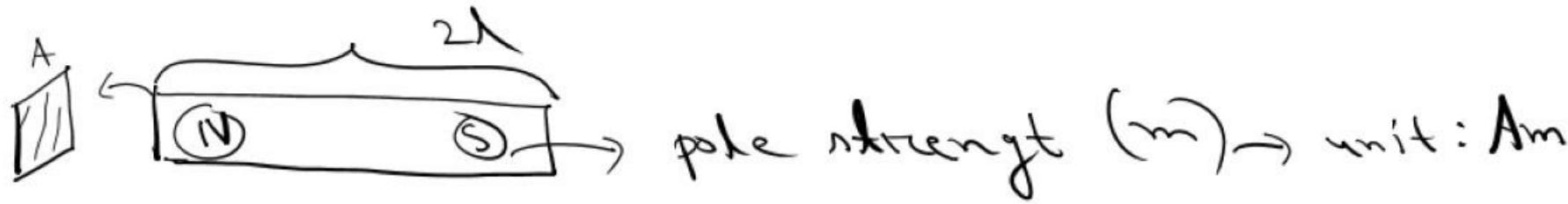


$$\begin{aligned} \vec{B}' &= \mu \vec{I} ; \quad \vec{B}_0 = \mu \vec{H} \\ &\uparrow \qquad \qquad \uparrow \\ &\text{newly produced} \qquad \text{Applied} \\ \vec{B}_{\text{total}} &= \vec{B}_0 + \vec{B}' = \mu (\vec{H} + \vec{I}) \\ &\hookrightarrow \text{magnetic induction} \end{aligned}$$

$$\eta = \frac{\text{output}}{\text{input}} ; \text{ here input} \rightarrow H ; \text{ output} \rightarrow I$$

$$\text{So, } \chi = \frac{I}{H} \quad (\text{no unit})$$

↳ magnetic susceptibility (or, mag. efficiency)



pole strength (m) \rightarrow unit: Am

$$V = A \times 2l ; \quad \vec{M} = m \times 2l$$

$$\vec{B} = \mathcal{N} \vec{I} \vec{A}$$

$$V \rightarrow M$$

$$\therefore 1 \rightarrow \frac{M}{V} = I \rightarrow \text{magnetization intensity}$$

$$\Rightarrow I = \frac{M}{V} = \frac{m \times 2l}{A \times 2l} = \underbrace{\frac{m}{A}}_{\substack{\rightarrow \text{pole strength per} \\ \text{unit Area}}}$$

A steel plate of 0.001 sq. meter area is placed in a magnetic field to make it a magnet. If its pole energy becomes 1 Am find out magnetization intensity?

I

$$I = \frac{M}{V} = \frac{m}{A} = \frac{1 \text{ Am}}{0.001 \text{ m}^2} = 1000 \text{ Am}^{-1}$$

(Am)

POLL QUESTION 01

What's iron's curie temperature?

- (a) 700°C
- (b) 770°C
- (c) 900°C
- (d) 970°C

Classification of magnetic substance

✓ Paramagnetism

✓ Diamagnetism

✓ Ferromagnetism

Ferrimagnetism

Antiferrimagnetism

$$\vec{\mu} = \vec{\mu}_v + \vec{\mu}_s = -\frac{e}{2m} (\vec{L} + 2\vec{s})$$



single orbital with single e^-
produce \vec{B} , \vec{m}

but, orbital with double e^-

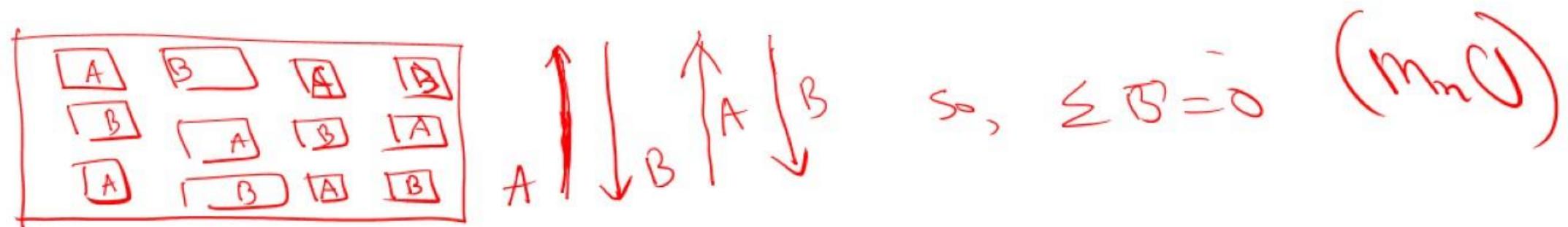
Diamagnetic
→ have no single e^- orbital (H_2O)
paramagnet
→ have at least one e^- orbital (O_{atom})

$$\text{produce } \cancel{\vec{B}} \cancel{\vec{m}} \quad \sum \vec{B} = 0$$
$$\sum \vec{m} = 0$$

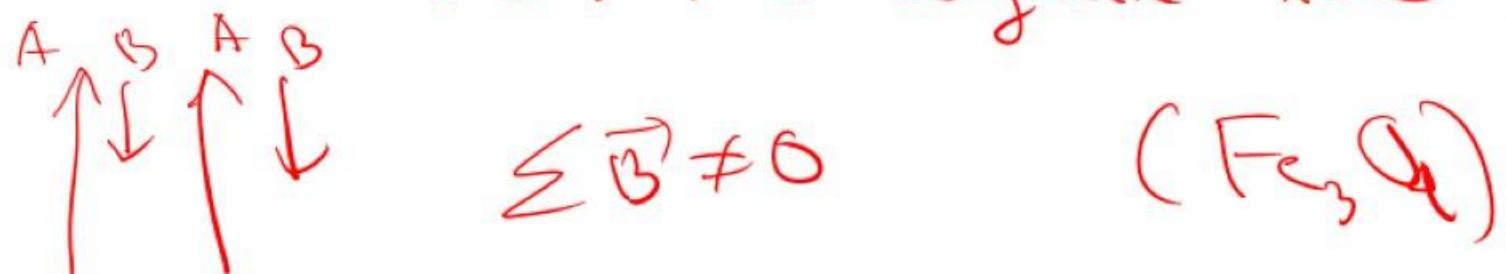
পদার্থবিজ্ঞান ২য় পত্র
অধ্যায় ০৪: তড়িৎ প্রবাহের চৌম্বক ক্রিয়া ও চুম্বকত্ব

- ↳ Ferromagnetic materials (having many single e^- orbital)
- ↳ Strong magnetic property (Fe, Co, Ni)

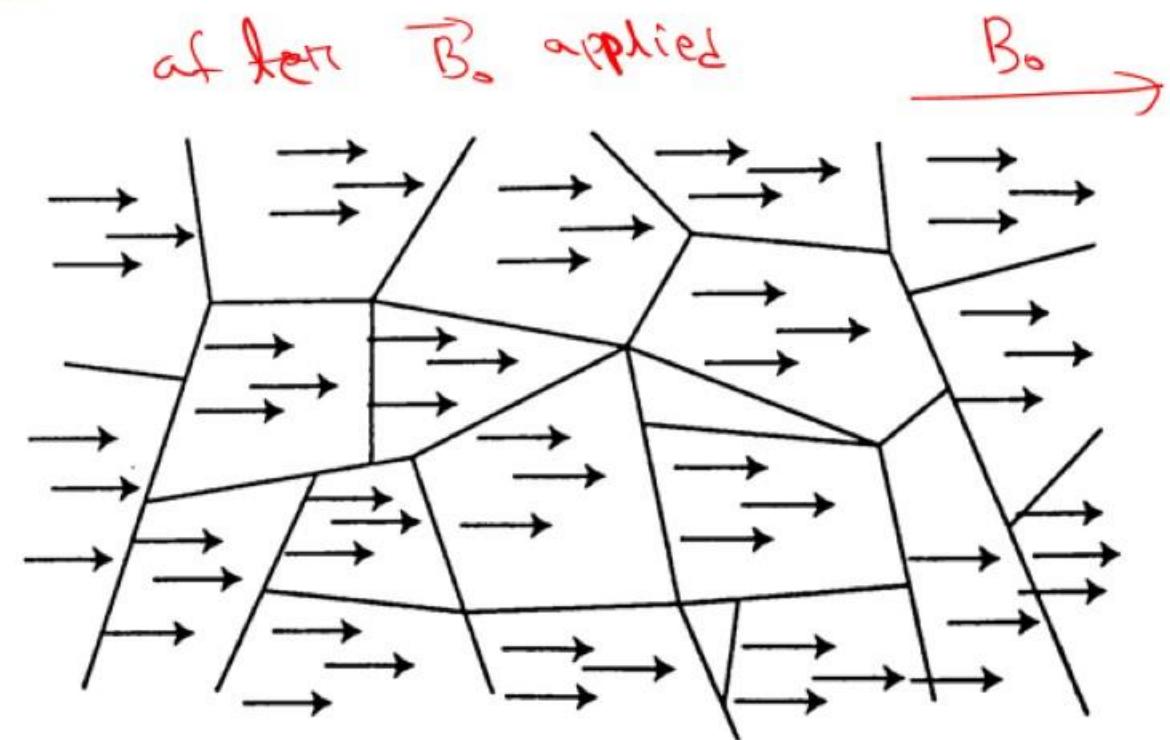
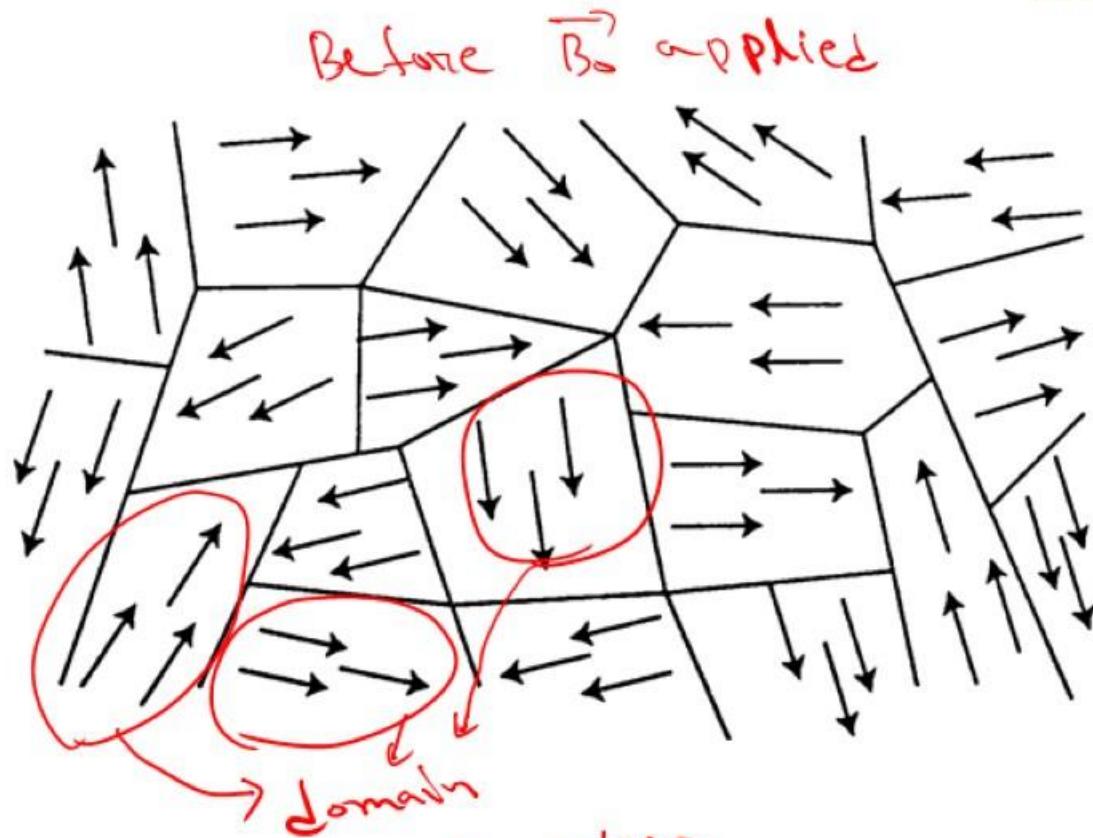
Anti-Ferro: 2 type of sub-lattice along one after another



Ferrimagnet: same as Anti-Ferro but Strength of two sub-lattice magnetic field isn't same



Magnetic Domain



$$\vec{T} = \vec{m} \times \vec{B}$$

\vec{B}_0

rotation due to \vec{B}

Permanent and Temporary Magnet

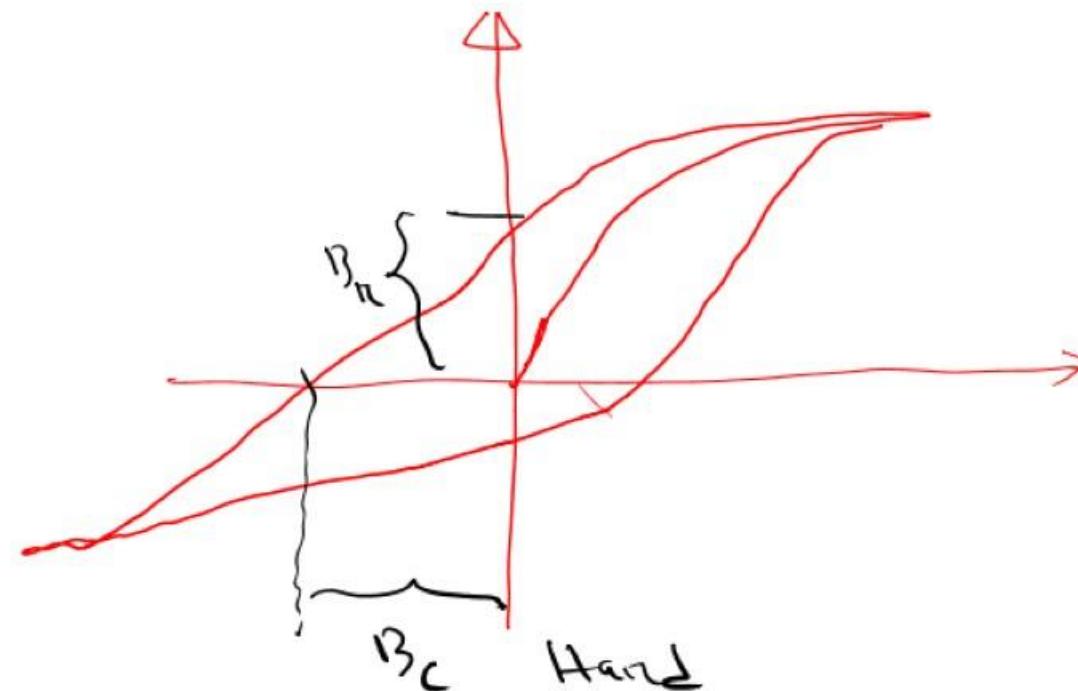
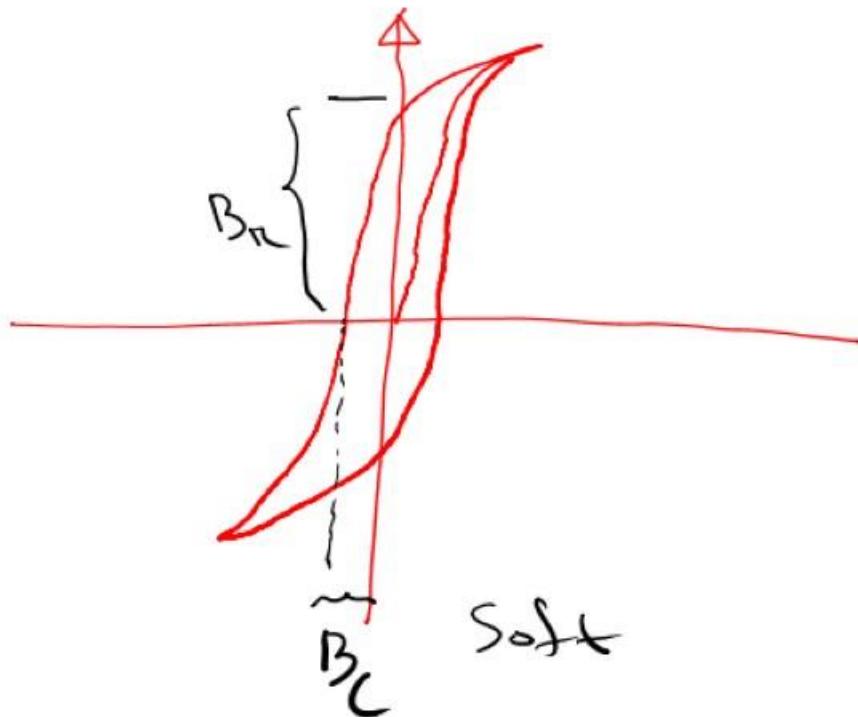
Artificial Magnet

Permanent Magnet

Temporary Magnet

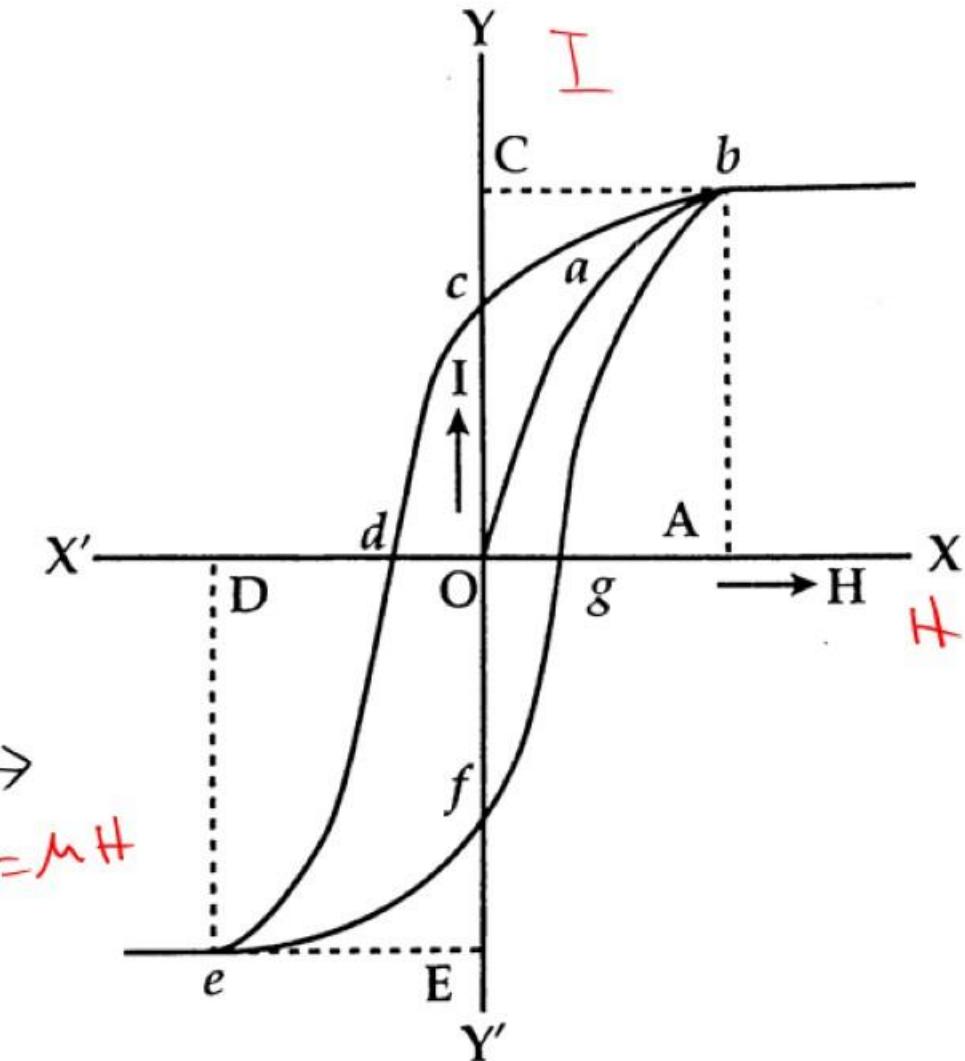
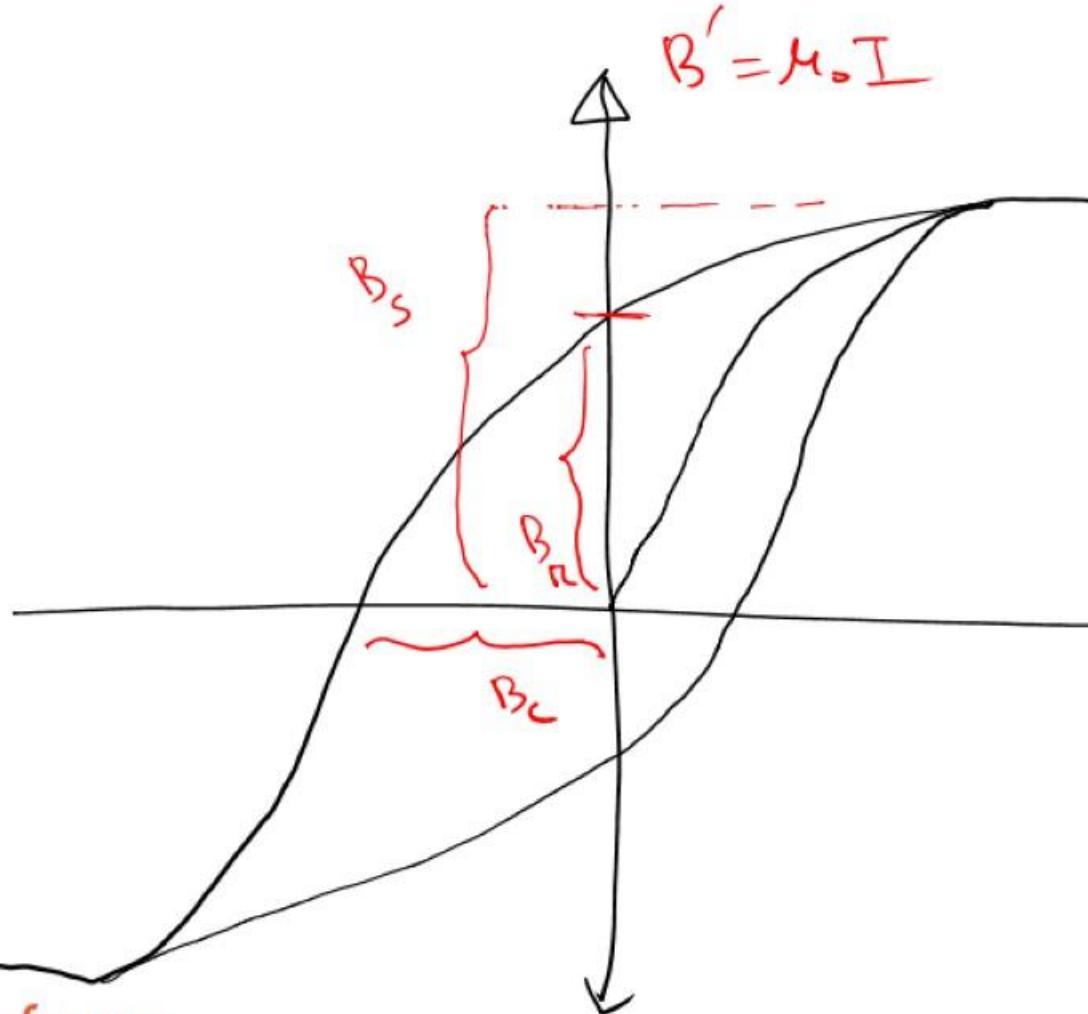
Hard $\rightarrow B_n(\downarrow), B_c(\uparrow)$

Soft $\rightarrow B_n(\uparrow), B_c(\downarrow)$



Hysteresis

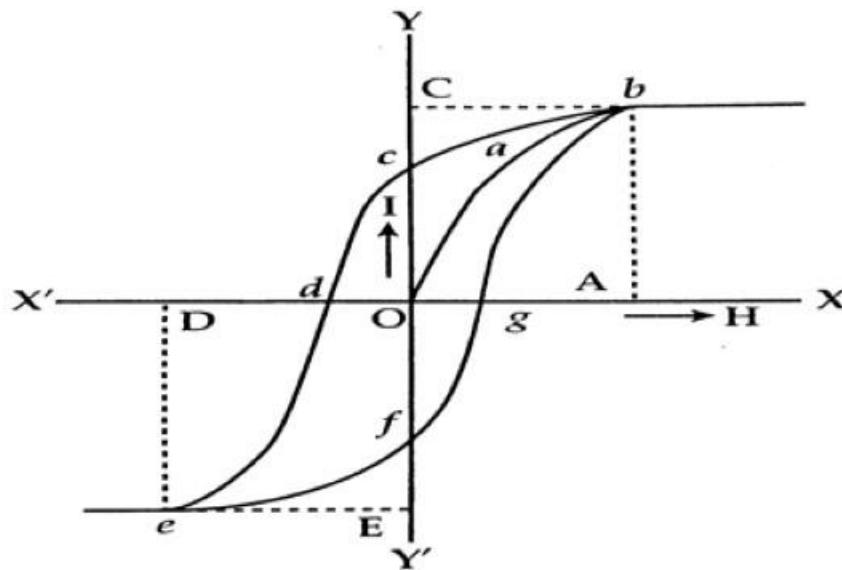
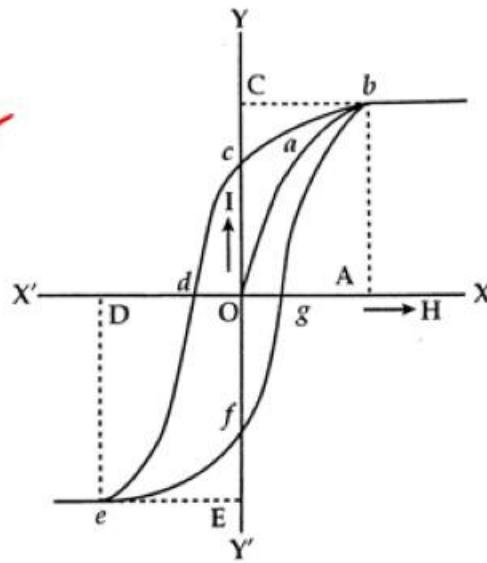
Only for Ferromagnetic materials.



POLL QUESTION 02

Which one is more preferable for temporary magnet?

(a)



Mathematical Examples

Find out magnetic flux intensity due to more than one current conducting wire at different points.

A point **inside** of both wire

Case 1: flow in **same** direction

Case 2: flow in **different** direction

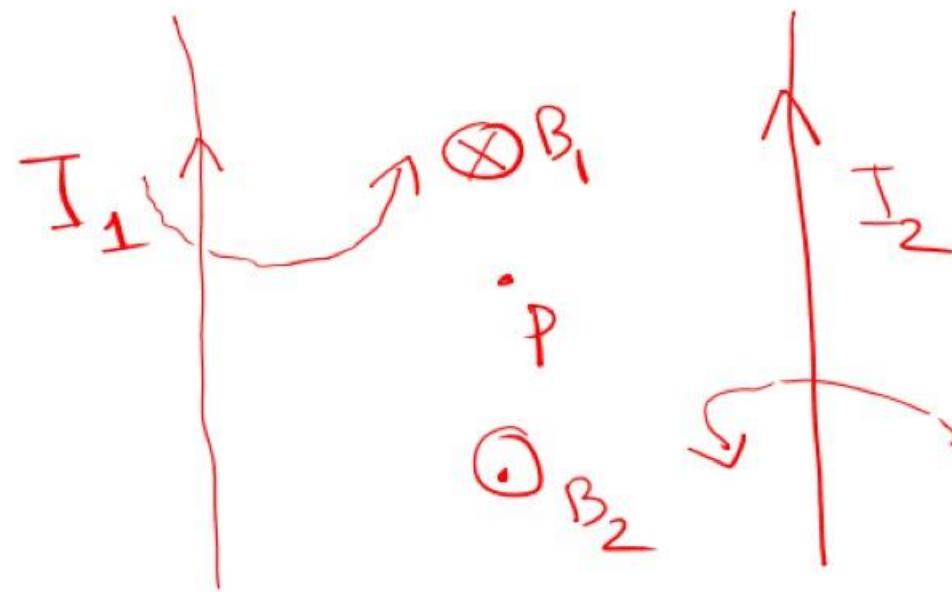
A point **outside** of both wire

Case 1: flow in **same** direction

Case 2: flow in **different** direction

A point **inside** of both wire

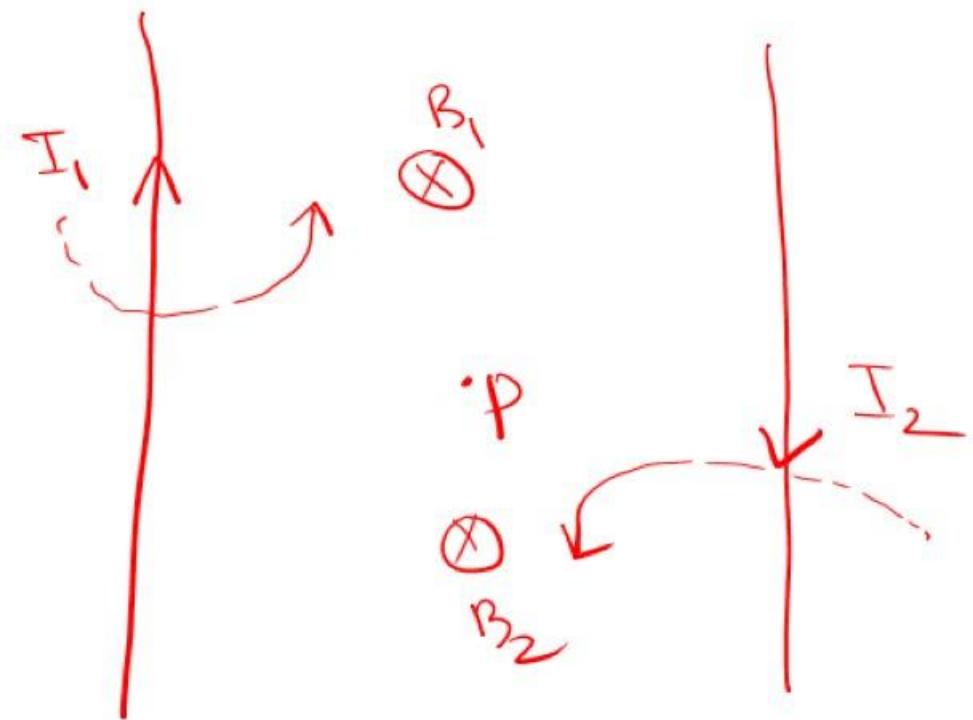
Case 1: flow in **same** direction



$$\vec{B}_{\text{total}} = \vec{B}_1 + \vec{B}_2$$

A point **inside** of both wire

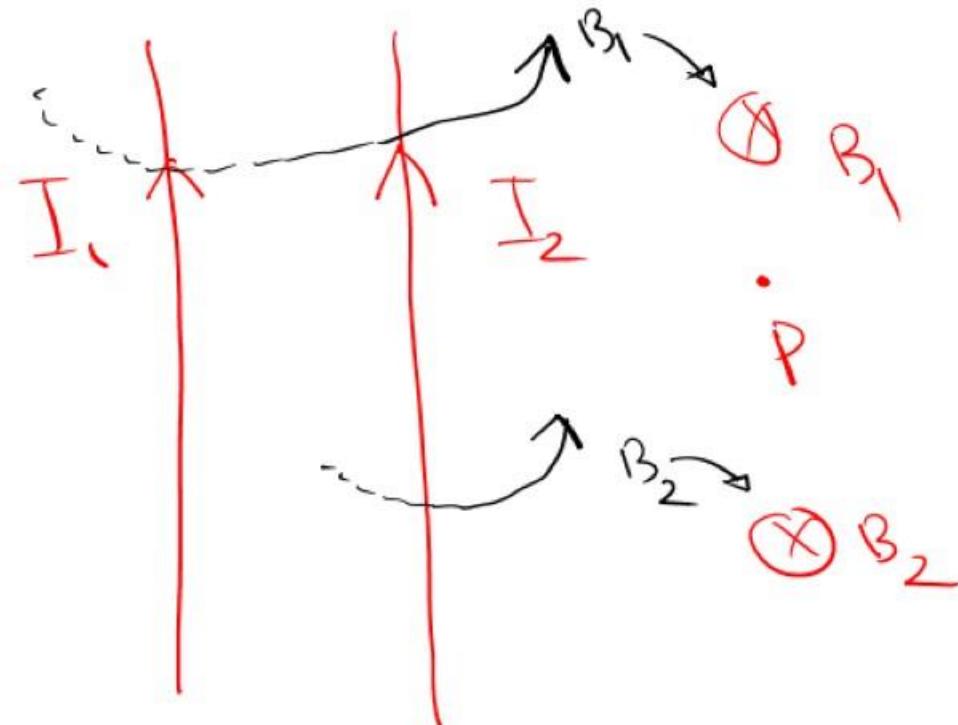
Case 2: flow in **different** direction



$$B_{\text{total}} = B_1 + B_2$$

A point **outside** of both wire

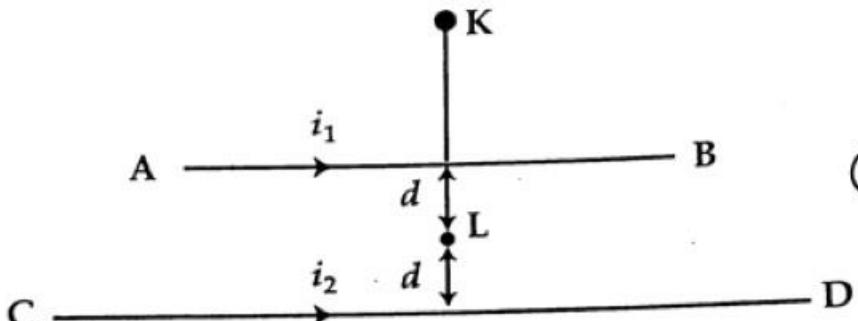
Case 2: flow in **same** direction



$$B_{\text{total}} = B_1 + B_2$$

MATH 05

চিত্রে i_1 প্রবাহের জন্য K বিন্দুতে চৌম্বক ক্ষেত্রের মান $8 \text{ NA}^{-1}\text{m}^{-1}$



(i) AB পরিবাহী তার হতে K বিন্দুর দূরত্ব d নির্ণয় কর।

(ii) i_1 প্রবাহের দিক বিপরীত করলে L বিন্দুতে লম্বি চৌম্বক ক্ষেত্রের মান ও দিক কীরূপ হবে? বিশ্লেষণ কর।

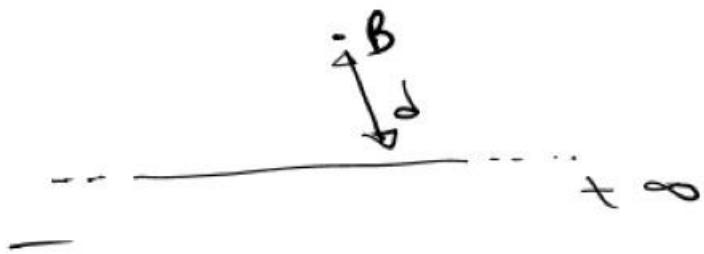
$$F = \mu \mu B$$

$$\Rightarrow B = \frac{F}{\mu} = \frac{F}{I \cdot l} \quad | \quad \mu = \frac{N}{Am}$$

$$= \frac{N}{A \cdot S \cdot \frac{m}{S}} = \frac{N}{Am}$$

$$B \rightarrow (\text{NA}^{-1}\text{m}^{-1})$$

(i)



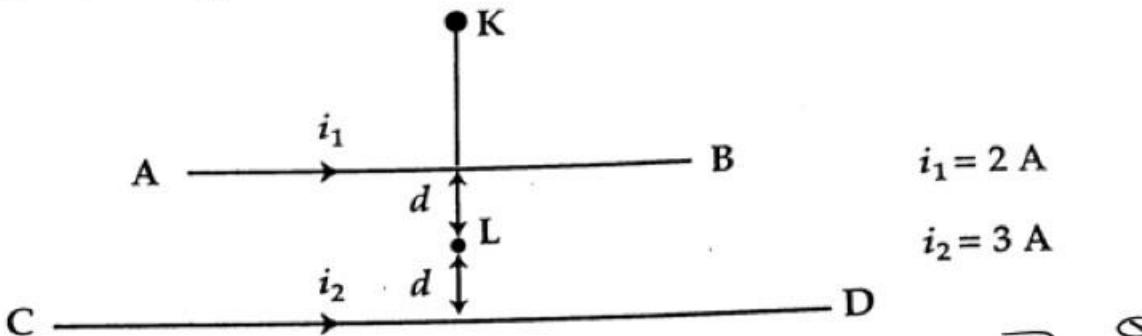
$$B = \frac{\mu_0 I}{2\pi r} = \frac{\mu_0 I}{2\pi d}$$

$$\Rightarrow S = \frac{4\pi \times 10^{-7} \times 2}{2\pi \times 1}$$

$$\Rightarrow l = 5 \times 10^{-8} \text{ m} \quad (\underline{\text{Am}})$$

MATH 05 continued

চিত্রে i_1 প্রবাহের জন্য K বিন্দুতে চৌম্বক ক্ষেত্রের মান $8 \text{ NA}^{-1}\text{m}^{-1}$



$$i_1 = 2 \text{ A}$$

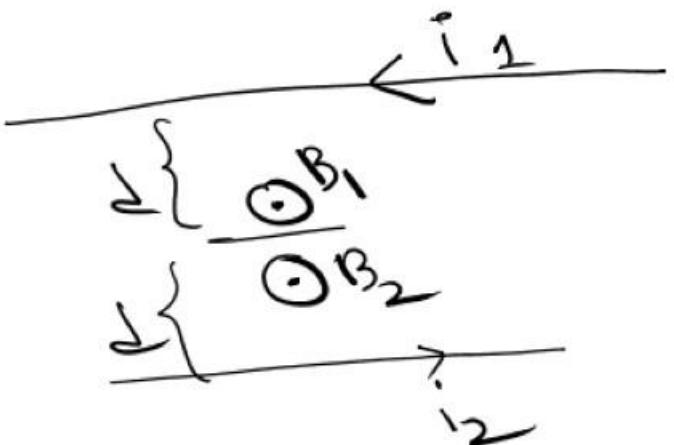
$$i_2 = 3 \text{ A}$$

outward

AB পরিবাহী তার হতে K বিন্দুর দূরত্ব d নির্ণয় কর।

(যদি i_1 প্রবাহের দিক বিপরীত করলে L বিন্দুতে লম্বি চৌম্বক ক্ষেত্রের মান ও দিক কীরূপ হবে ? বিশ্লেষণ কর।
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$$\text{So, } B = B_1 + B_2$$

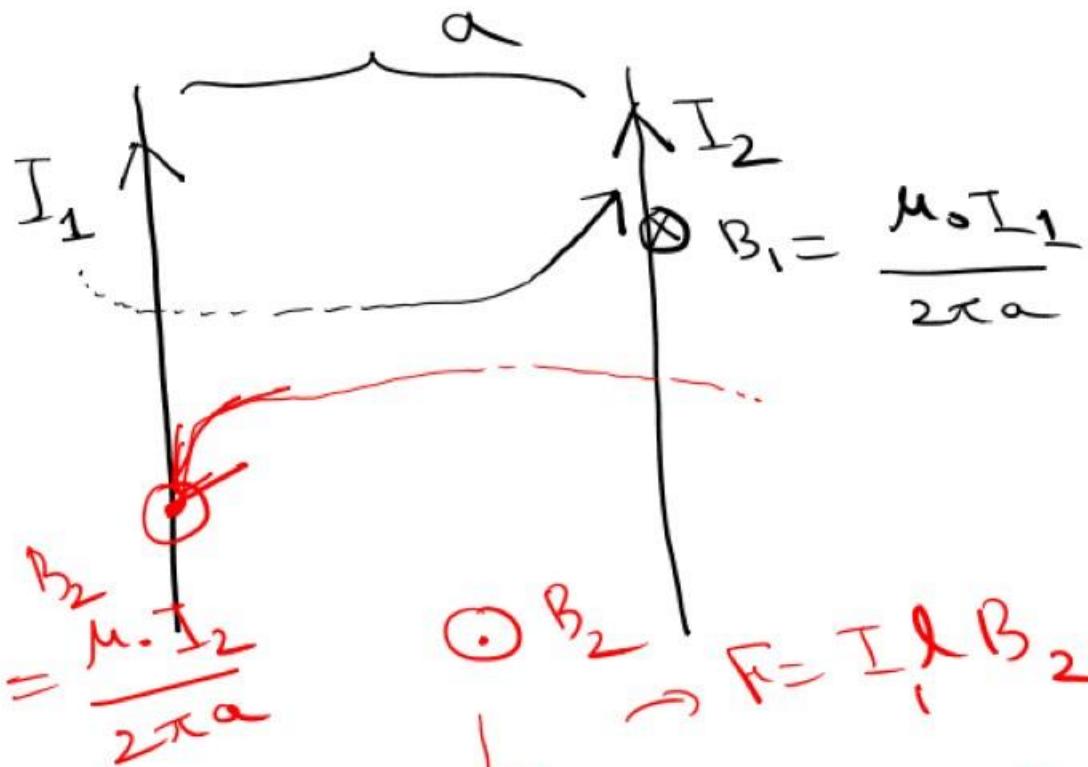
$$= \frac{\mu_0 I_1}{2\pi d} + \frac{\mu_0 I_2}{2\pi d} = \frac{\mu_0}{2\pi d} (I_1 + I_2)$$

$$B = \frac{4\pi \times 10^{-7}}{2\pi \times 5 \times 10^{-8}} \times (2+3)$$

$$= 20 \text{ T}$$

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Force on a conducting wire due to another wire conducting current.



$$\odot B_2 \rightarrow F = I_1 l B_2$$

$$F_{12} = I_1 B_2 = I_1 \frac{\mu_0 I_2}{2\pi a}$$

$$F_{12} = \frac{\mu_0 I_1 I_2}{2\pi a}$$

$$\odot B_1 \rightarrow F = I_2 l B_1$$

$$\rightarrow F_{21} = I_2 B_1$$

$$= I_2 \times \frac{\mu_0 I_1}{2\pi a}$$

$$F_{12} = \frac{\mu_0 I_1 I_2}{2\pi a}$$

না বুঝে মুখস্থ করার অভ্যাস
প্রতিভাকে ধ্বংস করে।