Introduction to Electromagnetic Fields

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GATE 2024

Batch

EMFT

INTRODUCTION

Electronics & Communication

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GATE 2024 ECE Syllabus

Section 8: Electromagnetics

Maxwell's Equations: differential and integral forms and their interpretation, boundary conditions, wave equation, Poynting vector.

Plane Waves and Properties: reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth.

Transmission Lines: equations, characteristic impedance, impedance matching, impedance transformation, S-parameters, Smith chart.

Rectangular and circular waveguides, light propagation in optical fibers, dipole and monopole antennas, linear antenna arrays.

GATE 2024 EE Syllabus

Section 3: Electromagnetic Fields

Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence, Electric field and potential due to point, line, plane and spherical charge distributions, Effect of dielectric medium, Capacitance of simple configurations, Biot-Savart's law, Ampere's law,Curl, Faraday's law, Lorentz force, Inductance, Magnetomotive force, Reluctance, Magnetic circuits, Self and Mutual inductance of simple configurations.

GATE 2024 IN Syllabus

Section 2: Electricity and Magnetism

Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence, Electric field and potential due to point, line, plane and spherical charge distributions, Effect of dielectric medium, Capacitance of simple configurations, Biot-Savart's law, Ampere's law, Curl, Faraday's law, Lorentz force, Inductance, Magnetomotive force, Reluctance, Magnetic circuits, Self and Mutual inductance of simple configurations.

Weightage of EMFT(last 5 years)

GATE

Year	Marks	
	ECE	EE
2023	11	7
2022	6	6
2021	11	6
2020	6	3
2019	9	3

Prerequisite

Vector Calculus

Imagination

Electric Fields:-When there is a constant unmoving Charge placed at a point then any other Charge surrounding to this charge feels a static force whish is called Electrostatic Force and the Field corresponding to this force is called Electrostatic Field.

$F = 2N$

Same polarity → repulsive

opposite polarity → attractive

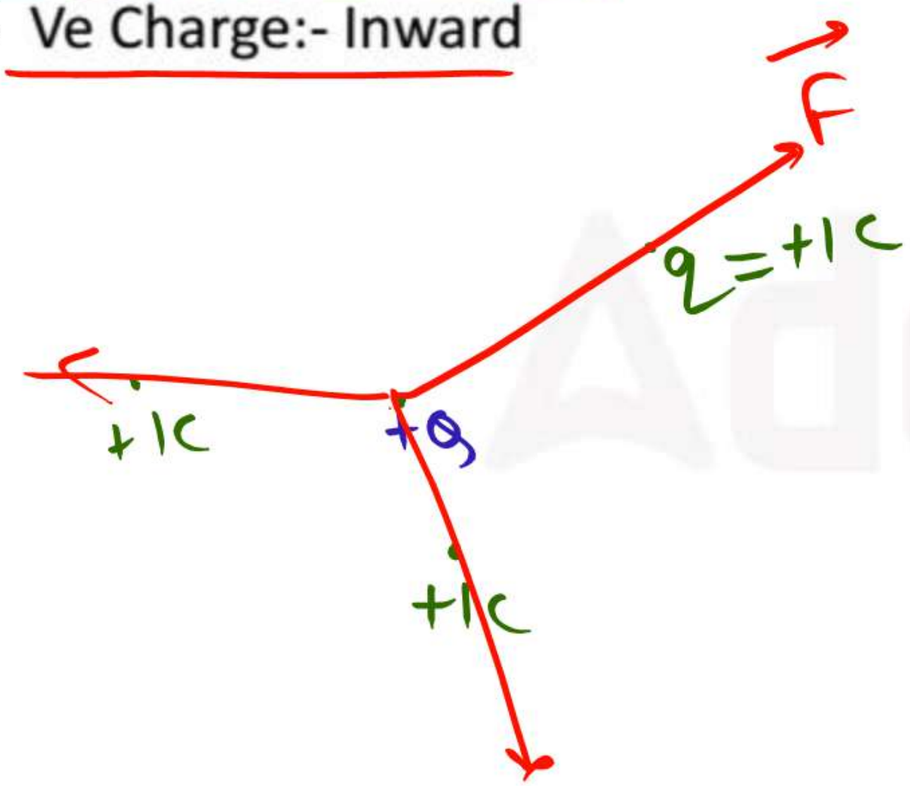
test charge = +1 C

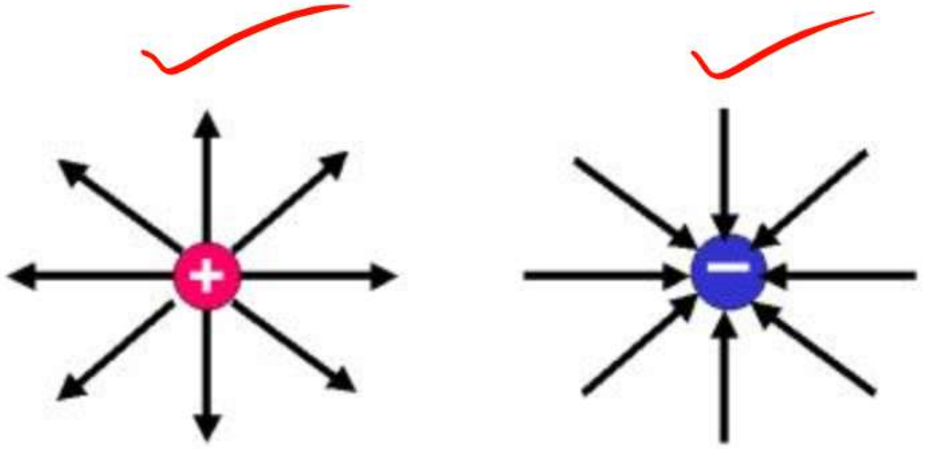
Generation → *Constant unmoving charge.

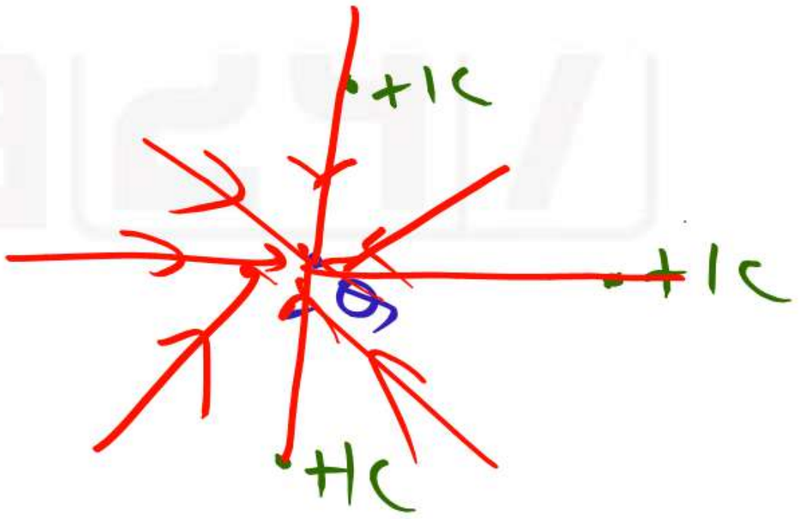
Direction:- of field

+ Ve Charge:- Outward

- Ve Charge:- Inward



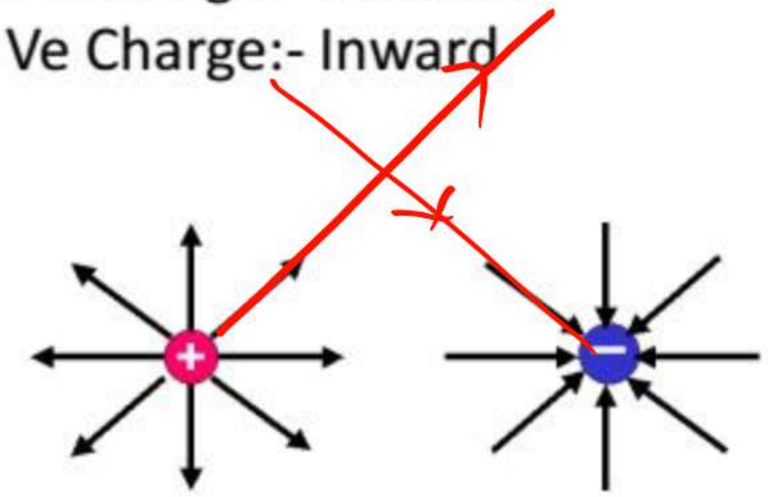


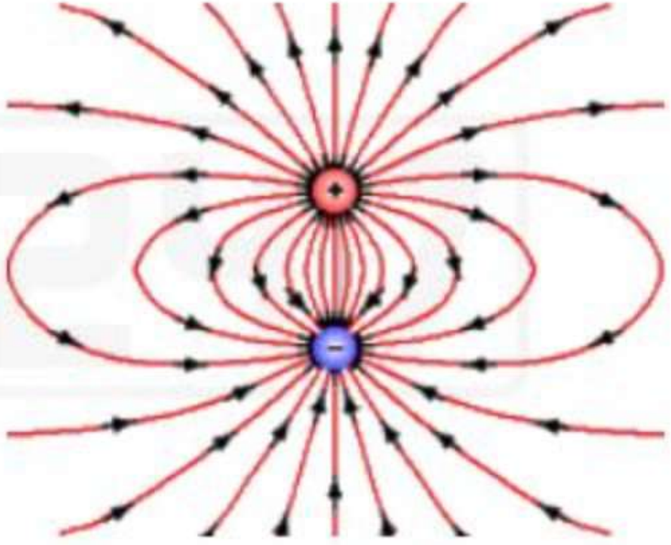


Direction:-

+ Ve Charge:- Outward

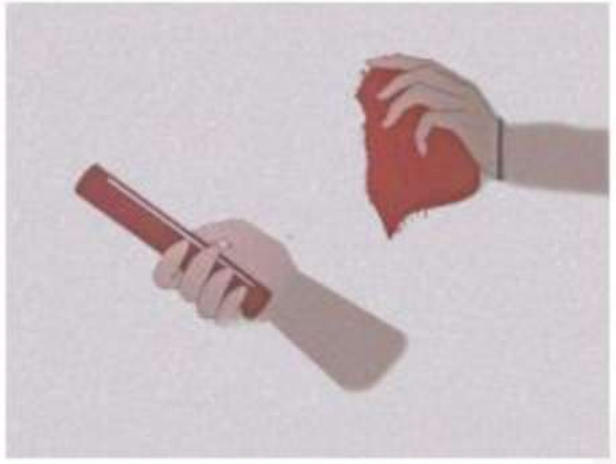
- Ve Charge:- Inward

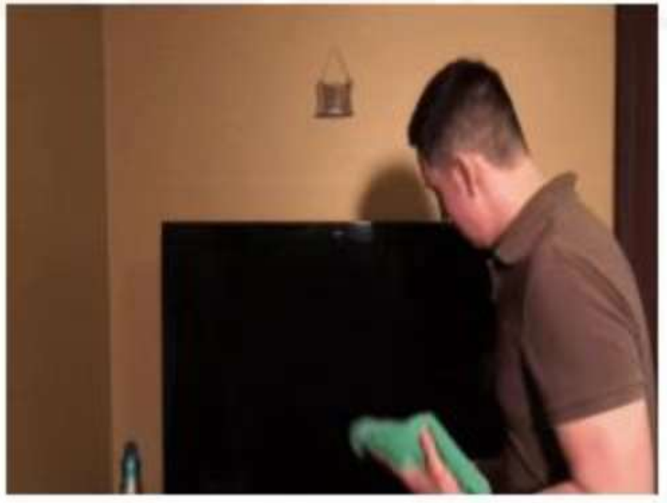




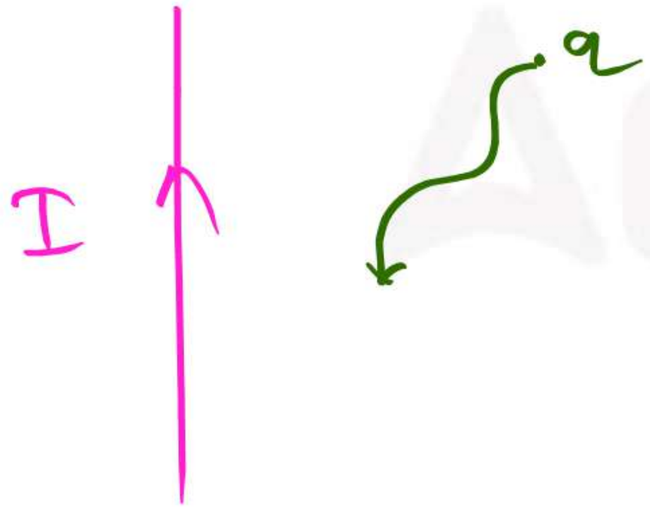
* Electric field lines never cuts each other.

Real Life Examples





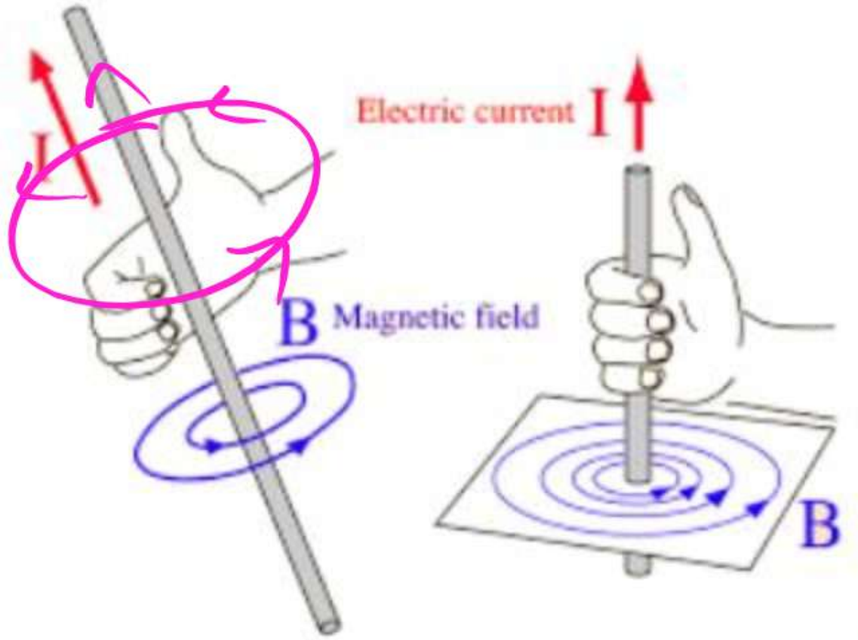
Magnetostatics Fields:- When there is unaccelerated charge flow then it results a dc current. Any moving charge surrounding to this current flow feels a force which is called Magnetostatic Force and the filed corresponding to this force is called magnetostatic field.



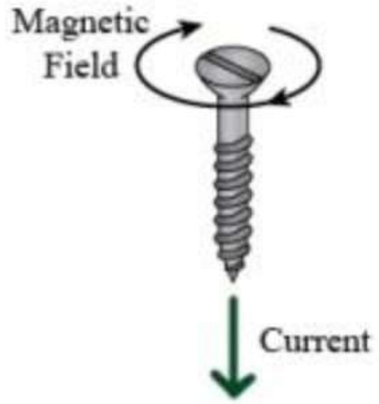
Generation

* moving charge with Constant velocity.

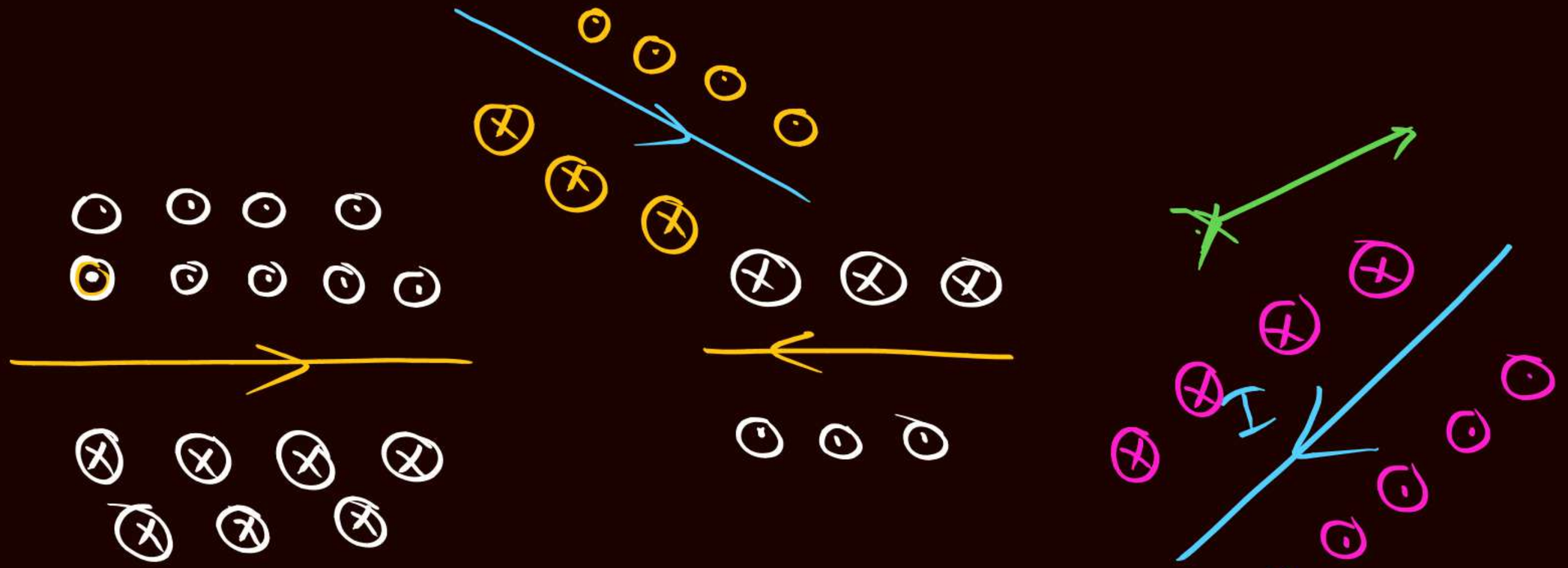
Direction:-



Right hand thumb rule



Screw rule.



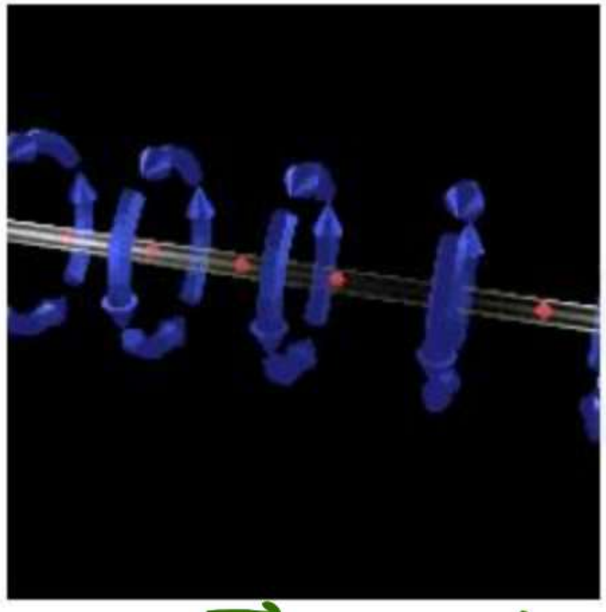
Arrow rule for inward/outward direction :→

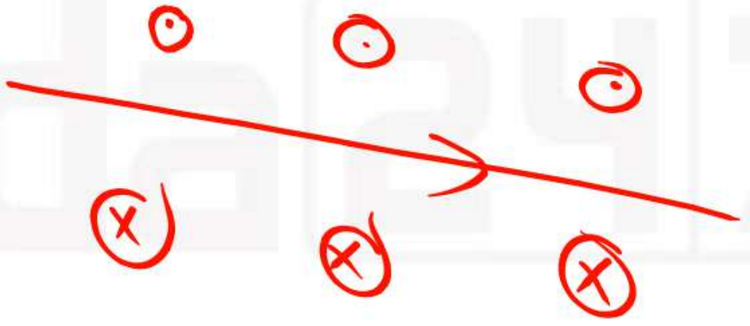
⊙ → outward → dot .

⊗ → inward → cross ×

Direction:-

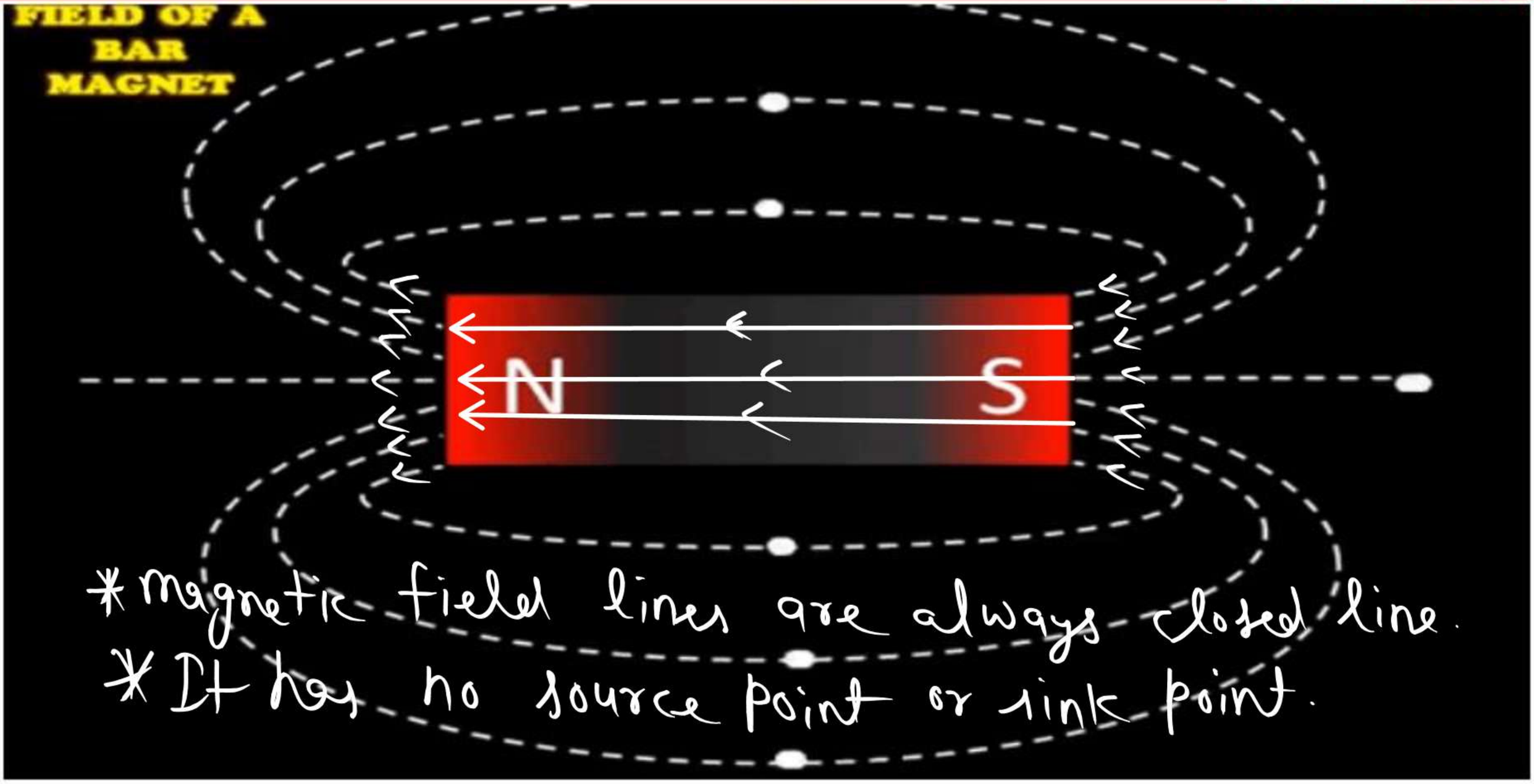
* Magnetic fields are divergences or solenoidal vectors.





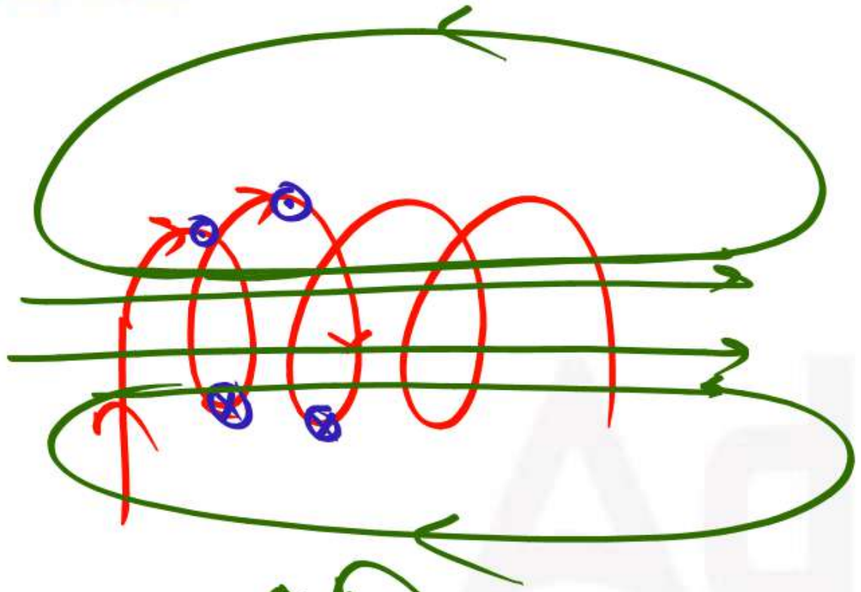
* $\vec{E}$ → electric field intensity vector
* $\vec{H}$ → magnetic field vector.

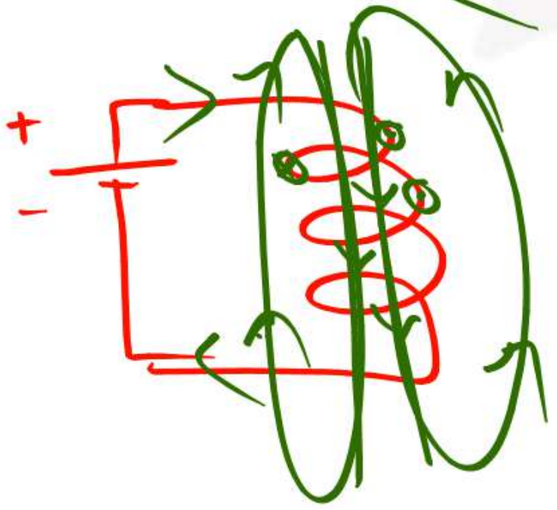
FIELD OF A BAR MAGNET

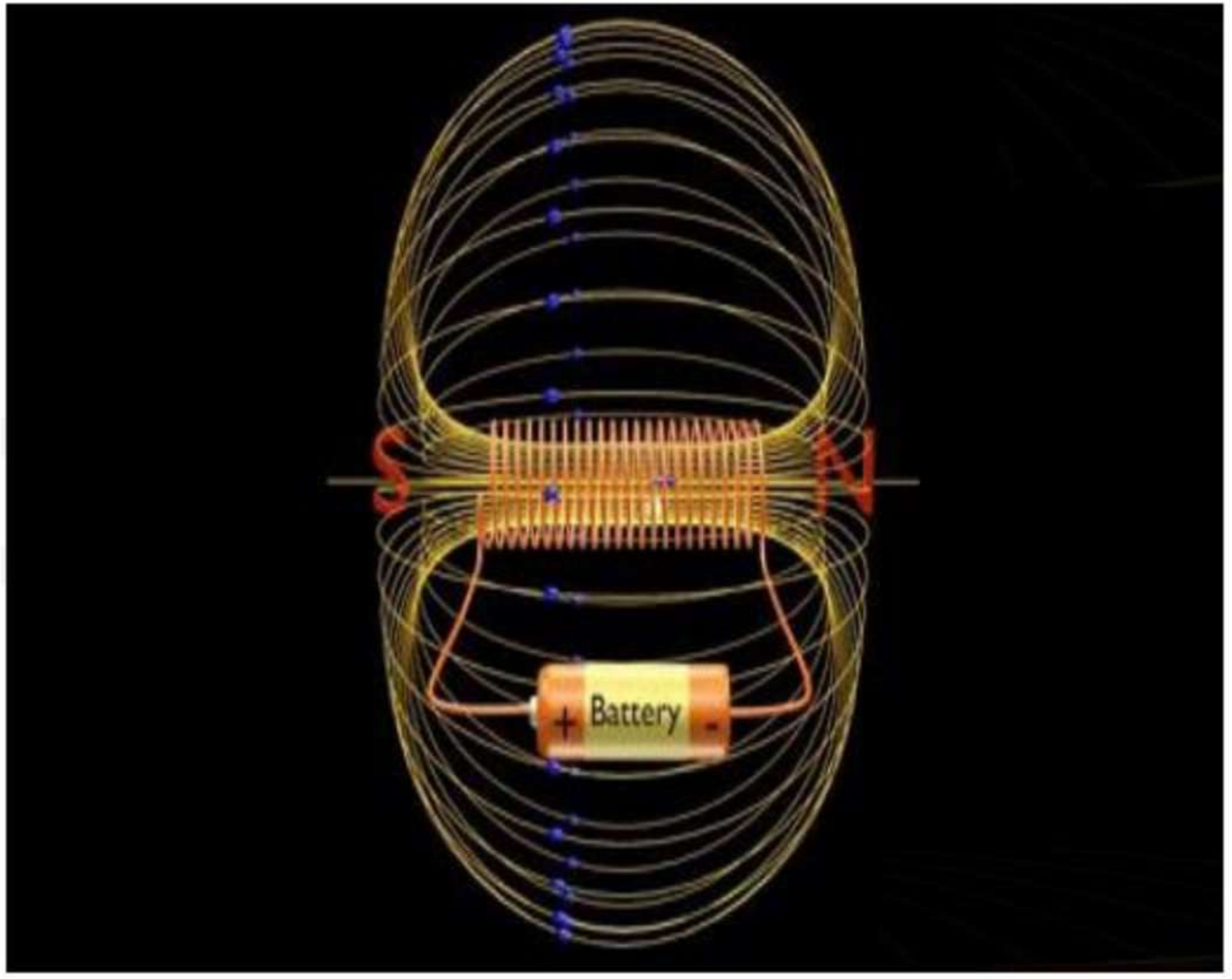


* magnetic field lines are always closed line.
* It has no source point or sink point.

Direction:-





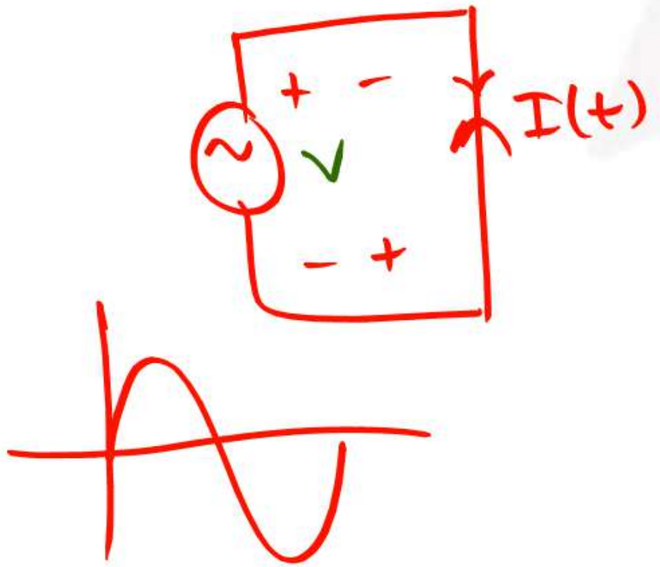


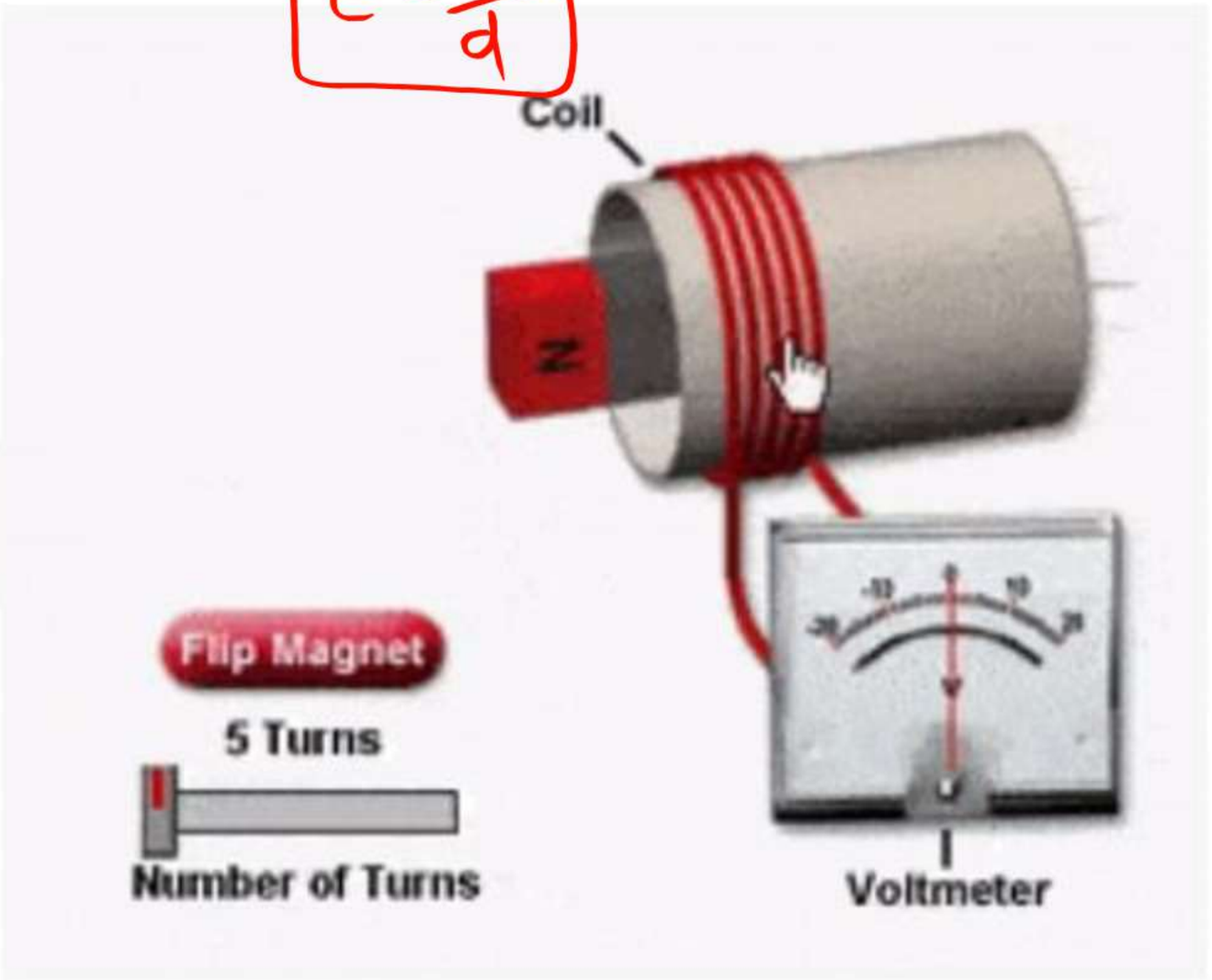
Electromagnetic Fields:-

$E = \frac{V}{d}$

Farraday's Experimantal Law

$V_{emf} \propto \frac{d\Phi}{dt}$

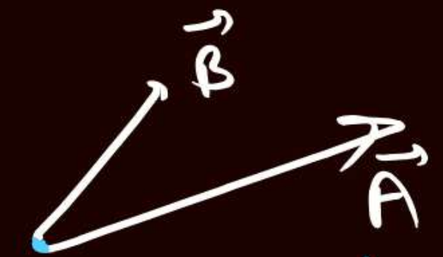




* Time varying electric and magnetic field are interelated with each other and as a combination it is called Electro magnetic field or E.M. wave.

Direction of E.M. wave:→ In direction of perpe-
-ndicular to both $\vec{E}$ & $\vec{H}$ fields.

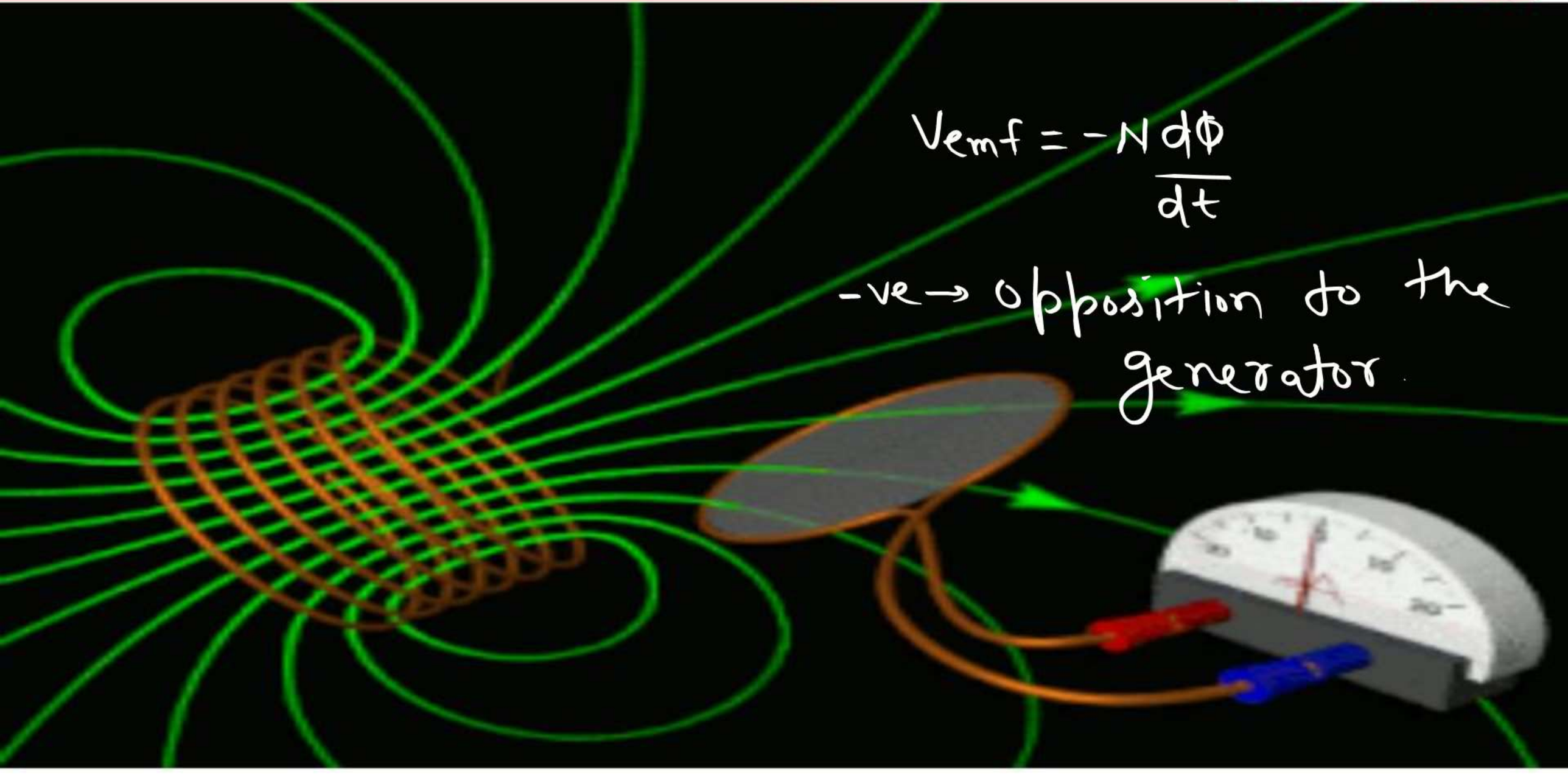
$$\hat{a}_{em.wave} = \hat{a}_E \times \hat{a}_H$$

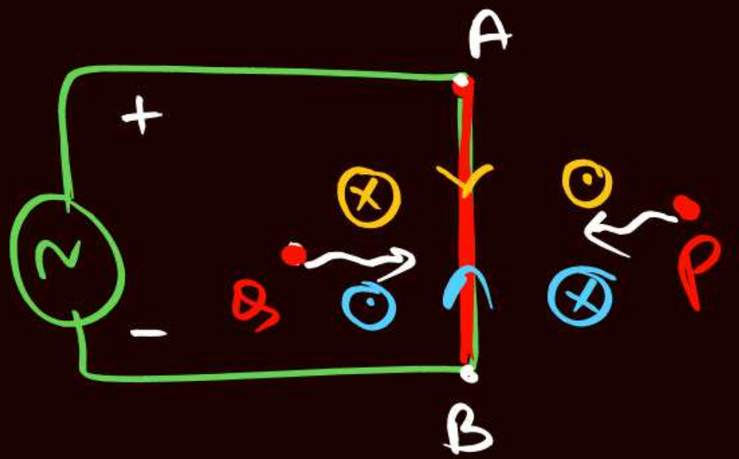


$\vec{A} \times \vec{B}$ → outward from Screen
$\vec{B} \times \vec{A}$ → inward to Screen

$$V_{emf} = -N\frac{d\Phi}{dt}$$

-ve → opposition to the generator



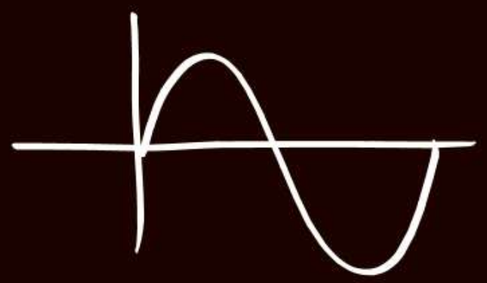


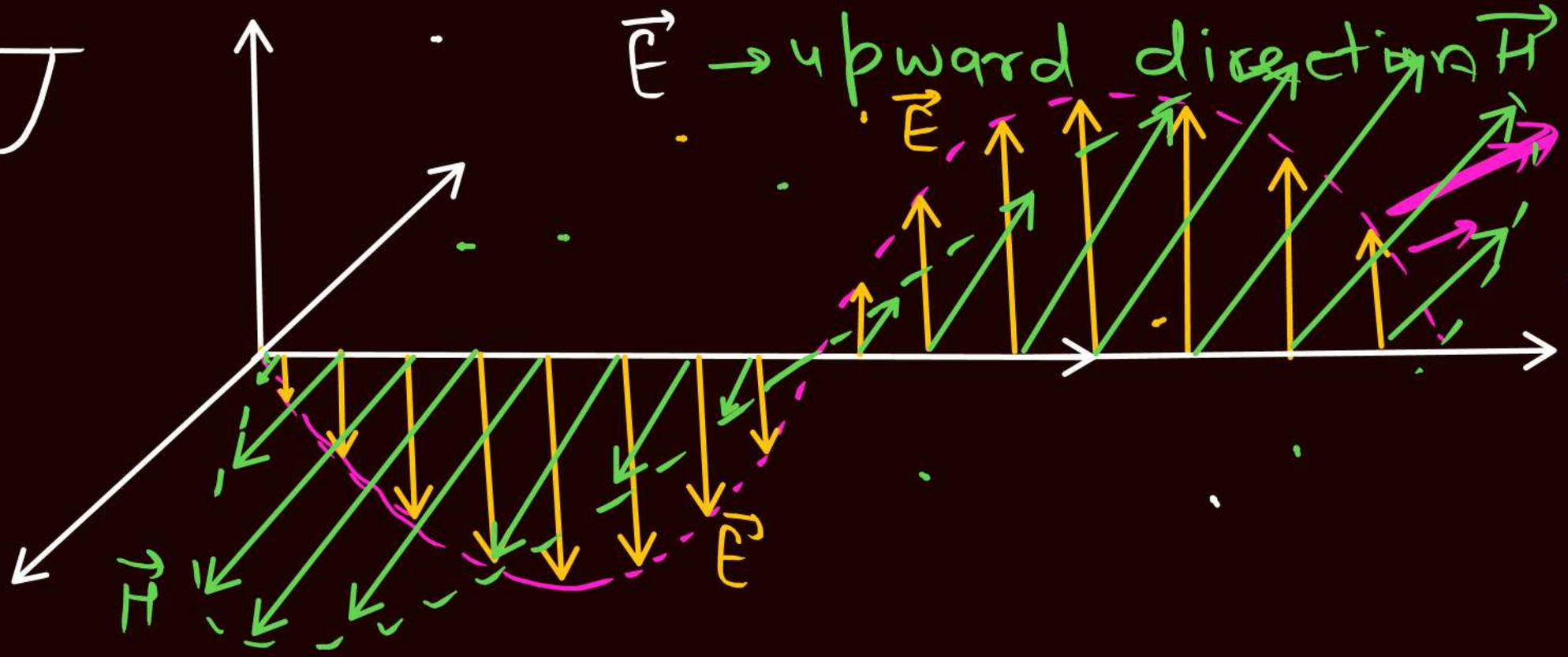
+ve cycle A at high potential

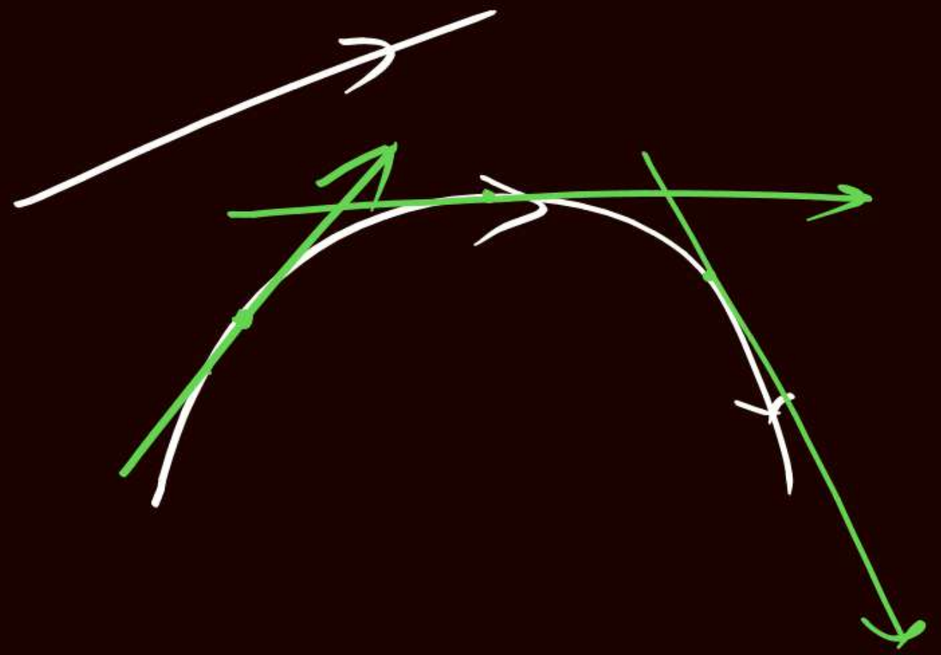
$\vec{E}$ → downward direction

−ve cycle :→ B is at high potent

$\vec{E}$ → upward direction

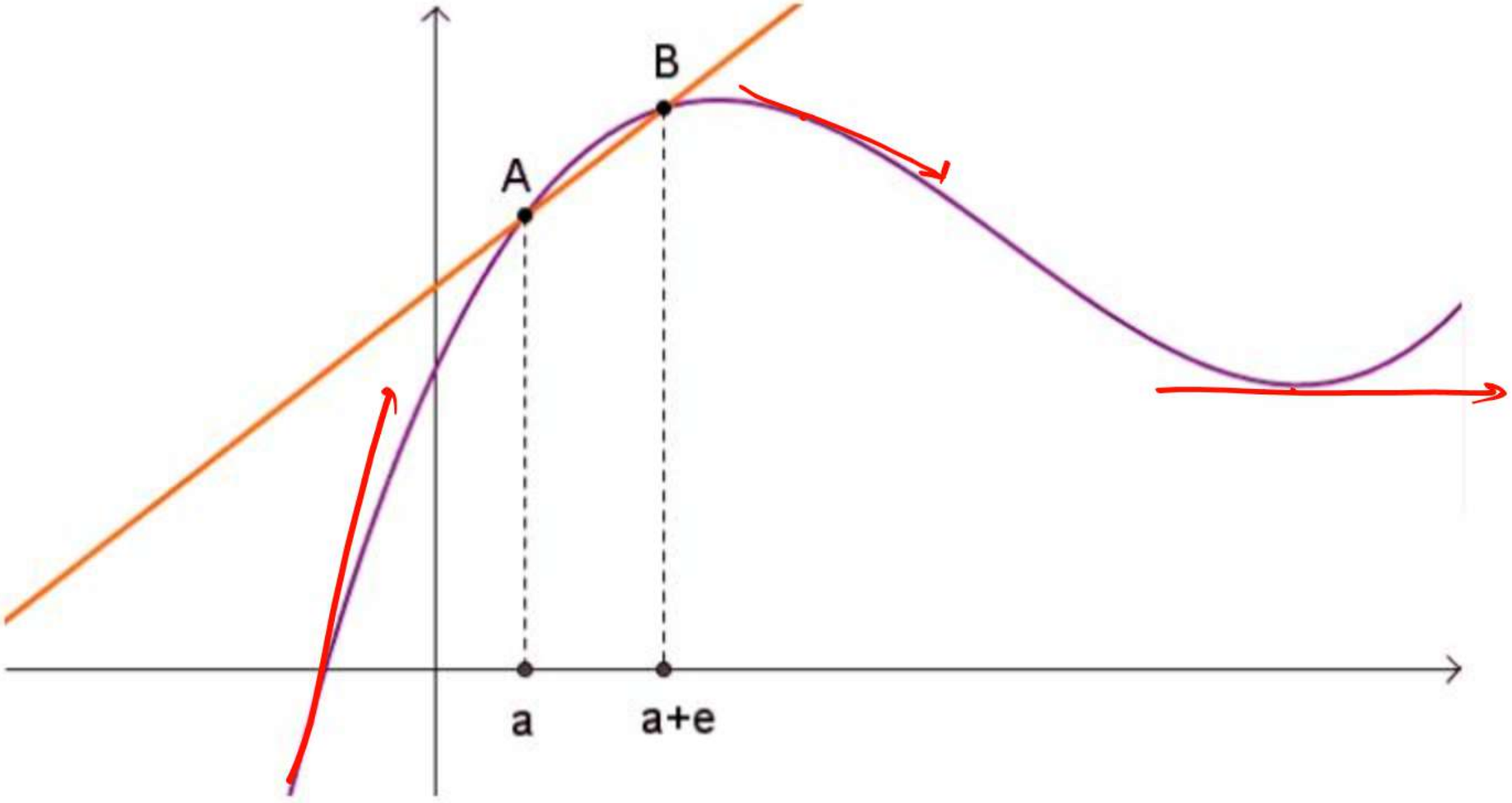




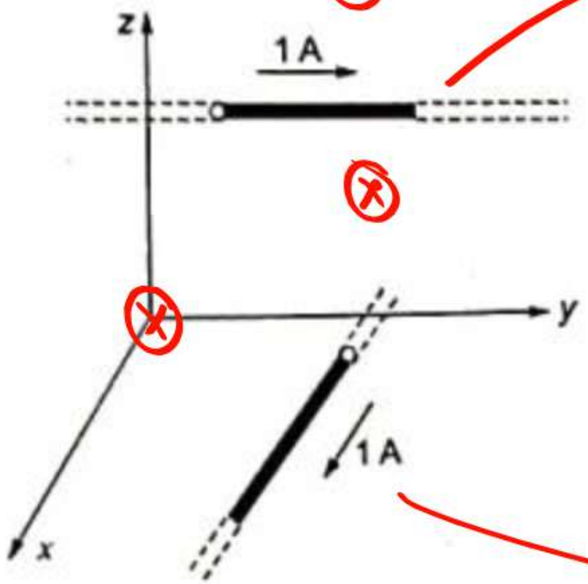


direction of Curved vector

In the direction of tangential line to the Curve at the point.



Q.1 Two infinitely long wires carrying current are as shown in the figure below. One wire is in the y - z plane and parallel to the y - axis. The other wire is in the x - y plane and parallel to the x - axis. Which components of the resulting magnetic field are non - zero at the origin?



(a) x, y, z components

(b) x, y components

(c) y, z components

(d) x, z components

at origin $\vec{H_1} = -K\hat{a}_z$

$\vec{H_2} = -P\hat{a}_z$

$\vec{H} = \vec{H_1} + \vec{H_2}$

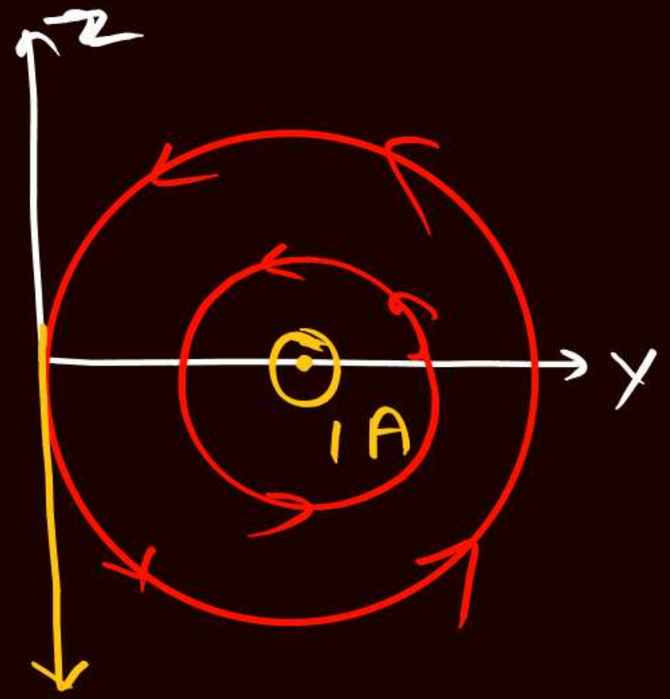
$= -K\hat{a}_x - P\hat{a}_z$

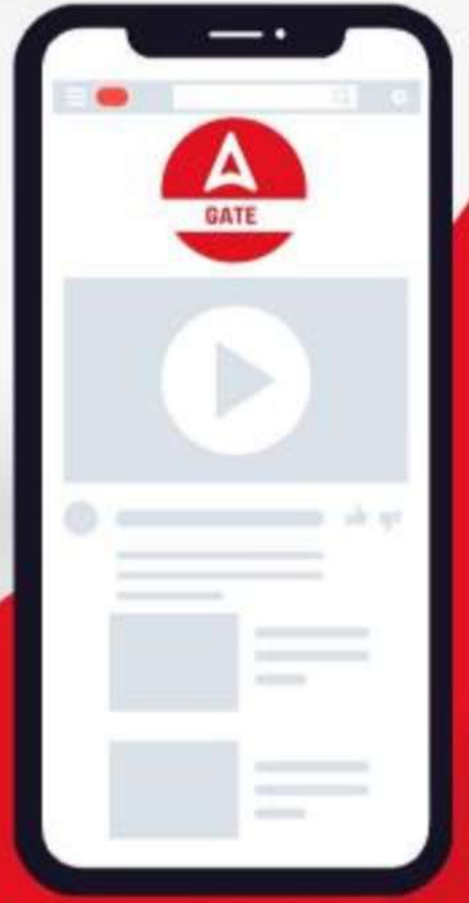
① Vector Calculus → Basics, Vector integral. Vector differentials.

② Electrostatic field
③ Magnetostatic fields
④ Time varying fields.
] common

⑤ Capacitor and inductor. → EF/IN

⑥ Transmission lines
⑦ plane wave propagation
⑧ Waveguide
⑨ Antenna


z
y
1 A



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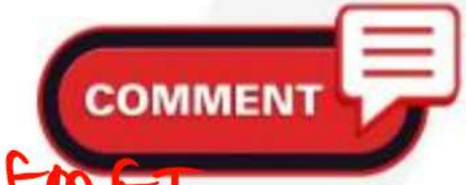

E.E.
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