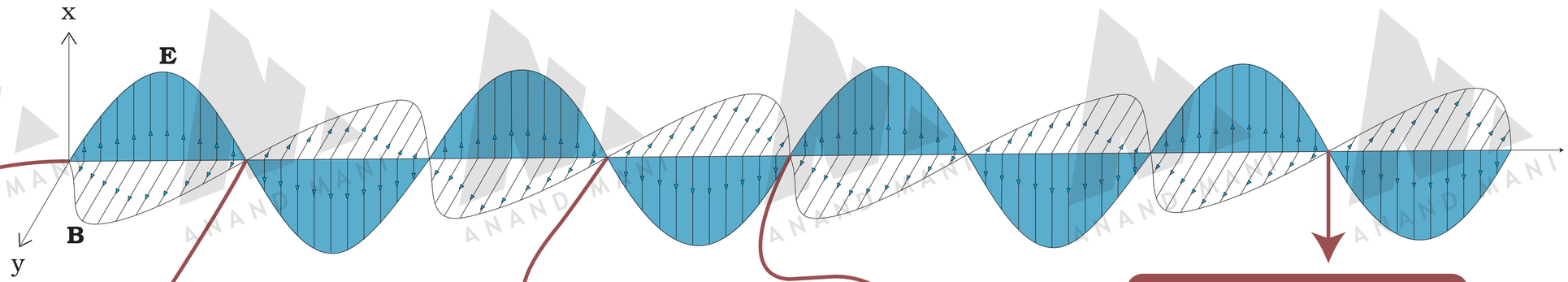
EM WAVES

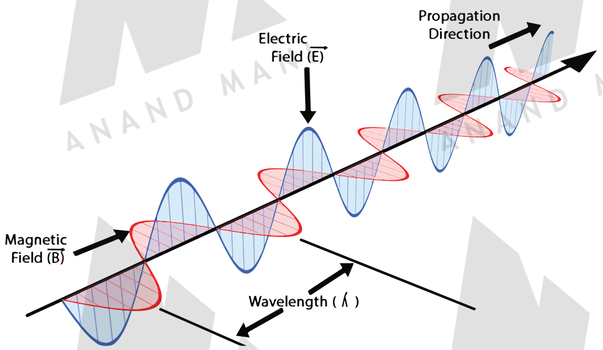


Electromagnetic waves

Generation of EM waves

1. Em waves are created as a result of vibrations between on electric field and a magnetic field.
2. Directions of propagation of wave is perpendicular to the direction of magnetic and electric field.

Electromagnetic Wave



Characteristics

1. Trasverse in nature.
2. Do not required any medium for propagation.
3. Produced by accelerated charge.
4. Travels with speed of light in free space.

$$C = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} = 3 \times 10^8 \, m/s$$

5. $\vec{\varepsilon}$ and $\vec{B}$ are in same phase.
6. In free space.

$$\frac{|\vec{\varepsilon}|}{|\vec{B}|} = c \quad (\text{Speed of light in vaccum})$$

Displacement Current

Current produced due to time varyingelectric field.

$$I_D = \varepsilon_0 \frac{d\phi}{dt} = \varepsilon_0 A \left(\frac{d\varepsilon}{dt}\right)$$

φ= electric flux
E = electric field

Ampere circuital law.

$$\oint \vec{B} \cdot d\vec{\ell} = \mu_0 I$$

I=Net current passing through Amperian loop. This law only consider current passing through the wire but it did not consider the current generated due to variation of electric flux or electric field with time.

Maxwell's Equations

Gauss's law in Electrostatic

$$\oint \vec{E} \cdot d\vec{A} = \frac{q}{\varepsilon_0}$$

Gauss's law in magnetism

$$\oint \vec{B} \cdot d\vec{A} = 0$$

Gauss's law in Electromagnetic induction induction

$$emf = \oint \vec{E} \cdot d\vec{\ell} = \frac{dA E_B}{dt}$$

Maxwell-Ampere's Circuital Law

$$\oint \vec{B} \cdot d\vec{\ell} = \mu_0 i_c + \mu_0 \varepsilon_0 \frac{d\phi_\varepsilon}{dt}$$

Energy density of wave

For electric Field

$$U_\varepsilon = \frac{1}{4} \varepsilon_0 E_0^2$$

For magnetic Field

$$U_B = \frac{1}{4\mu_0} B_0^2$$

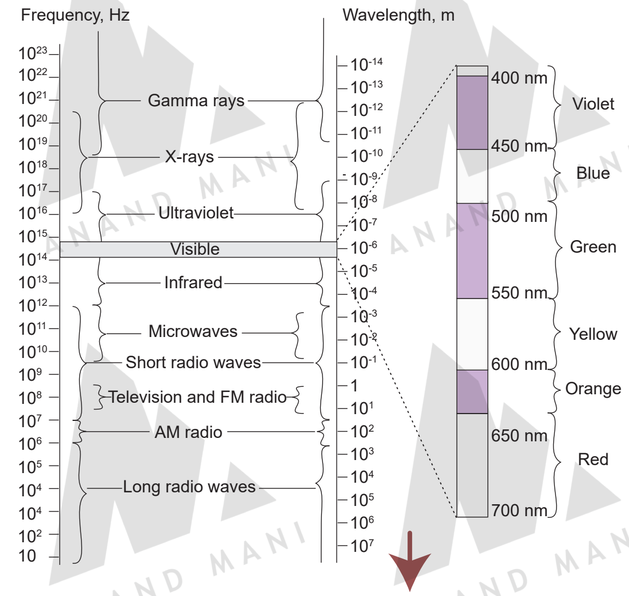
$$\Rightarrow U_{average} = \frac{1}{4} \varepsilon_0 E_0^2 + \frac{1}{4\mu_0^2} B_0^2$$

Intensity of EM waves

Intensity is the energy crossing per second per unit area perpendi cular to direction of propagation of EM waves.

$$I = \frac{1}{2} \varepsilon_0 E_0^2 C$$

Electromagnetic wave Spectrum



Different types of Electromagnetic wave

TYPES	WAVELENGTH RANGE	PRODUCTION
Radio waves	Greater than	Rapid acceleration and decelerations of electrons in aerials.
Microwaves	TO	Klystron valve or magnetron valve.
Infrared waves	TO	Vibration of atoms and molecules
X-rays	TO	X-ray tubes or inner shell electrons.
Gamma rays	TO	Radioactive decay of the nucleus.

Intensity of EM waves

Linear momentum of EM WAVES WITH ENERGY 'U' is given by.

$$P = \frac{U}{C}$$