

Wireless Communication

- Wireless communication doesn't require any physical medium but propagates of the signal through space.
- Since, space is only allowed for signal transmission without any guidance, the medium is used in wireless communication is called Unguided Medium.
- If there is no physical medium, then how does it transmits?
The transmission and reception of signals is accomplished with of antennas.

* Electromagnetic Waves

- Em waves carry em energy of em field through space.
- They include -
 - . Gamma Rays (γ -Rays)
 - . X Rays
 - . Ultraviolet Rays

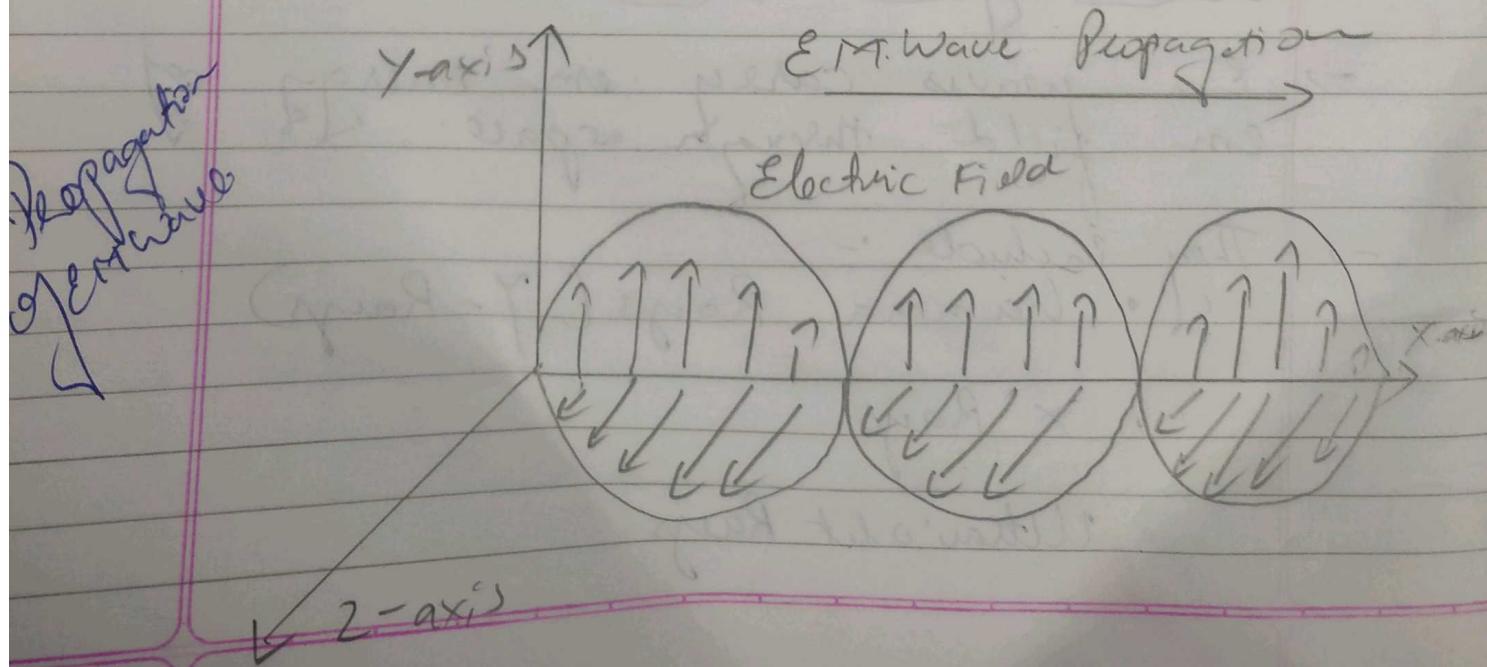
• Visible light

• Infrared Rays

• Midwave Rays

• Radio waves

- EM waves (aka Radio waves) are used in wireless communication to carry the signals.
- EM waves consists of electric fields and magnetic fields in form of sine to varying sinusoidal waves.
- Both these fields are oscillating perpendicular to each other and the direction of propagation of EM waves is again perpendicular to both these fields.



Frequency

- > The basic meaning of frequency is rate of change.
- > In context with electromagnetic waves, frequency means number of cycles / sec.
- > Unit of frequency is measured in Hz.

wavelength

- > Distance between two peak values of EM wave.
- > wavelength is inversely proportional to frequency.
- > Unit is same as distance

Amplitude

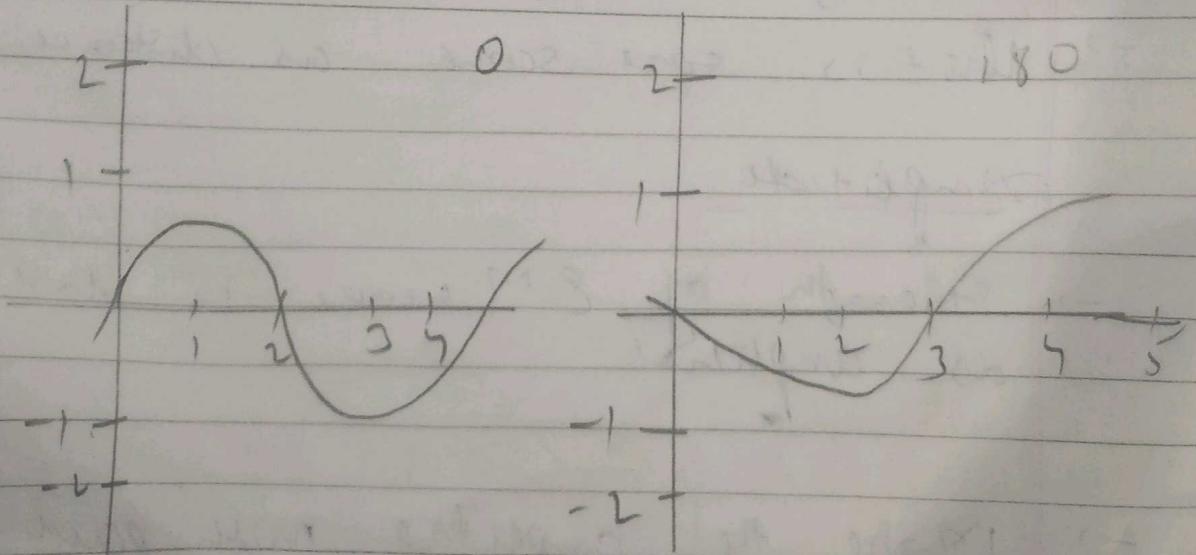
- > Strength of EM wave is termed as amplitude.
- > More the amplitude more power the wave has.

Example

The amplitude of light specifies the brightness of light.

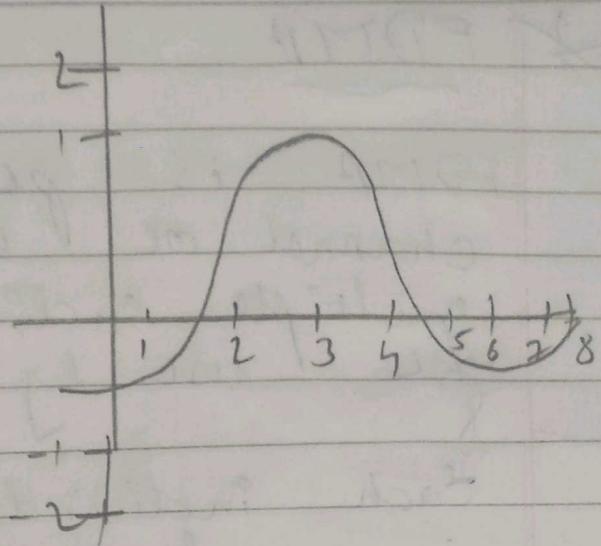
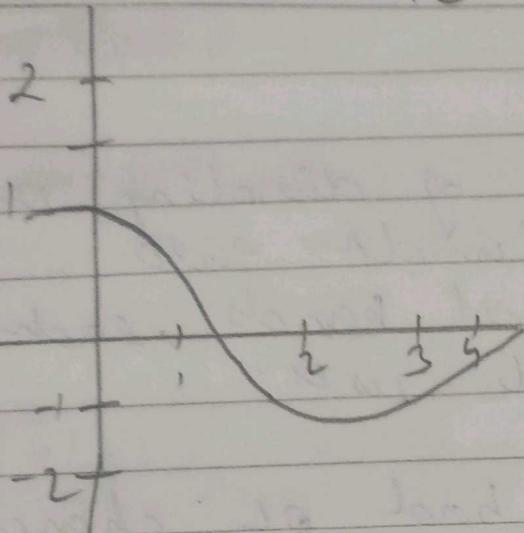
* Phase Shift

- Phase Shift represents the shift of wave from origin.
- Unit is degrees or radians.
- Negative phase indicates a wave right,
- Positive phase indicates wave to left



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-90



~~FDMA~~

FDMA is process of dividing one channel or bandwidth into multiple individual bands, each for use by single user.

Each individual band or channel is wide enough to accommodate the signal spectra of transmission to be propagated.

Merits

- Synchronization not necessary
- Channel capacity can be increased, if it can obtain efficient bit code.
- > No need for network ring

Demerits

- > Cell site cost is high
- > Bandwidth of FDMA is narrow
- > Carries only one cell phone circuit at a time
- > Network Planning is time consuming.

* TDMA

- TDMA stands for ~~TD~~ Time Division Multiple Access.
- It is used to facilitate channel sharing without interference.
- Different users share same time slot of complete time available. Each user is allocated a time slot in which we can access channel and in each slot, only one user is allowed to transmit or receive.

Merits

- Can carry 64 kbps to 120 Mbps
- Mobile assisted handoff possible.
- No frequency guard band required.
- No need to precise narrowband filter.

- Demerits

- High synchronization overhead.

- Frequency allocation is complex
- Equalization necessary for high rates

* CDMA

- CDMA stands for Code Division Multiple Access.
- It is one type of cellular technology in which two or more system Base stations and mobile subscriber units.
- It allows multiple transmitters to transmit information on single channel simultaneously.

Merits

- Smaller phones
- Lower Power requirement
- High voice quality
- ~~No synchronization required~~
- Easy to add many no. of user

Demerits

- Time synchronization
- Higher cost due to greater equipment.
- Cannot offer international roaming, a large OVSIM advantage is not fulfilled here.

~~SDMA~~

- SDMA is Spatial Division Multiple Access or Space Division Multiple Access.
- It is one type of channel access method.
- Used for mobile communication system which reuses same set of all phone frequencies in given service area.

Merits

- Purely Optical Path
- SDMA is frequency reuse
- Increases spectral efficiency
- SDMA is transparent to system

Disadvantages

- very expensive
- High insertion losses

Examples

FDM A = walkie Talkies

TDMA = IS-136 Personal Digital Cellular

CDMA = UHF Cellular Telephone system

SDMA = Proprietary wireless Broadband systems

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Signal Propagation Effects

It is behavior of radio wave as they travel or move from one point to another or across various parts of atmosphere.

- As a form of electromagnetic wave, radio wave can be affected by phenomena of reflection, refraction, diffraction, absorption.
- Line of sight propagation means radio wave which travel in straight line from transmitter antenna to receiving antenna.
- At lower frequencies in MF, LF and VLF band, diffraction allows radio waves to bend around hills and other obstacles.

Phenomena causing its effects

- When signal travels in free space, it bounces off light. It travels from sender to receiver.

These objects pose different effects on propagation of signals normally.

Reflection

When the propagating signal falls on an object whose size is large as compared to wavelength of signal is reflected.

For example

Surface of Earth buildings and walls off reflection & propagating signal

Diffraction

Diffraction of radio waves \rightarrow caused by obstacles or surfaces that has sharp irregularities.

Corners of building, furniture, back of trees { all offer diffraction

It's due to redistribution of energy within a wave front when it comes near the edge of an obstacle objects and allows radio wave to propagate from corners etc.

Refraction

when light penetrates into a medium, it slows down.

The way it slows down depends on index of refraction

$$V_m = \frac{C}{n_m}$$

Index of refraction varies according to frequency.

Thus, light can be refracted when it ~~passes~~ penetrates into a medium.

Example

When we put one orange in a bucket of water, it appears to be bent.

Similarly, light slows down when it passes through different media and bends.

$$\boxed{\lambda_0 \rightarrow \frac{\lambda_0}{n} = \lambda_m}$$

$$\lambda_m < \lambda_0$$

Scattering Scattering

when dimension of objects in path of radio wave are very small as compared to wavelength of waves taken place.

Example

Folage, street signs, lamp posts.

- The incoming signal is scattered into several smaller outgoing signals.
- For optical light of wavelength of order nanometer, water molecules offer scattering.

Example when sunlight fall a water droplet in clouds it gets scattered into constituent colors.

That is VIBGYOR. Here water droplets act as prism and we see a rainbow.