SNS COLLEGE OF ENGINEERING

(Autonomous)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

19EC502 – TRANSMISSION LINES AND ANTENNAS

III YEAR/ V SEMESTER

UNIT 1 – TRANSMISSION LINE THEORY

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TOPIC 1 - GENERAL THEORY OF TRANSMISSION LINES

GENERAL THEORY OF TRANSMISSION LINES

- A TRANSMISSION LINE is a device designed to guide electrical energy from one point to another. It is used, for example, to transfer the output rf energy of a transmitter to an antenna. This energy will not travel through normal electrical wire without great losses. Although the antenna can be connected directly to the transmitter, the antenna is usually located some distance away from the transmitter.
- On board ship, the transmitter is located inside a radio room, and its associated antenna is mounted on a mast. A transmission line is used to connect the transmitter and the antenna. The transmission line has a single purpose for both the transmitter and the antenna.
- This purpose is to transfer the energy output of the transmitter to the antenna with the least possible power loss. How well this is done depends on the special physical and electrical characteristics (impedance and resistance) of the transmission line.

TRANSMISSION MEDIUM

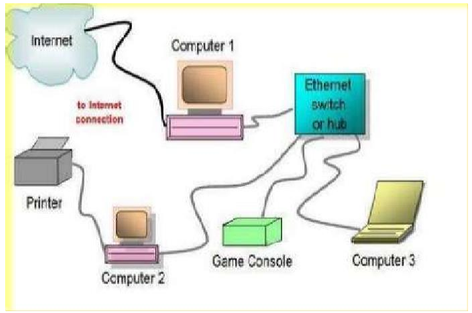
- For information transfer from one place to other requires a medium known as **Transmission medium**.

- The transmission mediums we use these days are telephone, IR wireless communication, television, cables, Bluetooth, etc

TRANSMISSION MEDIUM - TYPES

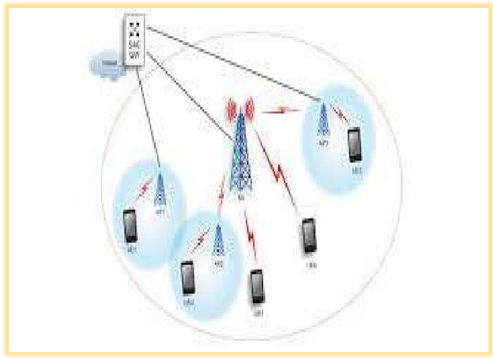
Wired (Guided)

A guiding structure needed for transmission.
Ex: telephone network , cable television or internet access , and fiber optic-communication etc.,



Wireless (Unguided)

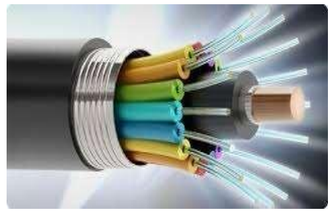
Transmission happens through free space (air medium)
EX: IR wireless communication, satellite communication, Bluetooth, Zigbee etc.,



GUIDED TRANSMISSION MEDIUM - TRANSMISSION LINES

Any physical structure that will guide an electromagnetic wave from one place to other is called a Transmission Line

- Transmission lines in microwave engineering are known as **distributed parameter networks.**.



- Enables the transfer of electrical signals by a pair of conducting wires that are separated from each other by a dielectric medium which is usually air.

TRANSMISSION LINE - TYPES

EXAMPLES

- Open wire lines
- cables
- Coaxial Lines
- Optical fibers
- Waveguides

OPEN-WIRE TRANSMISSION LINE

Open wire line

Structure

- These are the conductors having two lines (wires) separated by dielectric medium whose one end connected to the source and other to the destination.
- These lines are open to air hence called open wire lines.
- Mounted on towers - Ex., Electrical Power transmission lines, Telephone lines

OPEN-WIRE TRANSMISSION LINE

Advantages

- These are low cost and simplest form of transmission line.

Disadvantages

- But, their installation cost is somewhat higher .
- And its maintenance is sometimes difficult due to the change in atmospheric conditions.

CABLES

Structure

- These are underground lines
- Telephone cable consists of hundred of conductors which are individually insulated with paper.

CABLES

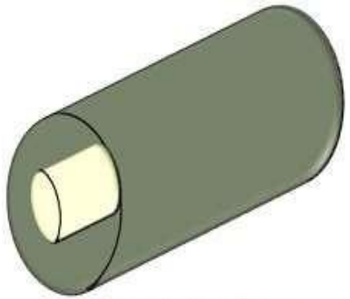
Advantages

- Reduced range of Electromagnetic field Emission into the surrounding area.
- They pose no hazard to low flying aircraft or to wildlife

Disadvantages

- More expensive
- Underground repairs can take days or weeks.

COAXIAL LINES

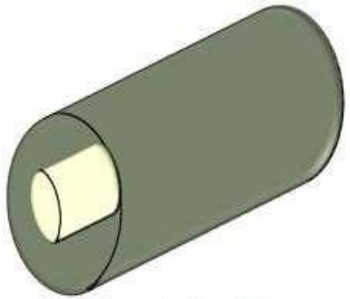


Coaxial cable

Structure

- These lines are formed when a conducting wire is coaxially inserted inside another hollow conductor.
- The dielectric may be solid or gaseous.
- These are widely used in applications where high voltage levels are needed.

COAXIAL LINES



Coaxial cable

Advantages

- Lower error rates.
- Coaxial cable shielding reduces noise

Disadvantages

- Expensive when compared to twisted pair cable.

WAVEGUIDES

Structure

- Used for signal transmission at microwave frequencies.
- These are basically hollow conducting tubes as they somewhat resemble like coaxial cable line but do not have center conductor as present in coaxial cables.
- The energy is transmitted from inner walls of the tube by the phenomenon total internal reflection

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WAVEGUIDES

Advantages

- Higher power handling capability
- Simple structure
- Lower attenuation
- Good amount of immunity against RF Interference from outside

Disadvantages

- Not suitable for low frequency applications
- Bulky in size and weight
- TEM mode propagation is not possible

NEED FOR LINE PARAMETERS

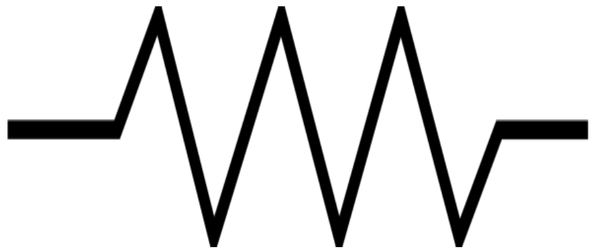
- To design a transmission line
- Understand the properties of a transmission line

TRANSMISSION LINE PARAMETERS

- Resistance (R)
- Capacitance (C)
- Inductance (L)
- Conductance (G)

RESISTANCE

- This parameter of any transmission line rely on the cross-sectional area of the conducting material
- These are distributed parameter networks that means its parameters are distributed uniformly along the entire length
- It is represented by R and its unit is ohms per unit length of the line



RESISTANCE

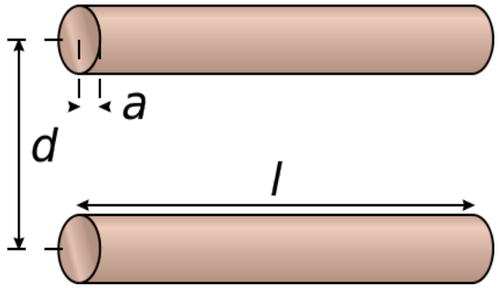
- Resistance R is given by

$$R = \rho \frac{l}{a}$$

ρ - conductivity of the conducting material
l - the length of the transmission line &
a - the cross-sectional area of the line

CAPACITANCE

- A transmission line is composed of two parallel conducting wire separated by dielectric material
- So it behaves as a parallel plate capacitor. Thus it has some capacitance which is also distributed uniformly over its length
- It is measured in farads per unit length of the transmission line

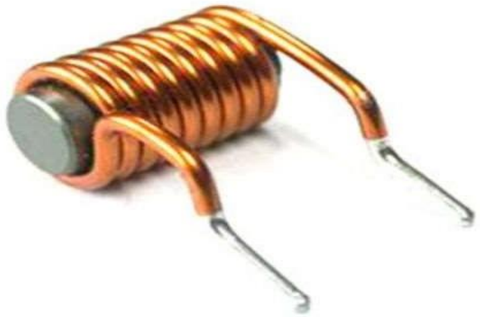


INDUCTANCE

- When current flows through a conductor it generates a magnetic field perpendicular to the direction of the electric field
- As the magnetic field varies, electromagnetic flux gets generated in the line
- So, this emf now flows in opposite direction with the current flowing through the device which is known as inductance

INDUCTANCE

- Its value depends on the current flowing through the conductor
- Inductance is represented by L
- It’s unit is Henry per unit length of the conductor



CONDUCTANCE

- The two parallel conductors are separated by dielectric medium but it is not a perfect insulator
- Due to which some current also flows through the dielectric
- This current is called leakage current and it is responsible for leakage conductance through the transmission line
- It is basically present between the conducting wires and is represented by G. Its unit is mho per unit length of the conductor