

Network Filter and Transmission Line

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Network

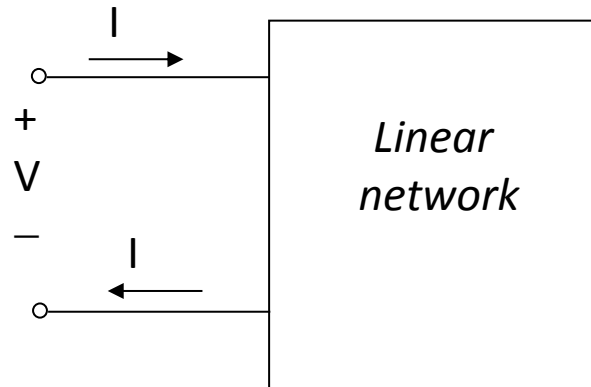
- Electrical Network A combination of various electric elements (Resistor, Inductor, Capacitor, Voltage source, Current source) connected in any manner what so ever is called an electrical network.

Network Configuration

- Symmetrical Network
- Asymmetrical Network
- L – Network
- Recurrent or cascaded Network
- Ladder network
- T-Network
- Pi-Network

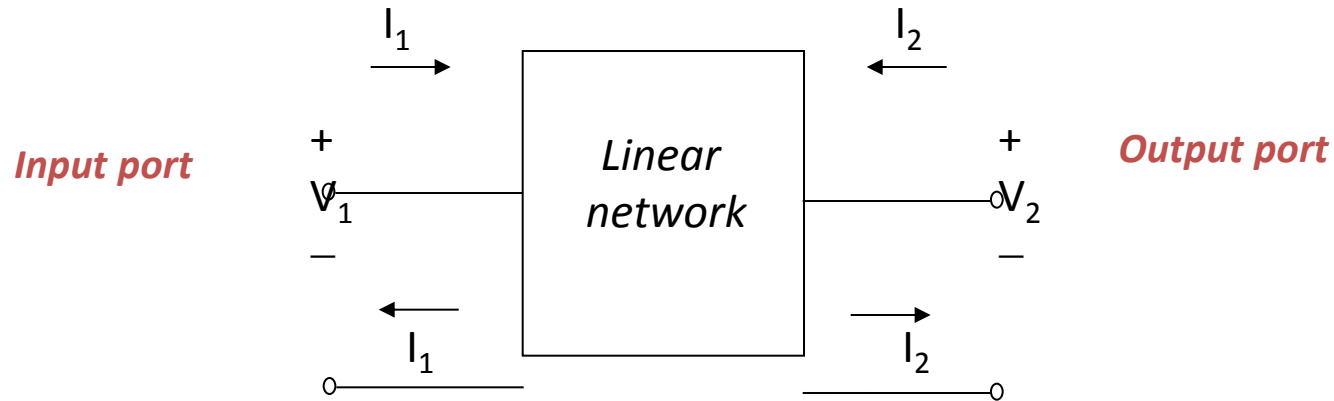
Port of Network

- One-port : an access to a network and consists of two terminals



- One pair of terminal
- Current entering the port = current leaving the port

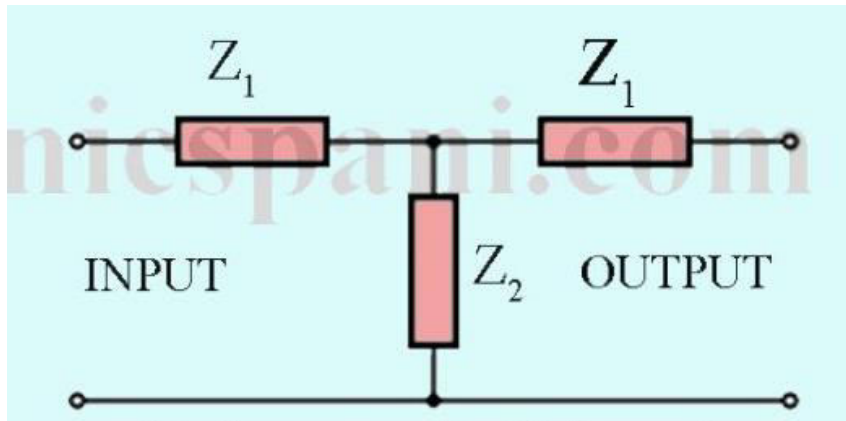
Two-Port Network



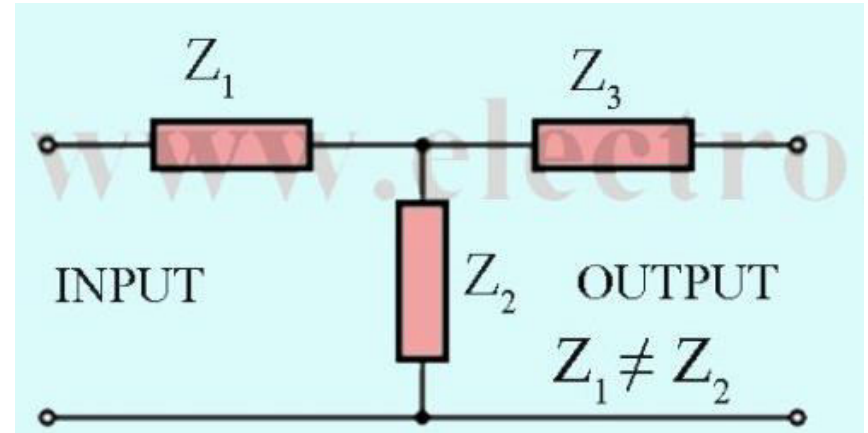
- Two pairs of terminal : two-port
- Current entering a port = current leaving a port
- V_1, V_2, I_1 and I_2 are related using two-port network *parameters*

T- Section

Symmetrical T- Network

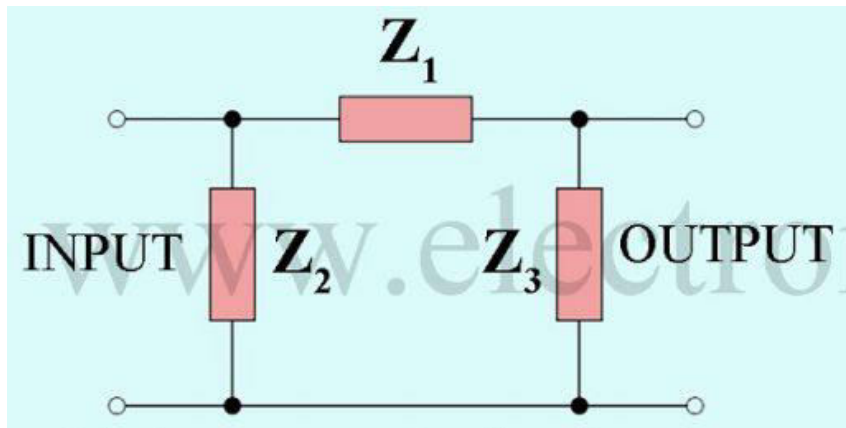


Asymmetrical T - Network

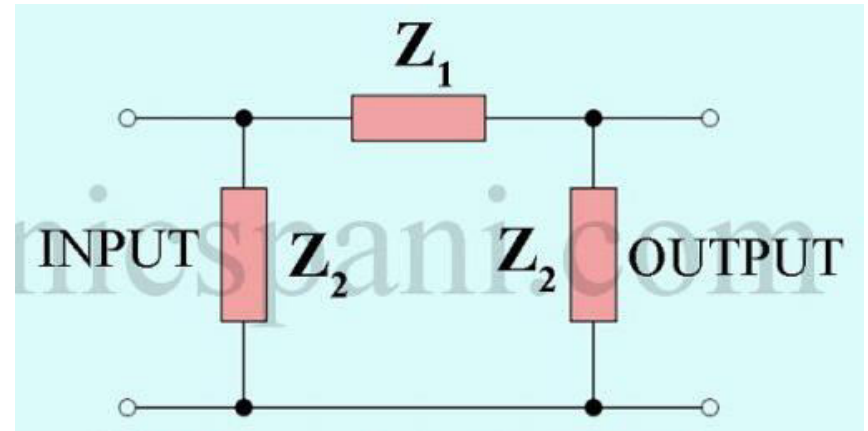


π -Section

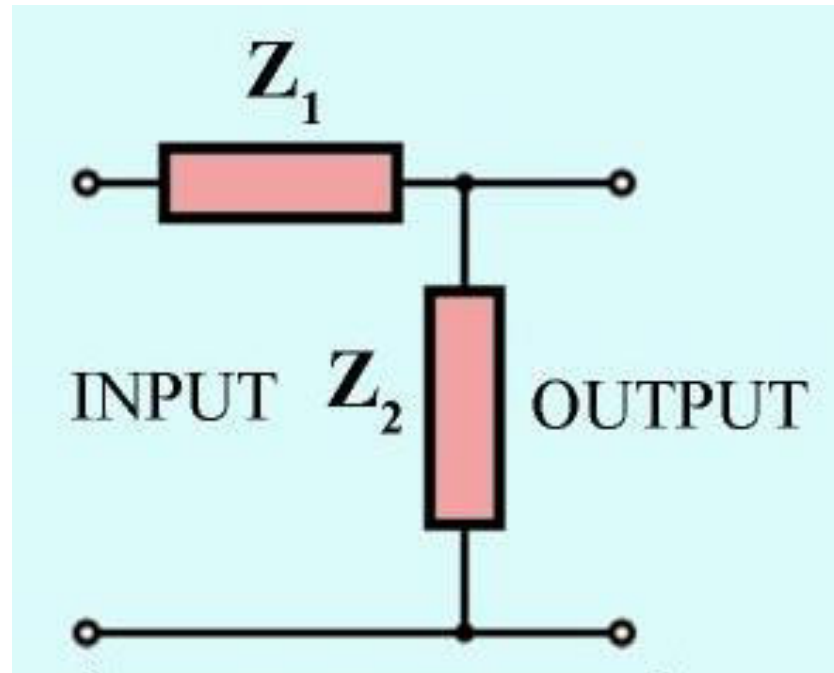
Asymmetrical π - Network



Symmetrical π - Network



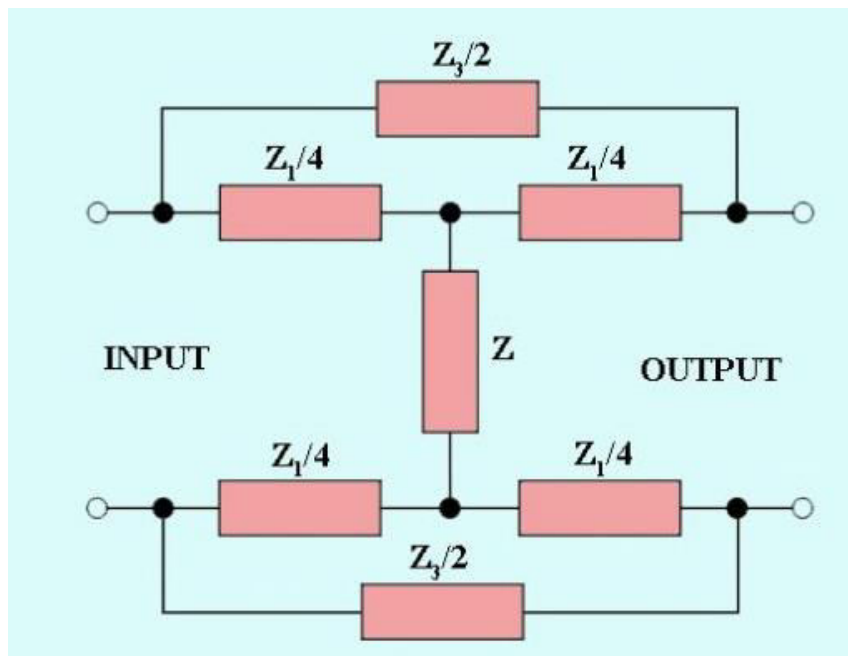
L - Section



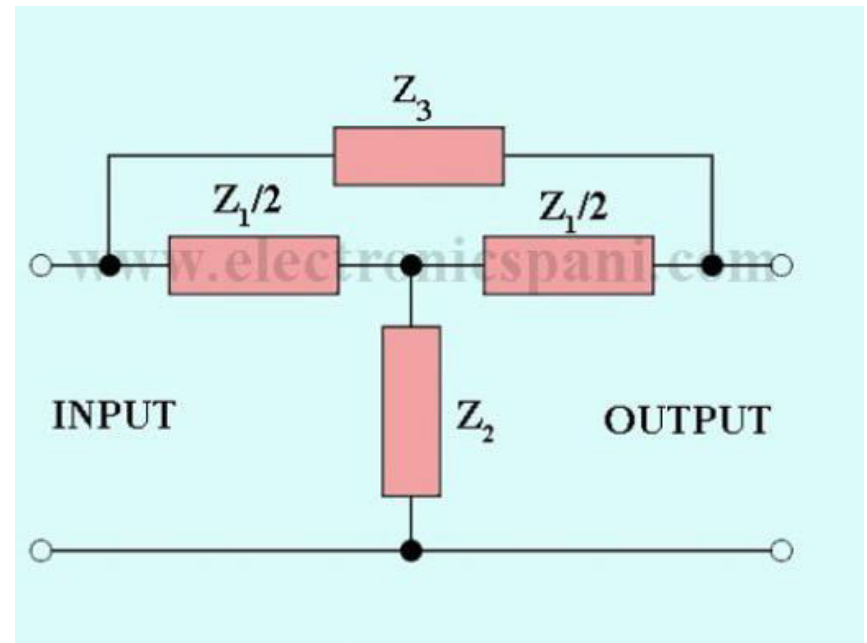
L - Network

Bridged T-section

Balanced bridged T-section



Unbalanced bridged T-section



Attenuators

- Attenuators is a two port network which reduce the signal level by desired amount when inserted between source and load.
- Attenuators are exactly opposite of amplifier
- Amplifiers are used to increase the signal level whereas Attenuators decrease the signal levels.
- Attenuators is resistive network.

Attenuation

- Power loss in any Network gives attenuation. It expressed in terms of neper & decibel (dB).
- Attenuation is defined as the ratio of output power to the input power
- $\text{Attenuation} = P_i/P_o$
- where, P_i = Input Power
- P_o = Output Power

Classification of attenuators

- Symmetrical attenuator : It is a resistive network which is inserted between source and load and having equal input and output resistance.
- Asymmetrical attenuator : It is a resistive network inserted between source and load having an unequal Input resistance when looked into from input and output terminals separately.

Filter

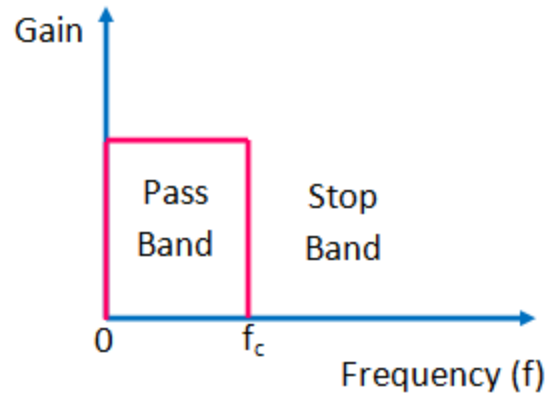
- Filter: A filter is network which suppress certain range of frequencies and pass other frequencies without any loss of signal .
- An electrical filter is a circuit which can be designed to modify, reshape or reject all the undesired frequencies of an electrical signal and pass only the desired signals.

Classification of Filters

- Depending on the type of element used in their construction, filters are classified into two types:
 - **Passive Filters** : A passive filter is built with passive components such as resistors, capacitors and inductors.
 - **Active Filters** : An active filter makes use of active elements such as transistors, op-amps in addition to resistor and capacitors.
- According to the operating frequency range, the filters may be classified as:
 - **Low Pass Filter**
 - **Band Pass Filter**
 - **High Pass Filter**
 - **Band Stop Filter**

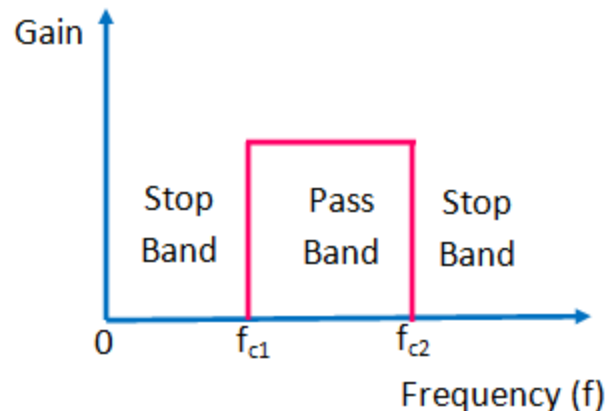
Low Pass Filter

- The low pass filter only allows low frequency signals from 0 Hz to its cut-off frequency, f_c point to pass while blocking any higher frequency signals.



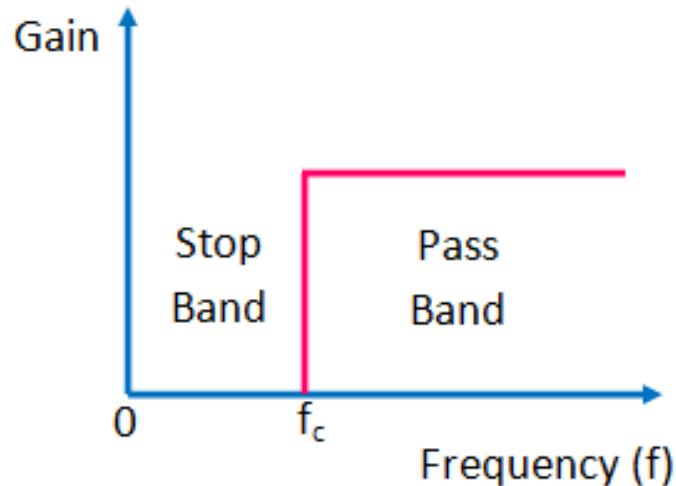
Band Pass Filter

- The band pass filter allows signals falling within a certain frequency band set up between two points to pass through while blocking both the lower and higher frequencies either side of this frequency band.



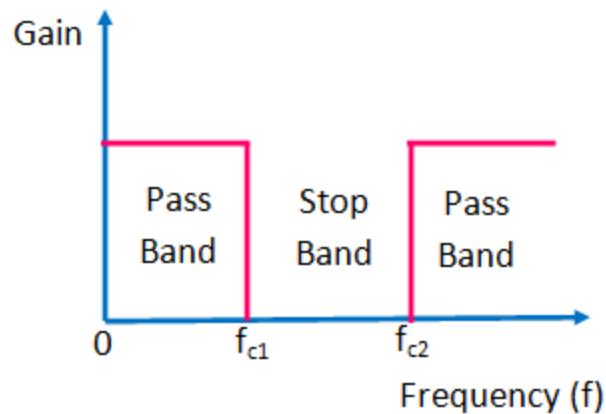
High Pass Filter

- The high pass filter only allows high frequency signals from its cut-off frequency, f_c point and higher to infinity to pass through while blocking those any lower.



Band Stop Filter

- The band stop filter blocks signals falling within a certain frequency band set up between two points while allowing both the lower and higher frequencies either side of this frequency band



Uses of Filters

- Filter are wisely used in communication system to separate various voice channels in carrier frequency telephone circuits.
- Filters are widely used in Radio , T.V etc.
- Filter is used in communication transmitters , receivers , multi channel communication etc.

Transmission line

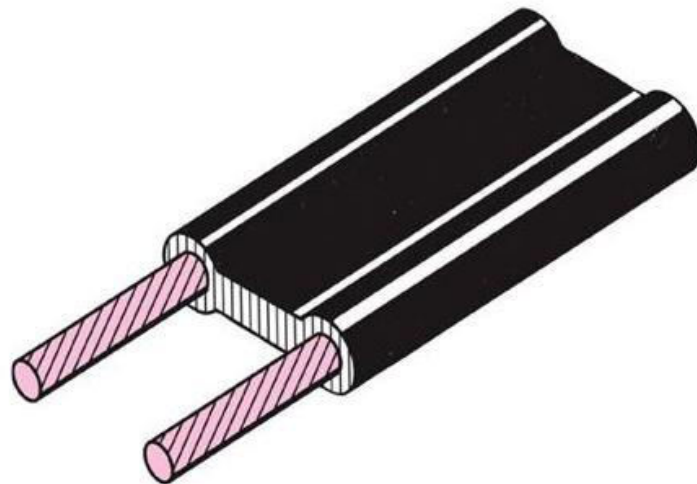
- It is a conductive medium consisting of two or more conductors through which electrical energy is transmitted from one place to another. These cables act as a channel or medium through which electrical energy is sent from one place to another place.

Different types of transmission lines

- Parallel wires lines.
- Co-axial lines.
- Wave guides.
- Optical fibre.

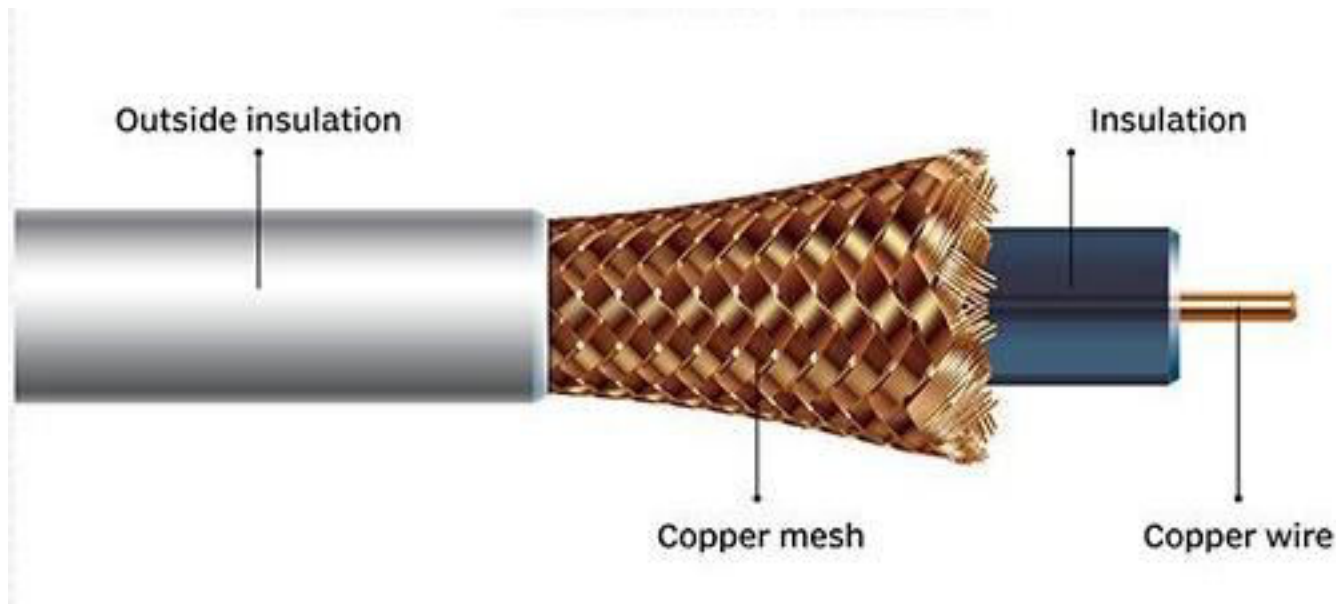
Parallel wires lines

- Parallel-wire line is made of two parallel conductors separated by a space of $\frac{1}{2}$ inch to several inches. A variation of parallel line is the 300- Ω twin-lead. Spacing between the wires is maintained by a continuous plastic insulator



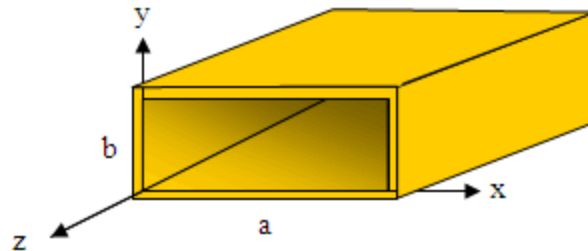
Co-axial cable

- It consist of a central conductor surrounded by an out side conductor with dielectric in between inner and outer conductor .



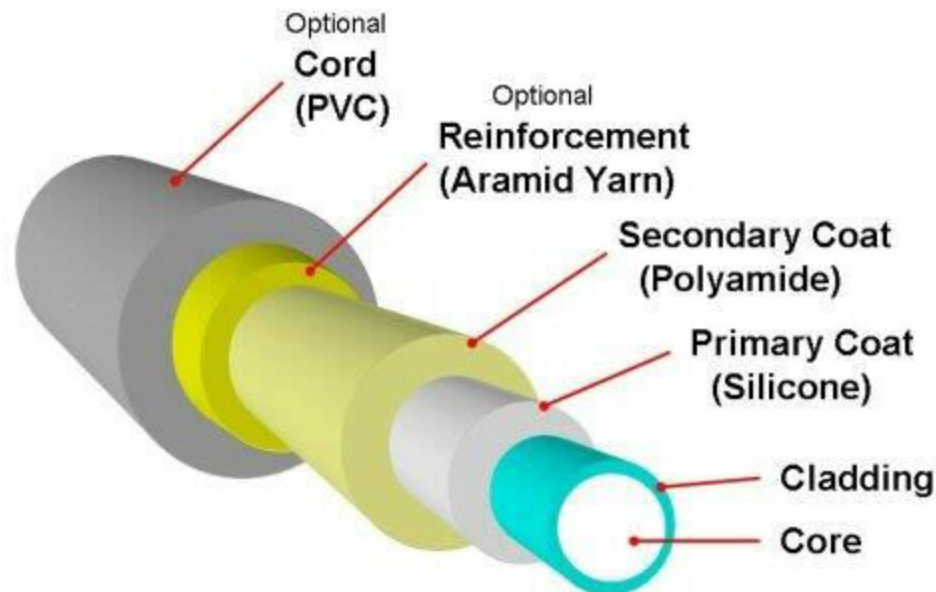
Wave Guide

- A hollow conducting metallic tube of uniform Cross section used for transmitting electromagnetic waves by successive reflections from inner walls tube. These are used in transmission of UHF and microwave signals.



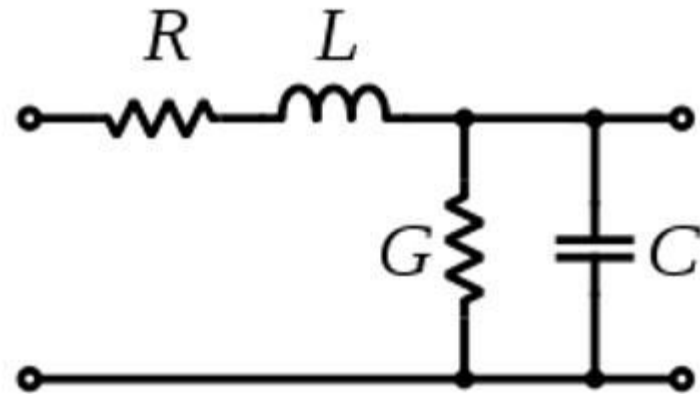
Optical Fibre

- It consist of very thin hollow glass fibre through which light wave is transmitted.



Equivalent Circuit of TL

- The lumped circuit elements are much smaller than the characteristic wavelength.
Transmission circuit has greater transportation of voltage and current than wavelength.



- C = capacitance – two conductors separated by an insulator
- R = resistance – opposition to current flow
- L = self inductance
- G = leakage resistance of dielectric

The Equivalent Circuit of Transmission Line

- For any given transmission line, resistance and inductance will occur along the line and capacitance and conductance will occur between the lines. These are called primary constants and are uniformly distributed along the length of the line. To make analysis simple these parameters are lumped together per unit length to form an artificial electrical model of the line.

The Equivalent Circuit of Transmission Line

- At radio frequencies the inductive reactance is much larger than the resistance, the capacitive susceptance is also much larger than the conductance. Both R and G may therefore be ignored resulting in what is called a lossless line

Transmission Characteristics

- These are called the secondary constants and are determined from the primary characteristics. They are:
 - The characteristic impedance and
 - The propagation constant

Characteristic Impedance

- Maximum power transfer is only possible if the load matches the characteristic impedance of the line. This is the impedance measure at the input of a transmission line when its length is infinite.
- The relationship between the capacitance and the inductance per unit length and the characteristic impedance is given as:

$$Z_0 = \sqrt{\frac{L}{C}}$$

Where,

Z_0 = Characteristic impedance of line

L = Inductance per unit length of line

C = Capacitance per unit length of line

Propagation Constant

- This is used to express the attenuation and phase shift per unit length of the transmission line. This can be expressed as:

$$\gamma = \alpha + j\beta$$

γ is the propagation constant

α is attenuation coefficient

β is the phase shift coefficient

Reflected Wave and Standing Wave Ratio

- When a transmission line terminates in a load that does not match the characteristic impedance of the line then reflected waves result.
- A summation of the incident and reflected waves at different points along the line will give rise to different rms voltage (current) values along the line.
- The ratio of the largest rms value to the smallest is called standing wave ratio. It is an indication of how close we are to transmitting maximum power to the load.

$$SWR = \frac{Z_L}{Z_o} = \frac{V_{\text{rms max}}}{V_{\text{rms min}}} = \frac{I_{\text{rms max}}}{I_{\text{rms min}}}$$

Reflection Coefficient

- This is defined as reflected voltage (current) divided by the incident voltage (current).

$$K_r = \frac{V_{\text{refl}}}{V_{\text{inc}}} = \frac{I_{\text{refl}}}{I_{\text{inc}}}$$

- This coefficient can also be expressed in terms of the SWR or the load resistance and characteristic impedance

$$K_r = \left| \frac{Z_L - Z_o}{Z_L + Z_o} \right|$$

Application of Transmission line

- To transmit electrical energy from one place to another place.
- To transmit communication signals from a transmitter to receiver.
- To work as circuit elements like capacitor , resistor , inductor , filter etc
- For Impedance matching purpose.