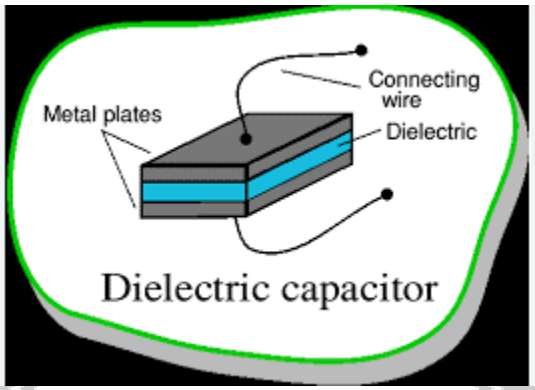
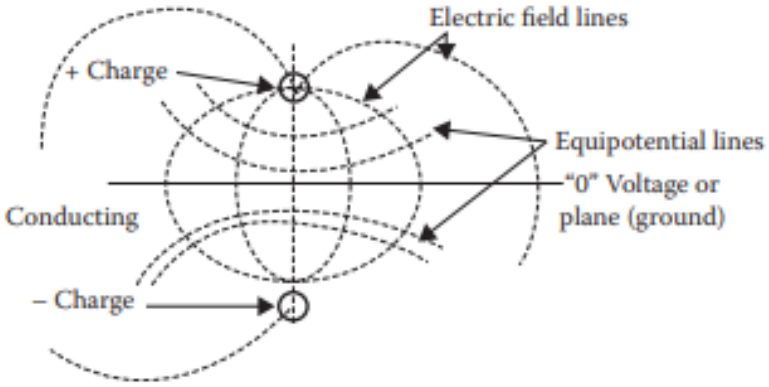
2.2 BASIC DIELECTRIC THEORY OF CABLE:



- Whether being used to convey electric power or signals, it is the purpose of a wire or cable to convey the electric current to the intended device
- Electrical insulation (dielectric) is provided to largely isolate the conductor from other paths or surfaces through which the current might flow

Electric Fields And Voltage:

- Current flow is charge in motion. We might consider the simple case of a conductor carrying current out to a load and then a return conductor as two separate parallel cylinders of charge
- If we neglect the conductor diameter (line of charge), there are electric field lines represented by circles of diameters such that the center of the circles are on the "0" line and each circle passes through the center of the cylinders.
- The voltage at any location is the sum of the voltages due to each charge.
- This then, neglecting the conductor diameter, represents the electric field lines and equipotential (equal voltage lines) lines for an energized current carrying conductor above ground.



Air Insulated Conductors:

A metallic conductor suspended from insulating supports, surrounded by air, and carrying electric signals or power may be considered as the simplest case of an insulated conductor.

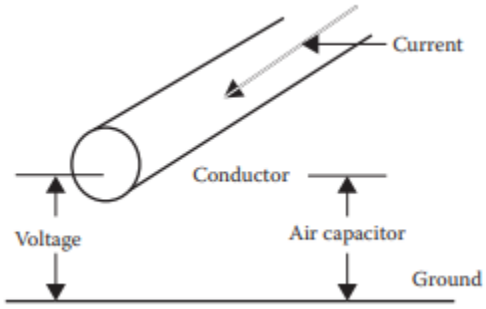
It also presents an opportunity to easily visualize the parameters involved

The charge separation between the conductor and the ground, results in a capacitor and because there is some (generally very small) conduction from the conductor to the ground, a large resistance also exists between the conductor and the ground.

As long as the ground is well away from the conductor, the electric field lines leave the conductor outer surface as reasonably straight lines emanating from the center of the conductor.

Air is not a very good insulating material since it has a lower voltage breakdown strength than many other insulating materials It is low in cost and if space is not a constraint, then it is a widely used dielectric.

As the voltage between the conductor Basic Dielectric Theory of Cable



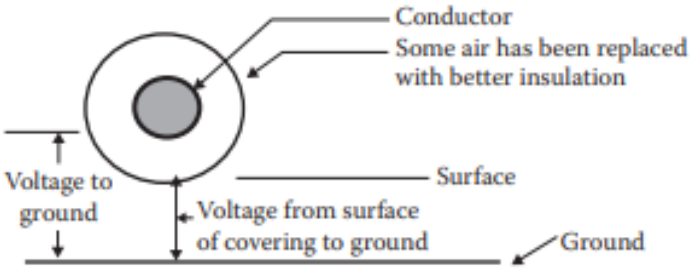
Insulating To Save Space:

Space is a common constraint that precludes the use of air as an insulator. Imagine the space requirements to wire a house or apartment using bare conductors on supports with air as the insulation.

Let us consider the next step where some of the air surrounding the previous conductor is replaced with a better insulating material (dielectric).

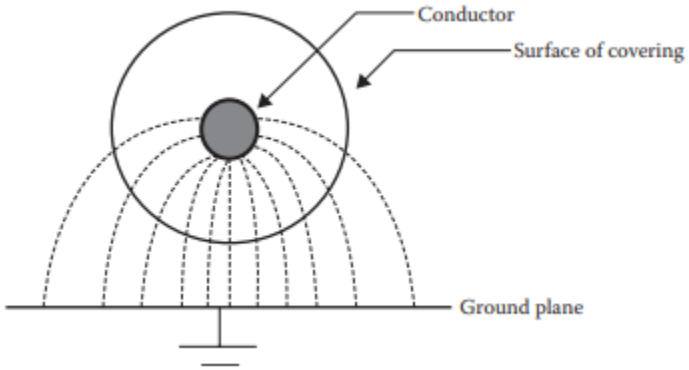
The distribution of voltage from the conductor to the covering surface and from the covering surface to the ground will be in proportion to these impedances.

It is important to note that with ground relatively far away from the covered conductor, the majority of the voltage exists from the covering surface to the ground.



Rising Voltage:

- Return to the metallic conductor that is covered with an insulating material and suspended in air
- When the ground plane is brought close or touches the covering, the electric field lines Recognizing that equipotential lines are perpendicular to the field lines, the bending results in potential differences on the covering surface.



Insulation Shield:

- Imagine that the ground plane was "wrapped" around the conductor with the same thickness of air separating the two.
- Barring surface irregularities at the conductor or ground, the electric field lines would be straight lines taking the shortest path from the conductor to the ground and the equipotential lines would be concentric cylinders around the conductor
- This would form a cylindrical capacitor and would make the most effective use of the dielectric.