$$\nabla^2 V = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = 0$$

- In cylindrical coordinate system.

$$\nabla^2 V = \frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial V}{\partial_r}\right) + \frac{1}{r^2}\left(\frac{\partial^2 V}{\partial \phi^2}\right) + \frac{\partial V^2}{\partial z^2} = 0$$

- In spherical coordinate system,

$$\nabla^2 V = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial V}{\partial_r}\right) + \frac{1}{r^2 Sin\theta}\frac{\partial}{\partial \theta}\left[Sin\theta\frac{\partial v}{\partial \theta}\right] + \frac{1}{r^2 Sin^2\theta}\frac{\partial^2 V}{\partial \phi^2} = 0$$

- Laplace's and Poisson's equations are not only useful in solving electrostatic field problem; they are used in various other field problems.

**TWO MARK QUESTIONS**

1. State Poisson's equation.

$\nabla^2 V = -\frac{\rho}{\varepsilon}$ - Poisson's Equation.

Laplace equation in Cartesian form.

$$\nabla^2 V = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = -\frac{\rho}{\varepsilon}$$

In cylindrical coordinate system.

$$\nabla^2 V = \frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial V}{\partial_r}\right) + \frac{1}{r^2}\left(\frac{\partial^2 V}{\partial \phi^2}\right) + \frac{\partial V^2}{\partial z^2} = -\frac{\rho}{\varepsilon}$$

In spherical coordinate system,

$$\nabla^2 V = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial V}{\partial_r}\right) + \frac{1}{r^2 Sin\theta}\frac{\partial}{\partial \theta}\left[Sin\theta\frac{\partial v}{\partial \theta}\right] + \frac{1}{r^2 Sin^2\theta}\frac{\partial^2 V}{\partial \phi^2} = -\frac{\rho}{\varepsilon}$$

Laplace's and Poisson's equations are not only useful in solving electrostatic field problem; they are used in various other field problems.

2. State Uniqueness Theorem.

The Uniqueness theorem can be stated as, If the solutions of Laplace's equation satisfy the boundary condition then that solution is unique, by whatever method is obtained. The solution of Laplace's equation gives the field which is unique satisfying the same boundary conditions, in a given region.

3. State the applications of Poisson's equation and Laplace's equation.
   - To obtain potential distribution over the region.
   - To obtain E in the region.
   - To check whether given region is free of charge or not.
   - To obtain the charge induced on the surface of the region.
4. Define current density

The current density is defined as the current passing through the unit surface area, when the surface is held normal to the direction of the current. The current density is measured in $A/m^2$

5. Define a current and its unit Ampere.

The current is defined as the rate of flow of charge and is measured as Ampere's. A current of 1 Ampere is said to be flowing across the surface when the charge of 1 coulomb is passing across the surface in 1 second.

6. What is drift current and convection current?

The current constituted due to the drifting of electrons in metallic conductor is called drift current. While in dielectrics, there can be flow of charges, under the influence of electric field intensity. Such a current is called convection current.

7. State the principle of conservation of charge.

The principle of conservation of charge is, the charges can neither be created nor be destroyed.

8. What is drift velocity?

Under the effect of applied electric field, the available free electrons start moving. The moving electrons strike the adjacent atoms and rebound in the random directions. This is called drifting of the electrons. After sometime, the electrons attain the constant average velocity called drift velocity.

9. Define the unit of Potential difference.

The unit of potential difference is Volt. One Volt potential difference is one Joule of work done in moving unit charge from one point to other in the field . E

10. Define dielectric strength.

The minimum value of the applied electric field at which the dielectric breaks down is called dielectric strength of dielectric.

11. Define dielectric breakdown

Dielectric breakdown is said to have occurred when a dielectric becomes conducting. Dielectric breakdown occurs in all kinds of dielectric materials (gases, liquids, or solids) and depends on the nature of the material, temperature, humidity, and the amount of time that the field is applied. The minimum value of the electric field at which dielectric breakdown occurs is called the dielectric strength of the dielectric material. The dielectric strength is the maximum electric field that a dielectric can tolerate or withstand without breakdown.

12. State the boundary conditions at the interface between two perfect dielectrics

- The tangential component of electric field is continuous Et1 = Et2
- The normal component of electric flux density is continuous. Dn1 = Dn2

13. Define Polarization

The product of charge Q and length l between dipole is dipole moment. Dipole moment per unit volume is called polarization, a vector field directed from –Q to +Q . P = $\frac{Ql}{Al}$ = $\frac{Q}{A}$ Ql where Ql is unit vector directed –Q to +Q.

14. What is Gaussian surface? What are the conditions to be satisfied in special Gaussian surface?

The surface over which is the Gauss's law is applied is called Gaussian surface. Obviously such a surface is a closed surface and it has to satisfy the following conditions. The surface may be irregular but should be sufficiently large so as to enclose the entire charge. The surface must be closed.