Poisson's Equation

* Poissons Equation derived by S.D. Poisson's his very popular french mathematician, Engineer and physist.

Statement :- Poissons Equation gives the relation -ship between electric potential and charge density in a semiconductor.

or

* The rate of change of carriers concentration at any point of semiconductor is given by poissons Eqn.

Proof :-

* In case of electrostatistic, electric field is Equal to the gradient of electric potential.

$$\vec{E} = -\nabla V \quad \text{——} \textcircled{1}$$

∇ — gradient

where V = electric potential

E = electric field

* we know that :-

Gauss theorem is

• Differential form of Goss theorem is denote by

$$\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\epsilon_0} \quad \text{——— (11)}$$

divergence ——— ; ρ ——— volume charge density ; ϵ_0 ——— permitivity of free space

Above Equation state that, divergence of electric field is equal to the volume charge density and permitivity of that space.

~~where~~ ——

Now putting the value of $\vec{E}$ in Eqn (11) then we get —

$$\vec{\nabla}(-\nabla V) = \frac{\rho}{\epsilon_0}$$

$$\boxed{\nabla^2 V = -\frac{\rho}{\epsilon_0}} \longrightarrow (3)$$

Nebula operator

—— or laplession Square

• Above Equation is the poisson's Eqn for electric statistics.

Now Here we ~~also~~ proof the poisson's ~~Eqn~~ Equation for Semiconductor matterial so the charge density become —

$$\rho = q(-n + p + N_d^+ - N_a^-)$$

eqn ③ become

$$\vec{\nabla} \cdot \vec{E} = \frac{S}{\varepsilon_0} = \frac{S(-n + p + N_d^+ - N_a^-)}{\varepsilon_0} \quad \text{--- ④}$$

We know that —

In case of Semiconductor electric field Equal to the rate of chang of electric flux so —

$$E = -\frac{d\phi(x)}{dx}$$

$$E = -\nabla\phi(x) \quad \text{--- ⑤}$$

electrostatics $E = -\nabla V$

putting the value of E in eqn ④ and we get —

$$\boxed{\nabla^2\phi(x) = \frac{S(-n + p + N_d^+ - N_a^-)}{\varepsilon_0}}$$

This is the poissons eqn for