Continuity Equation

$$\cancel{\frac{\partial n(x,t)}{\partial t}} = \mu_n n \cancel{\frac{\partial \mathcal{E}}{\partial x}} + \cancel{\mu_n \mathcal{E} \frac{\partial n(x,t)}{\partial x}} + D_n \frac{\partial^2 n(x,t)}{\partial x^2} + G_n(x,t) - R_n(x,t)$$

$$\cancel{\frac{\partial p(x,t)}{\partial t}} = -\mu_p p \cancel{\frac{\partial \mathcal{E}}{\partial x}} + \cancel{\mu_p \mathcal{E} \frac{\partial p(x,t)}{\partial x}} + D_p \frac{\partial^2 p(x,t)}{\partial x^2} + G_p(x,t) - R_p(x,t)$$

$$\frac{\delta n}{\tau_{n0}} \qquad \frac{\delta p}{\tau_{p0}}$$

To solve for the Continuity equation,

A. First, we need a mathematical formulation of the generation and recombination rates

B. We will assume that net recombination rate is limited by minority carrier density

C. We will solve in quasi-neutral region of the semiconductor where ε is small and current is due to diffusion primarily

- **In the quasi-neutral region, where ε is small and diffusion prevails, continuity equation reduces to diffusion equation**

$$0 = D_n \frac{\partial^2 n_p(x)}{\partial x^2} + \frac{n_p - n_{p0}}{\tau_n} \quad \text{— p-type Sample}$$

$$0 = D_p \frac{\partial^2 p(x)}{\partial x^2} + \frac{p_n - p_{n0}}{\tau_p} \quad \text{— n-type Sample}$$

General solution to 2nd order differential equation:

$$n_p(x) = n_{p0} + C e^{-x/L_n} + D e^{+x/L_n}$$

$$p_n(x) = p_{n0} + A e^{-x/L_p} + B e^{+x/L_p}$$

$$L_n = \sqrt{D_n \tau_n} \quad , \quad L_p = \sqrt{D_p \tau_p}$$

$L_n \rightarrow$ minority carrier diffusion length

Spatial dependence of excess carriers

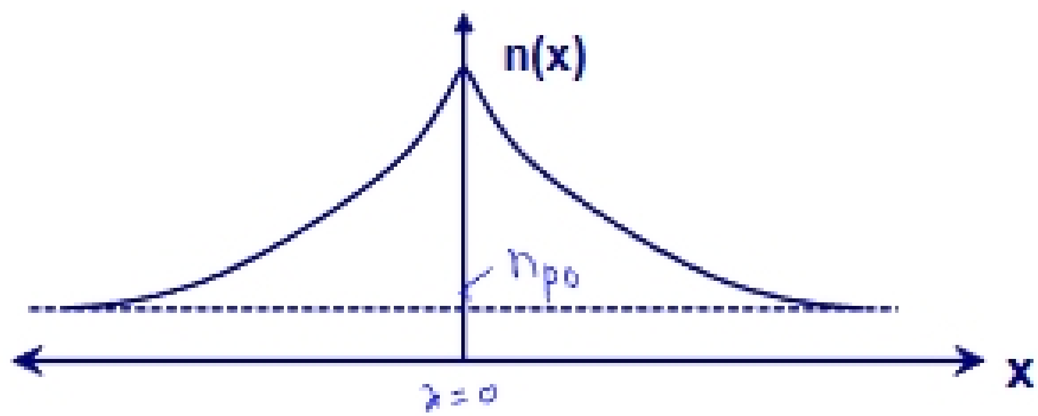
- We can rewrite the diffusion equation in terms of excess carrier densities and get

$$\frac{d^2 \delta n_p}{dx^2} + \frac{\delta n_p}{L_n^2} = 0$$

Assume there is a plane source of carriers at x=0. Since far away from the source excess carrier density will reduce to zero

$$\delta n_p = A e^{-x/L_n} \quad x > 0$$

$$\delta n_p = A e^{+x/L_n} \quad x < 0$$



L_n and L_p are the characteristic decay length for the excess carriers in a semiconductor