Space charge density $= \frac{\rho}{A} =$

Poisson's eqn:

$$\nabla^2 v = -\frac{\rho(x, y, z)}{\varepsilon_0 \varepsilon_r}$$

p side

$\rho = -qN_A$

$$\frac{d^2v}{dx^2} = -\frac{\rho}{\varepsilon}$$

$$= +\frac{qN_A}{\epsilon}$$

$$\frac{dv}{dx} = \frac{qN_A}{\epsilon}.x + c$$

$$V = \frac{qN_A x^2}{2\epsilon} + cx + D$$

At $x = 0$; $v = 0$; $D = 0$

At $x = x_1$ $\frac{dv}{dx} = 0 \Rightarrow c = -\frac{qN_A}{\epsilon} x_1$

$v = v_1$

$\therefore V_1 =$

$$x_1^2 = \frac{2\epsilon_0 \epsilon_r V_0}{q N_A \left(1 + \frac{N_A}{N_D}\right)}$$

$$x_2^2 = \frac{2\epsilon_0 \epsilon_r V_0}{q N_D \left(1 + \frac{N_D}{N_A}\right)}$$

$$x_1 x_2 = \sqrt{x_1^2 \cdot x_2^2}$$

$$= \sqrt{\frac{2 \times 2\, \epsilon_0^2 \epsilon_r^2 V_0^2}{q^2 N_A N_D \left(1 + \frac{N_A}{N_D}\right)\left(1 + \frac{N_D}{N_A}\right)}}$$

$$= \frac{2\epsilon_0 \epsilon_r V_0}{q} \sqrt{\left[\frac{1}{\cancel{N_A}\cancel{N_D}\left[\frac{N_D + N_A}{\cancel{N_D}}\right]\left[\frac{N_A + N_D}{\cancel{N_A}}\right]}\right]}$$

$$x_1 x_2 = \frac{2\epsilon_0 \epsilon_r V_0}{q\left[N_A + N_D\right]}$$

$$-2x_1 x_2 = \frac{-4\epsilon_0 \epsilon_r V_0}{q\left[N_A + N_D\right]}$$