5.8. $$I_n(x_n) = I - I_p(x_n)$$

$$= qA\left(\frac{D_p}{L_p}p_n + \frac{D_n}{L_n}n_p\right)\left(e^{qV/kT}-1\right)$$

$$- qA\frac{D_p}{L_p}p_n e^{-x_n/L_p}\left(e^{qV/kT}-1\right)$$

$$I_n(x_n) = qA\left(\frac{D_p}{L_p}p_n\left(1-e^{-x_n/L_p}\right) + \frac{D_n}{L_n}n_p\right)\left(e^{qV/kT}-1\right)$$

$$I_n(x_n) = I_n(\text{drift}) + I_n(\text{diff.})$$

In neutral n-region $\frac{dn}{dx} \approx 0$, so, $\boxed{I_n(\text{diff.}) \approx 0}$

And $I_n(x_n, \text{neutral}) \approx I_n(\text{drift})$

$$\boxed{I_n(\text{drift}) \approx qA\left(\frac{D_p}{L_p}p_n\left(1-e^{-x_n/L_p}\right) + \frac{D_n}{L_n}n_p\right)\left(e^{qV/kT}-1\right)}$$

5.11. (a) $$\alpha = \frac{|I_n(x=-x_{p0})|}{I}$$

$$\alpha = \frac{\left|-\frac{\cancel{q}AD_n}{L_n}n_p\cancel{\left(e^{qV/kT}-1\right)}\right| \text{ ...... (5-34)}}{\cancel{qA}\left(\frac{D_p}{L_p}p_n + \frac{D_n}{L_n}n_p\right)\cancel{\left(e^{qV/kT}-1\right)} \text{ ...... (5-36)}}$$

$$\boxed{\alpha = \frac{1}{\frac{D_p}{D_n}\frac{L_n}{L_p}\frac{p_n}{n_p}+1}}$$

5.11. (b). $\left.\begin{aligned} p_p &= p_n e^{qV_0/kT} \\ n_n &= n_p e^{qV_0/kT} \end{aligned}\right\} \Rightarrow \frac{p_p}{n_n} = \frac{p_n}{n_p}$

$$\mu = q\cdot\left(\frac{D}{kT}\right) \Rightarrow \frac{D_p}{D_n} = \frac{\mu_p}{\mu_n}$$

Then. $\boxed{\alpha = \left(1 + \frac{\mu_p L_n p_p}{\mu_n L_p n_n}\right)^{-1}}$

To increase α, we can reduce the ratio of

$\left(\frac{\mu_p L_n p_p}{\mu_n L_p n_n}\right)$, but the most practical way is to

increase N_d and decrease N_a to reduce the ratio

$$\frac{p_p}{n_n} \approx \frac{N_a}{N_d}$$

5.12. p^+-n junction, so $N_a \gg N_d$

$$I = I_p(x_n=0) + I_n(x_p=0) \approx I_p(x_n=0)$$

$$\therefore\ I = \frac{qAD_p}{L_p} p_n \left(e^{qV/kT} - 1\right)$$

$$L_p = \sqrt{D_p \cdot \tau_p} = \sqrt{10\times10^{-6}} = 3.16\times10^{-3}\ \text{cm}$$

$$p_n = \frac{(n_i)^2}{N_d} = \frac{(1.5\times10^{10})^2}{5\times10^{16}} = 4500\ \text{cm}^{-3}$$

$$I = 1.6\times10^{-19} \times 10^{-3} \times \frac{10}{3.16\times10^{-3}} \times 4500 \times \left(e^{\frac{0.5\,eV}{0.0258\,eV}} - 1\right)$$

$$\boxed{I = 5.9\times10^{-7}\ A}$$