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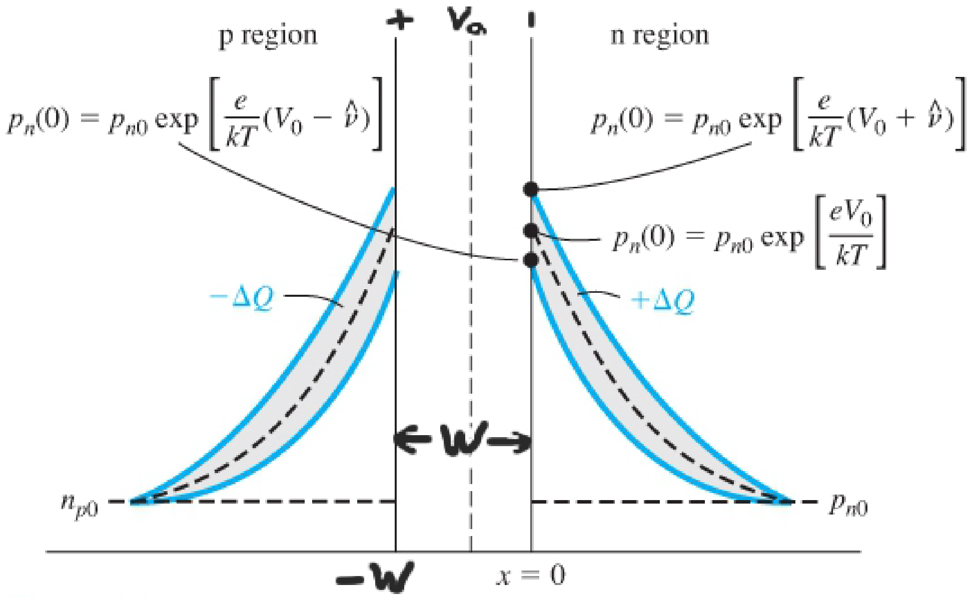

Figure 8.21 | Minority carrier concentration changes with changing forward-bias voltage.

- At the boundary between the depletion layer and n region (now at $x = 0$), the minority carrier (holes) concentration varies between a high of $p_n(0) = p_{n0}\, e^{(V_a + \hat{v})/V_t}$ and a low of $p_n(0) = p_{n0}\, e^{(V_a - \hat{v})/V_t}$ as $V_a = V_0 + \hat{v}\sin(\omega t)$ varies sinusoidally.
- Similarly, at the boundary between the depletion layer and p region, the minority carrier (electrons) concentration varies between a high of $n_p(-W) = n_{p0}\, e^{(V_a + \hat{v})/V_t}$ and a low of $n_p(-W) = n_{p0}\, e^{(V_a - \hat{v})/V_t}$ as $V_a = V_0 + \hat{v}\sin(\omega t)$ varies sinusoidally.
- These will serve as boundary conditions for the ambipolar transport equation for the excess minority carriers into the n & p regions.
- In turn, this is used to find the overall small-signal admittance $Y = \frac{1}{V_t}\left[I_{p0}\sqrt{1 + j\omega\tau_{p0}} + I_{n0}\sqrt{1 + j\omega\tau_{n0}} \right]$.
- Next, we make the <u>low-frequency assumption</u> that $\omega\tau_{p0} << 1$ and $\omega\tau_{n0} << 1$ to allow the use of the approximation $\sqrt{1 + x} \approx 1 + x/2$ (truncated Binomial series) to get $Y = \left(\frac{1}{V_t}\right)\left(I_{p0} + I_{n0}\right) + j\omega\left[\left(\frac{1}{2V_t}\right)\left(I_{p0}\tau_{p0} + I_{n0}\tau_{n0}\right)\right] = g_d + j\omega C_d$.