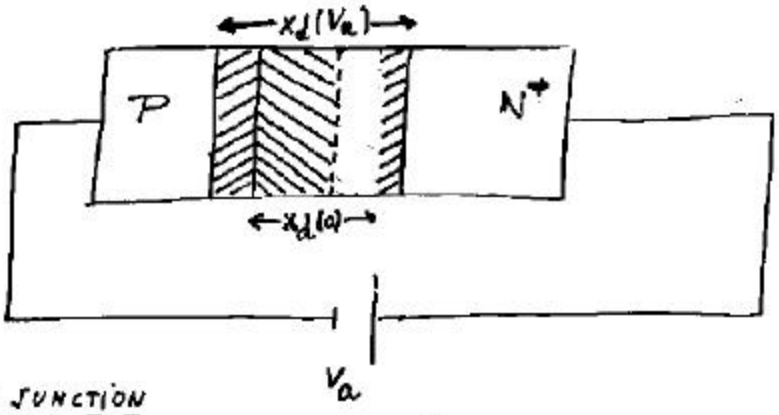
REVERSE BIASED PN JUNCTIONS



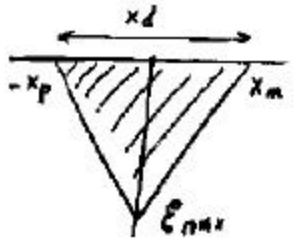
N_a^-

ABRUPT JUNCTION

$$x_d = \left[\frac{2\epsilon_0\epsilon_s}{q}\left(\frac{1}{N_a} + \frac{1}{N_d}\right)(\phi_i - V_a)\right]^{1/2}$$

ϕ_i : BUILT-IN VOLTAGE

$$\mathcal{E}_{max} = \frac{q(\phi_i - V_a)}{x_d} \propto (\phi_i - V_a)^{1/2}$$

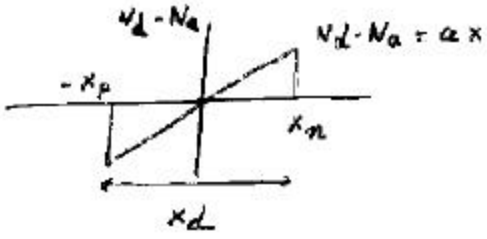


$$\phi_i - V_a = \frac{\mathcal{E}_{max} x_d}{2}$$

LINEARLY GRADED JUNCTION

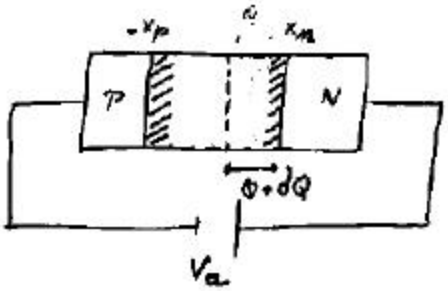
$$x_d = \left[\frac{12\epsilon_s(\phi_i - V_a)}{qa}\right]^{1/3}$$

$$\mathcal{E}_{max} = \frac{3(\phi_i - V_a)}{2x_d} \propto (\phi_i - V_a)^{2/3}$$



JUNCTION CAPACITANCE

$$C_j = \frac{dQ}{dV_a}$$



Q : CHARGE/UNIT AREA

$$- Q = qN_d x_n = qN_a x_p \longrightarrow x_p = \frac{N_d}{N_a} x_n$$

$$- C_j = \frac{dQ}{dV_a} = qN_d \frac{dx_n}{dV_a} = qN_a \frac{dx_p}{dV_a}$$

$$- x_d = x_n + x_p = x_n + \frac{N_d}{N_a} x_n = \frac{N_a + N_d}{N_a} x_n$$

$$\Rightarrow C_j = q \frac{N_a N_d}{N_a + N_d} \frac{dx_d}{dV_a} \qquad x_d = \left[\frac{2\epsilon_s \epsilon_0}{q} \left(\frac{1}{N_a} + \frac{1}{N_d} \right) (\phi_i - V_a) \right]^{1/2}$$

$$\Rightarrow \frac{dx_d}{dV_a} = \frac{1}{2} \left[\frac{2\epsilon_s \epsilon_0}{q} \left(\frac{1}{N_a} + \frac{1}{N_d} \right) \frac{1}{\phi_i - V_a} \right]^{1/2} = \frac{\epsilon_s \epsilon_0}{q} \frac{N_a + N_d}{N_a N_d} \frac{1}{x_d}$$

$$\Rightarrow \boxed{C_j = \frac{\epsilon_0 \epsilon_s}{x_d}}$$

DEMONSTRATED FOR ABRUPT JUNCTIONS
GENERAL FOR ALL JUNCTIONS

- j : CAPACITANCE PER UNIT AREA (F/cm^2)