p-n JUNCTIONS

$$\frac{dE(x)}{dx} = \frac{q}{\varepsilon}\,(p - n + N_d^+ - N_a^-)$$

$$V_o - V = \frac{E_o W}{2}$$

$$V_0 = \frac{kT}{q}\ln\frac{N_a N_d}{n_i^2} \qquad \mathcal{E}_{\max} = \frac{-q}{\varepsilon} N_d\, x_{n0} = \frac{-q}{\varepsilon} N_a\, x_{p0} \qquad \Delta p_n = p(x_{n0}) - p_{no} = p_{no}(e^{qV/kT} - 1)$$

$$W = \left[\frac{2\varepsilon(V_0 - V)}{q}\left(\frac{N_a + N_d}{N_a N_d}\right)\right]^{1/2} \qquad C_j = \frac{\varepsilon A}{W} \qquad \Delta n_p = n(-x_{p0}) - n_{po} = n_{po}(e^{qV/kT} - 1)$$

$$x_{n0} = \frac{N_a W}{N_a + N_d},\quad x_{p0} = \frac{N_d W}{N_a + N_d} \qquad G_s = \frac{q}{kT}\, I(\text{d-c}) \qquad \delta n(x_p) = \Delta n_p e^{-x_p/L_n}$$

$$\delta p(x_n) = \Delta p_n e^{-x_n/L_p}$$

$$\Phi_{Bn} = \Phi_m - \chi$$

$$\Phi_{Bp} = (E_g/q) - \Phi_m + \chi$$

$$I = qA\left(\frac{D_p}{L_p}p_n + \frac{D_n}{L_n}n_p\right)(e^{qV/kT} - 1) = I_0(e^{qV/kT} - 1)$$

MESFET Equations

$$I_D(sat.) = G_0 V_p\left[\frac{V_0}{V_p} + \frac{2}{3}\left(\frac{V_0 - V_G}{V_p}\right)^{3/2} - \frac{2}{3}\right] = G_0 V_p\left[\frac{1}{3} - \frac{V_0 - V_G}{V_p} + \frac{2}{3}\left(\frac{V_0 - V_G}{V_p}\right)^{3/2}\right]$$

(V_G negative) $\quad V_D = V_p - V_0 + V_G \quad G_o \equiv aZ/\rho L \quad V_p = \dfrac{qa^2 N_d}{2\varepsilon}$

Illuminated Junction

$$I = I_{th}(e^{qV/kT} - 1) - I_{op}$$

$$I_{op} = qAg_{op}(L_p + L_n + W)$$

MOSFET Relationships

$$V_T = \Phi_{ms} - \frac{Q_i}{C_i} - \frac{Q_d}{C_i} + 2\phi_F \qquad \phi_s(\text{inv.}) = 2\phi_F = 2\frac{kT}{q}\ln\frac{N_a}{n_i} \qquad W = \left[\frac{2\varepsilon_s\phi_s}{qN_a}\right]^{1/2} \qquad C_i = \varepsilon_i/d$$

$$Q_d = -qN_a W_m = -2(\varepsilon_s q N_a \phi_F)^{1/2} \qquad V_{FB} = \Phi_{ms} - \frac{Q_i}{C_i}$$

$$\frac{1}{C} = \frac{1}{C_i} + \frac{1}{C_D} \qquad I_D = \frac{\bar{\mu}_n Z C_i}{L}\left[(V_G - V_T)V_D - \frac{1}{2}V_D^2\right] \qquad g_d = \left.\frac{\partial I_D}{\partial V_D}\right|_{V_G} \qquad g_m = \left.\frac{\partial I_D}{\partial V_G}\right|_{V_D}$$

The Ideal PNP Transistor Relationships

$$\gamma = \frac{i_{Ep}}{i_{En} + i_{Ep}} \qquad i_C = Bi_{Ep} \qquad \frac{i_C}{i_E} = \frac{Bi_{Ep}}{i_{En} + i_{Ep}} = B\gamma \equiv \alpha \qquad \frac{i_C}{i_B} = \frac{B\gamma}{1 - B\gamma} = \frac{\alpha}{1 - \alpha} \equiv \beta = \frac{\tau_p}{\tau_t}$$