Solid-State Equations (Chapter 2)

$$\sigma = q\,(n\,\mu_n + p\,\mu_p) \qquad (\Omega\cdot\mathrm{cm})^{-1}$$

$$pn = n_i^2$$

$$N_D + p = N_A + n$$

$$v = \mu E$$

$$\frac{D_n}{\mu_n} = \frac{kT}{q} = \frac{D_p}{\mu_p} = V_T = \text{Thermal voltage}$$

$$j_n^T = q\mu_n nE + qD_n \frac{\partial n}{\partial x}$$

$$j_p^T = q\mu_p pE - qD_p \frac{\partial p}{\partial x}$$

Diodes

$$\phi_j = V_T \ln\left(\frac{N_A N_D}{n_i^2}\right)$$

$$w_{d0} = \sqrt{\frac{2\varepsilon_s}{q}\left(\frac{1}{N_A}+\frac{1}{N_D}\right)\phi_j}$$

$x_n = w_{d0}/(1+N_D/N_A)$ and $x_p = w_{d0}/(1+N_A/N_D)$

$$i_D = I_S\left[\exp\left(\frac{v_D}{V_T}\right)-1\right]$$

$$V_r \cong \frac{(V_P - V_{on})}{R}\frac{T}{C}$$ Ripple Voltage for Half Wave Rectifier

$$V_r \cong \frac{(V_P - 2V_{on})}{2R}\frac{T}{C}$$ Ripple Voltage for Bridge Rectifier

MOSFET

$$i_D = K_n\left(v_{GS} - V_{TN} - \frac{v_{DS}}{2}\right)v_{DS}$$ for $V_{DS} < V_{GS} - V_t$

$$i_D = \frac{K_n}{2}\left(v_{GS} - V_{TN}\right)^2(1+\lambda v_{DS})$$ for $V_{DS} > V_{GS} - V_t$

where, $K_n = K_n' W/L$

$K_n' = \mu_n C_{ox}''$ (A/V^2)

$C_{ox}'' = \varepsilon_{ox}/T_{ox}$

ε_{ox} = oxide permittivity (F/cm)

T_{ox} = oxide thickness (cm)

$$R_{on} = \frac{1}{K_n' \frac{W}{L}\left(V_{GS} - V_{TN}\right)}$$ in the linear region