Basic Physical Equations

Maxwell's Equations for Homogeneous and Isotropic Materials

Time Variant Form

$$\nabla \times E = -\frac{\partial B}{\partial t}$$

$$\nabla \times H = \frac{\partial D}{\partial t} + J_{cond} = J_{tot}$$

$$\nabla \bullet D = \rho(x, y, z)$$

$$\nabla \bullet B = 0$$

$$B = \mu H$$

$$D(r,t) = \int_{-\infty}^{t} \varepsilon(t-\tau) E(r,\tau) d\tau$$

Time Invariant Form

$$\nabla \times E = 0$$

$$\nabla \times H = J_{cond} = J_{tot}$$

$$\nabla \bullet D = \rho(x, y, z)$$

$$\nabla \bullet B = 0$$

$$B = \mu H$$

$$D = \varepsilon E$$

For a doped semiconductor $\rho = q\left(p - n + N_D^+ - N_A^-\right)$

Current Density Equations

$$J_n = q\mu_n n\mathcal{E} + qD_n \nabla n = n\mu_n \nabla E_{Fn}$$

$$J_p = q\mu_p p\mathcal{E} + qD_p \nabla p = p\mu_p \nabla E_{Fp}$$

$$J_{tot} = J_n + J_p$$

Einstein Relationships

$$D_n = \frac{kT}{q}\mu_n$$

$$D_p = \frac{kT}{q}\mu_p$$

Continuity Equations

$$\frac{\partial n}{\partial t} = G_n - U_n + \frac{1}{q}\nabla \bullet J_n$$

$$\frac{\partial p}{\partial t} = G_p - U_p + \frac{1}{q}\nabla \bullet J_p$$