Maxwell equations:

$$D = \varepsilon_o E + P = \varepsilon\varepsilon_o E$$
$$B = \mu_o (H + M)$$
$$\nabla \bullet B = 0$$
$$\nabla \bullet D = \rho_{free(non-dipole)}$$
$$\nabla \bullet (\varepsilon - 1)\varepsilon_o D = \rho_{dipole}$$
$$\nabla \times H = J + \frac{\partial D}{\partial t}$$
$$\nabla \times E + \frac{\partial B}{\partial t} = 0$$

Solid-State Electronics

Equation of motion of carriers in solid:

$\frac{d\vec{\mathbf{p}}}{dt} + \frac{\vec{\mathbf{p}}}{\tau} = \vec{\mathbf{F}} = -e(\mathbf{E} + \mathbf{v} \times \mathbf{B})$**,** where **p=mv**

$\mathbf{v} = \frac{q\mathbf{E}}{m}\tau$ **, or** $\mu = \frac{q}{m}\tau$

where q is the charge (-e for electron)

Boltzmann Transport Equation

$$\frac{df}{dt} = -v \bullet \nabla f - \boldsymbol{F} \bullet \nabla_{\boldsymbol{p}} f + \left(\frac{\partial f}{\partial t}\right)_{collision}$$

where *f(x,v,t)* is the distribution function and ***F*** *is the force field.*

Shockley Equations for semiconductors:

$$q\frac{\partial n}{\partial t} = \nabla \bullet j_n + q(g_n - r_n)$$
$$q\frac{\partial p}{\partial t} = -\nabla \bullet j_p + q(g_p - r_p)$$
$$j_n = q\mu_n nE + qD_n \nabla n = n\mu_n \nabla \mathrm{E}_{Fn}$$
$$j_p = q\mu_p pE - qD_p \nabla p = p\mu_p \nabla \mathrm{E}_{Fp}$$
$$\nabla \bullet \varepsilon E = \rho = q(p - n + N_D^+ - N_A^-)$$
$$\frac{\partial n_T}{\partial t} = (g_p - r_p) - (g_n - r_n)$$

Mechanical beam equation

$D\nabla^4 y + T\nabla^2 y = \rho d^2y/d^2t$, where ρ is the mass per unit area.

Energy Transfer Equations (first law of thermal dynamics):

$$\rho c_p \frac{dT}{dt} = k\nabla^2 T + \mu\Phi + \dddot{q}$$
$$\ddot{q} = -k\nabla T$$

where μΦ is viscous dissipation (kinetic energy→ heat) and q''' is internal heat generation and q'' is the heat flux.

Navier Stokes equations:

$$\rho \frac{du}{dt} = -\nabla p + \mu\nabla^2 u + F$$

μ the dynamic viscosity ($\nu=\mu/\rho$, the kinematic viscosity).

Continuity Equation:

$$\frac{d\rho}{dt} + \rho\nabla \bullet u = 0$$

Plasma as a fluid:

$$mn\left[\frac{\partial u}{\partial t} + (u \bullet \nabla)u\right] = total\ \ force = qn(E + u \times B) - \nabla p - \frac{mn(u - u_0)}{\tau} + \rho\upsilon\nabla^2 u + mngh$$
$$p = C\rho^\gamma or\ \ p = nKT$$
$$\frac{\partial n}{\partial t} + \nabla \bullet (nu) = 0$$

(convective derivative) of momentum =Lorentz force+pressure-collision+viscous damping + gravitation.