Chapter 2:

$m_0 v = \frac{h}{\lambda} \equiv \hbar k$

$\frac{d^2\psi}{dx^2} + \frac{2m_0}{\hbar^2}[E-U]\psi(x) = 0$

$\frac{d^2\psi}{dx^2} + g^2\psi(x) = 0$

Gen. solutions (U =constant):

$\psi(x) = A\sin(gx) + B\cos(gx)$

or: $\psi(x) = A\exp(igx) + B\exp(-igx)$

Bloch's Theorem: $\psi(x+a) = e^{ika}\psi(x)$

$k = \frac{2\pi n}{Na}, \quad (n = 0, \pm 1, \pm 2, ... \pm N/2)$

Chapter 3:

$v = \frac{1}{\hbar}\frac{dE}{dk}$

$m^* = \left[\frac{1}{\hbar^2}\frac{d^2E}{dk^2}\right]^{-1}$

$\vec{J} = \frac{1}{\Omega}\sum_{\text{filled states}} -q\vec{v_k}$

Chapter 4:

$n_i = p_i$

$n_0 p_0 = n_i^2$

$g_C(E) = \frac{8\sqrt{2}\pi}{h^3} m_e^{*3/2}(E-E_C)^{1/2}$

$f(E) = \frac{1}{1+\exp[(E-E_F)/kT]}$

$N_C = 2\left(\frac{2\pi m_e^* kT}{h^2}\right)^{3/2}$

$n_0 = N_C \exp\left(\frac{E_F - E_C}{kT}\right)$

$p_0 = N_V \exp\left(\frac{E_V - E_F}{kT}\right)$

$f_{MB}(E) = e^{-\frac{(E-E_F)}{kT}}$

$n_i = N_C \exp\left(\frac{E_{Fi} - E_C}{kT}\right)$

$p_i = N_V \exp\left(\frac{E_V - E_{Fi}}{kT}\right)$

$\int_{\text{device}} q(p(x) - n(x) + N_D(x) - N_A(x))dx = 0$

$n_0 = n_i \exp\left(\frac{E_F - E_{Fi}}{kT}\right)$

$p_0 = n_i \exp\left(\frac{E_{Fi} - E_F}{kT}\right)$

Chapter 5:

$v_R = \sqrt{\frac{kT}{2\pi m^*}}$

$1/v_d = 1/\mu\,\mathcal{E} + 1/v_{\text{sat}}$

$\mu \equiv \frac{q\bar{\tau}_{\text{coll}}}{m^*}$

$\vec{J}_{e,\text{drift}} = -qn\vec{v_d} = -qn\mu_e(-\vec{\mathcal{E}})$

$\vec{J}_{h,\text{drift}} = qp\vec{v_d} = qp\mu_e\vec{\mathcal{E}}$

$\sigma = 1/\rho = q(n\mu_e + p\mu_h)$

$\vec{J}_{h,\text{diff}} = -qD_h\frac{d\vec{p}}{dx}$

$\vec{J}_{e,\text{diff}} = qD_e\frac{d\vec{n}}{dx}$

$D_e = \frac{kT}{q}\mu_e$

$\frac{\partial n}{\partial t} = \frac{1}{q}\frac{dJ_e}{dx} - \frac{n-n_0}{\tau_e}$

$\frac{\partial p}{\partial t} = -\frac{1}{q}\frac{dJ_h}{dx} - \frac{p-p_0}{\tau_h}$

Gen. solution to Cont. Eqns.:

$c(x) - c_0 = A\exp(-x/\sqrt{D_e\tau_e}) + B\exp(x/\sqrt{D_e\tau_e})$

Chapter 6:

$-q\psi(x) = E_l(x) - E_0$

$V_{bi} = \frac{kT}{q}\ln\left[\frac{N_D N_A}{n_i^2}\right]$

$\psi(-x_N) - \psi(x_P) = V_{bi} + V_a$

$E_F(-x_N) - E_F(x_P) = -qV_a$

$W = \sqrt{\frac{2\epsilon}{q}(V_{bi}+V_a)\left(\frac{1}{N_D}+\frac{1}{N_A}\right)}$

$n = n_i\exp\left(\frac{E_{Fn} - E_{Fi}}{kT}\right)$

$p = n_i\exp\left(\frac{E_{Fi} - E_{Fp}}{kT}\right)$

$-q\phi_n(x) = E_{Fn}(x) - E_F$

$-q\phi_p(x) = E_{Fp}(x) - E_F$

$\vec{J}_T = \vec{J}_e + \vec{J}_h = -q\mu_e n\nabla\phi_n - q\mu_h p\nabla\phi_p$

$$\begin{aligned} -\nabla^2\psi &= \frac{q}{\epsilon}[p - n + N_D - N_A] \\ J_e &= -qn\mu_e\nabla\psi + qD_e\nabla n \\ J_h &= -qp\mu_h\nabla\psi - qD_h\nabla p \\ \frac{\partial n}{\partial t} &= \frac{1}{q}\nabla\cdot J_e - \frac{n-n_0}{\tau_e} \\ \frac{\partial p}{\partial t} &= -\frac{1}{q}\nabla\cdot J_h - \frac{p-p_0}{\tau_h} \end{aligned} \tag{1}$$

$n(x_{dp}) = n_{0p}\exp(\frac{-qV_{aj}}{kT})$

Chapter 7:

$\partial V_{aj} = \partial V_{GS}\frac{1}{1+C_S/C_{ox}}$

$V_{bi} = \frac{\Phi_S - \Phi_G}{q} = -V_{fb}$

$-qV_{CB}(x) = E_{Fn}(x) - E_{FB}$

$\psi_s(x) = \frac{2kT}{q}\ln\frac{N_A}{n_i} + V_{CB}(x) \equiv 2\phi_B + V_{CB}(x)$

$C_{ox} = \frac{\epsilon_{ox}}{t_{ox}}$

$Q_B(x) = -\sqrt{2\epsilon_S qN_A(2\phi_B + V_{SB} + V_{CS}(x))}$

$V_T = V_{fb} + 2\phi_B + \frac{1}{C_{ox}}\sqrt{2\epsilon_S qN_A(2\phi_B + V_{SB})}$

$Q_n(x) = -C_{ox}\left[V_{GS} - V_{fb} - 2\phi_B - V_{CS}(x)...\right.$

$\left.... -\frac{1}{C_{ox}}\sqrt{2\epsilon_S qN_A(2\phi_B + V_{SB} + V_{CS}(x))}\right]$

$Q_n(x) \approx -C_{ox}\left[V_{GS} - V_T - mV_{CS}(x)\right]$

$m = (1 + C_B(0)/C_{ox})$

$I_D(\text{LEVEL1}) = ZC_{ox}\left[V_{GS} - V_T - m\frac{V_{DS}}{2}\right]\mu_{\text{eff}}\frac{V_{DS}}{L}$

$V_{DSsat} = (V_{GS} - V_T)/m$

$1/v_d = 1/\mu\,\mathcal{E} + 1/v_{\text{sat}}$

$I_D(\text{LEVEL49}) = ZC_{ox}\left[V_{GS} - V_T - m\frac{V_{DS}}{2}\right]$ ...

... $\mu_{\text{eff}}\frac{V_{DS}}{L+(\mu_{\text{eff}}V_{DS}/v_{\text{sat}})}$

$V_{DSsat} = \frac{2(V_{GS}-V_T)/m}{\sqrt{1+2\mu_{\text{eff}}(V_{GS}-V_T)/(mv_{\text{sat}}L)}+1}$

Chapter 8:

$L_e = \sqrt{D_e\tau_e}$

$n_E^* = n_{0E}e^{-q(V_{biE}-V_{BE})/kT} = n_{0B}e^{qV_{BE}/kT}$

$n(x_{dp}) = n_E^* + \frac{J_e(x_{dp})}{q2v_R}$

$J_e = -qn_{0B}\left[e^{qV_{BE}/kT} - e^{qV_{BC}/kT}\right]\frac{1}{\frac{W_B}{D_e}+\frac{1}{v_R}}$

$I_{B,\text{rec}} = Aqn_{0B}\left[(e^{qV_{BE}/kT}-1) + (e^{qV_{BC}/kT}-1)\right]\frac{W_B}{2\tau_e}$

$I_{B,\text{inj}} = Aqp_{0E}\left[e^{qV_{BE}/kT}-1\right]\frac{1}{\frac{L_h}{D_h}+\frac{1}{2v_R}}$

$\beta_0 = I_C/I_B$

$\alpha_0 = I_C/|I_E|$

Chapter 9:

$C_{jk} = -\frac{\partial Q_j}{\partial V_k}$ (+ if $k = j$)

$C_{jj} = \sum_{k\neq j} C_{jk} = \sum_{k\neq j} C_{kj}$

$C'_{EB,j} = \frac{\epsilon_S A_E}{W}$

$C'_{EB,b} = q^2\frac{W_B A_E}{2kT}n_{0p}e^{qV_{BE}/kT}$

$C'_{BE,t} = g_m d/(2v)$

$C'_{CB} = \frac{\epsilon_S A_C}{d}$

Chapter 10:

$E - E_C = \frac{\hbar^2k_1^2}{2m_1^*} + \frac{\hbar^2k_2^2}{2m_2^*} + \frac{\hbar^2k_3^2}{2m_3^*}$

$T \approx \exp\left\{\frac{-4\pi}{h}\int_0^{t_{ox}}\sqrt{2m\,[U(x)-E]}\,dx\right\}$

$I_{D,\text{sub-threshold}} = ZC_{ox}(m-1)\frac{kT}{q}$ ...

... $e^{q(V_{GS}-V_T)/mkT}\cdot(\frac{\mu_{\text{eff}}kT}{qL})$

$S = \left(\frac{\partial\log_{10}I_D}{\partial V_{GS}}\right)^{-1} = 2.303m\frac{kT}{q}$

$m = 1 + \frac{t_{ox}\epsilon_s}{\epsilon_{ox}}\sqrt{\frac{q^2N_A}{4\epsilon_s kT}\ln(n_i/N_A)}$

$\tau = \frac{kV_{DD}C_X}{I_Dsat}$

$P_{\text{dyn}} = C_X V_{DD}^2 f$

Chapter 11:

$i_c = g_m v_{be} + g_o v_{ce}$

$i_b = g_\pi v_{be} + g_{12}v_{ce}$

$R_{B,\text{spread}} = R_{\text{Bulk}}/3$

$2\pi f_T = \frac{g_m}{C_\pi + C_\mu(1+gmR_{ec})}$

$2\pi f_T = \frac{g_m}{C_{gs} + C_{gd}(1+gmR_{sd})}$

$f_{\max} = \sqrt{\frac{f_T}{8\pi R_B C_\mu}}$

Chapter 12:

$J_{\text{Schottky}} = qN_C e^{-\phi_B/kT}v_R(e^{-qV_a/kT}-1)$

$\Phi_B = \Phi_G - \chi_S$

$I_{D,\text{MESFET}} \propto G_0$

$G_0 = qZ\mu N_D a/L$

$g_{C,2D,p} = m^*/(\pi\hbar^2)$

$n_{2D,p} = \frac{m^*kT}{\pi\hbar^2}\ln\left[e^{(E_F-E_p)/kT}+1\right]$

Chapter 13:

$S = \overline{v_{n^2}}/\Delta f$ or $\overline{i_{n^2}}/\Delta f$

$S_{\text{thermal}} = 4kTR$

$S_{\text{shot}} = 2qI_{DC}$

$S_{1/f} \propto I_{DC}/f$

$NF = 10\log_{10}\left[N_{\text{out}}/(GN_{\text{in}})\right]$

Chapter 14:

$V_{\text{br}} = \mathcal{E}_{\text{br}}^2\frac{\epsilon}{2q}(\frac{1}{N_D} + \frac{1}{N_A})$