ECE-305: Key Equations (for exam 1)
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Physical constants:

$\hbar = 1.055\times10^{-34}$ [J-s]
$m_0 = 9.109\times10^{-31}$ [kg]
$k_B = 1.380\times10^{-23}$ [J/K]
$q = 1.602\times10^{-19}$ [C]
$\varepsilon_0 = 8.854\times10^{-12}$ [F/m]

Silicon parameters (T = 300K)

$N_C = 3.23\times10^{19}$ cm^{-3}
$N_V = 1.83\times10^{19}$ cm^{-3}
$n_i = 1\times10^{10}$ cm^{-3}
$K_S = 11.8$

Miller Indices: (hkl) {hkl} [hkl] <hkl>

Angle between two planes: $\cos\theta = \dfrac{h_1h_2 + k_1k_2 + l_1l_2}{\sqrt{h_1^2 + k_1^2 + l_1^2}\sqrt{h_2^2 + k_2^2 + l_2^2}}$

Spacing between two planes: $d = \dfrac{1}{\left|\vec{N}\right|} = \dfrac{a}{\sqrt{h^2 + k^2 + l^2}}$

DOS: $g_C(E) = \dfrac{\left(m_n^*\right)^{3/2}\sqrt{2\left(E - E_C\right)}}{\pi^2\hbar^3}$ FF: $f(E) = \dfrac{1}{1 + e^{(E-E_F)/k_BT}}$ $n_i = \sqrt{N_CN_V}\,e^{-E_G/2k_BT}$

Equilibrium carrier densities:

$n_0 = N_Ce^{(E_F - E_C)/k_BT}$ $N_C = \dfrac{1}{4}\left(\dfrac{2m_n^*k_BT}{\pi\hbar^2}\right)^{3/2}$ $n = n_i\,e^{(E_F - E_i)/k_BT}$

$p_0 = N_Ve^{(E_V - E_F)/k_BT}$ $N_V = \dfrac{1}{4}\left(\dfrac{2m_p^*k_BT}{\pi\hbar^2}\right)^{3/2}$ $p = n_ie^{(E_i - E_F)/k_BT}$

Space charge neutrality: $p - n + N_D^+ - N_A^- = 0$ **Law of Mass Action:** $n_0p_0 = n_i^2$