ECE 656 Homework (Week 7)

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1) In Lecture 15, we derived a current equation for a 2D, n-type conductor and wrote it as $J_n = \sigma_S \, d\left(F_n/q\right)/dx$. Derive the corresponding equation for a p-type semiconductor.

2) In Lecture 15, we derived the drift-diffusion equation for a 2D n-type semiconductor with parabolic energy bands. Repeat the derivation for a 3D semiconductor with parabolic energy bands. **Do not** assume Maxwell-Boltzmann statistics.

3) In 1D, we write $R_{1D} = \left(1/\sigma_{1D}\right)L$, in 2D $R_{2D} = \left(1/\sigma_{2D}\right)L/W$, and in 3D $R_{3D} = \left(1/\sigma_{3D}\right)L/A$. Assuming a degenerate conductor, begin with $G_{ball} = \dfrac{2q^2}{h} M\left(E_F\right)$ and develop expressions for the 1D, 2D, and 3D "ballistic conductivities."

4) When we write the resistance as $R = R_{\text{ball}}\left(1 + L/\lambda_0\right)$, we assume a constant (energy-independent) mean-free-path. What is the corresponding expression for an energy dependent mean-free-path, $\lambda\left(E\right)$?