Physics 3313, Homework #7 (due 3/30)

P1 Find the electron diffusion current density in an n-type semiconductor as a function of \( x \), \(-5 \ \mu m \leq x \leq 5 \ \mu m\). The electron concentration varies as

\[
n(x) = a_0 + a_1 \tanh(x/x_0),
\]

where \( x_0 = 2 \ \mu m, \ a_0 = 2 \times 10^{15} \ \text{cm}^{-3}, \ a_1 = 1 \times 10^{14} \ \text{cm}^{-3} \). What is the maximum diffusion current density? At what \( x \) it occurs? Assume \( D_n = 25 \ \text{cm}^2/\text{s} \).

P2 Find the induced electric field in an n-type semiconductor (in thermal equilibrium at \( T=300 \ \text{K} \)) as a function of \( x \), \( 0 \leq x \leq 2 \ \mu m \). The electron concentration varies as

\[
n(x) = \frac{x + x_0}{a} \exp\left[\frac{1}{2} \left(\frac{x + x_0}{a}\right)^2\right] \times 10^{14} \ \text{cm}^{-3},
\]

where \( a = 2 \ \mu m, \ x_0 = 1 \ \mu m \). What is the minimum induced electric field? At what \( x \) it occurs?

P3 (a) Assume that the diffusion coefficient of a carrier at \( T=300 \ \text{K} \) is \( D = 28.3 \ \text{cm}^2/\text{s} \). Calculate the carrier mobility.

(b) Assume that the mobility of a carrier at \( T=300 \ \text{K} \) is \( \mu = 925 \ \text{cm}^2/\text{V} \cdot \text{s} \). Calculate the carrier diffusion coefficient.