The following equations will be given to you at the second midterm exam on Monday, November 1, 2005

\[
n = N_e \frac{e^{\frac{E_a - E_b}{kT}}}{kT} = n_e \frac{e^{\frac{E_a - E_b}{kT}}}{kT} = \frac{N_D - N_A}{2} + \sqrt{\left( \frac{N_D - N_A}{2} \right)^2 + n_i^2}
\]

\[
p = \frac{n_i^2}{n}, \quad C_{dpl} = \frac{dQ}{dV_a}, \quad E = \frac{\nabla E}{q}
\]

\[
\frac{\partial p}{\partial t} = -\frac{1}{q} \nabla \cdot J_p - \frac{\Delta p}{\tau_p} + G_L, \quad J_p = -q \mu_p p \nabla V - qD_p \nabla p
\]

\[
\frac{\partial n}{\partial t} = \frac{1}{q} \nabla \cdot J_n - \frac{\Delta n}{\tau_n} + G_L, \quad J_n = -q \mu_n n \nabla V + qD_n \nabla n
\]

For a pn-junction with abrupt junctions: \( V_n = V_T \ln \frac{N_a N_d}{n_i^2} \) and \( W = \sqrt{\frac{2e_b (V_b - V_a)}{q}} \left( \frac{1}{N_a} + \frac{1}{N_d} \right) \).

In all problems you can use the following constants as given:

\( q = 1.6 \times 10^{-19} \text{ C} \), \( h = 6.625 \times 10^{-34} \text{ Js} \), \( V_T = 25 \text{ mV} \).