# MS Exam, Spring 2015, ECE230A, B

## 230A Problem:

**To answer the following problem, use the following properties for a "hypothetical semiconductor".**

$E_g = 1.0\ eV \quad assume\ E_V = 0\ eV\ as\ the\ reference$
$N_C = N_V = 1 \times 10^{18}\ cm^{-3}$
$C_{pe} = C_{ph} = 10^{-9}\ cm^3 s^{-1}$
$\mu_n\ (electron\ mobility) = 1500\ cm^2 V^{-1} s^{-1}$
$\mu_p\ (hole\ mobility) = 200\ cm^2 V^{-1} s^{-1}$
$T = 300\ (K), \qquad kT = 0.0259\ (eV)$

(a) Calculate the intrinsic carrier concentration $n_i$ at room temperature (300K).
(b) Calculate the electron and hole diffusivity.
(c) Assuming $E_d$ (donor state energy) is 0.01 eV below $E_C$, $N_d = 10^{17}\ cm^{-3}$, $T = 300K$, calculate the Fermi energy.
(d) If the material in (c) has a trap density of $N_t = 1x10^{15}\ cm^{-3}$, calculate the minority carrier lifetime.
(e) Find the minority carrier diffusion length of material in (d).

## 230B Problem:

An n-channel MOSFET has a 10 nm thick gate oxide and uniform p-type body doping of $10^{17}$ cm$^{-3}$. The device is 10 μm wide and the channel length is 1 μm. Assume Si, room temperature, and complete ionization.
(a) What is the inverse slope of the log subthreshold current vs. $V_g$ curve?
(b) For a gate bias such that $V_g$-$V_t$=2.5 V where the mobility is 400 cm$^2$/V-s, what is the MOSFET channel conductance, $dI_{ds}/dV_{ds}$, at low drain bias voltages?
(c) How short can the channel length be reduced before onset of severe short-channel effects?