COLLEGE OF ENGINEERING & TECHNOLOGY

Department: Electronics and Communications Engineering
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Course Title: Advanced Devices Spring 2013
Course No.: EC738 **Problem Set # 2**
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Drift, Diffusion, Poisson's Eq., Guass Law, Band Diagrams

Question 1

For a p-type silicon slice with:
Boron doping, $N_A = 10^{17}$ cm^{-3}, mobility = 600 $cm^2V^{-1}sec^{-1}$,
Cross section area: W=10um, H= 1 um, length= 100um
$V_{applied}$ = 10V, temperature = 50C.

a- Find the resistance
b- Total current.
c- Sheet resistivity(resistance of a square where L=W).
Hint: *use Eqns. 2.28-2.35*

Question 2

For a p-type silicon slice with:
- Cross section area = 10 um^2, length= 100um, mobility = 600 $cm^2V^{-1}sec^{-1}$, temperature = 27C.
- Boron doping gradient with a linear dependence on distance, with N_A(at x=0um) = $5x10^{16}$ cm^{-3}, and N_A(at x= 100um) =$10^{17}cm^{-3}$.
  - Find the total diffusion current.

Hint*: use Eqn. 2.36-2.39*

Question 3

For Question 1, assume that the whole semiconductor is in depletion, due to an external field (i.e. donors are ionized). Assume electric field and potential are both zero at L=100um.
  - Calculate and plot both the electric field and potential distribution as a function of distance.

Hint*: use Eqn. 2.40-2.44*

Question 4

For Question 3, use Guass's Law to find:
a- The integrated two-dimensional (2D) charge density at x=0cm.
b- The electric field at x=0cm.
Hint*: use Eqn. 2.43*

Question 5

For a p-n junction with n-reqion having $N_D = 2x10^{16}cm^{-3}$ (Phosphorus) and p-type region with $N_A = 5x10^{15}cm^{-3}$ (Boron)
a- Calculate the depletion region widths.
b- Calculate the field and potential at the interfaces
c- Calculate built-in potential, V_{bi}.
b- Plot the band diagram.
Hint*: use eqns. 2.75-2.80*