

**EECS 40, Fall 2007**  
**Prof. Chang-Hasnain**

**Homework #9**

Due at 5 pm in 240 Cory on MONDAY, 11/26/07  
Total Points: 100

- Put (1) your name and (2) discussion section number on your homework.
- You need to put down all the derivation steps to obtain full credits of the problems. Numerical answers alone will at best receive low percentage partial credits.
- No late submission will be accepted except those with prior approval from Prof. Chang-Hasnain.
- Problems of this HW are from Hambley 4<sup>th</sup> Edition

**Wave-Shaping Circuits**

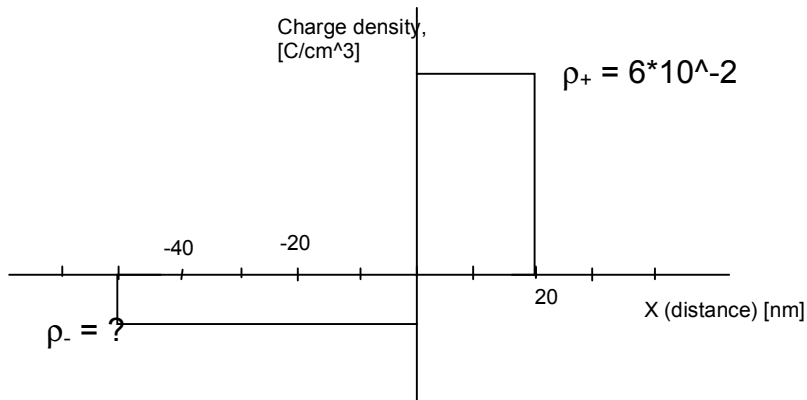
1. P10.63 (11pts)
2. P10.71 (12pts)
3. P10.74 (12pts)

4. **Doping** (17 pts)

- α. Does pure silicon conduct at room temperature? Why or why not? Does its conductance increase or decrease with temperature?
- β. Identify the majority carrier and find the electron and hole concentrations at room temperature if Aluminum is added with a concentration of  $10^{14} \text{ cm}^{-3}$ .
- χ. Identify the major carrier and find the electron and hole concentrations at room temp if instead Antimony is added at  $1.1 \cdot 10^{14} \text{ cm}^{-3}$ .

5. **PN Junction and the Depletion Approximation (26 pts)**

- a. Why do the quasi-neutral p and n regions of the PN Junction have low resistivity, while the depletion region has high resistivity?
- b. What is the *approximation* in the Depletion Approximation?
- c. Sketch (and label charge accumulations) for the depletion region for a PN junction.
- d. Now suppose you have the following charge profile for a PN junction:



Which is the P side and which is the N side? Find  $\rho_-$ .

- e. Write down an expression for the electric field  $E(X)$  and plot it (call the permmissivity of the material  $\epsilon$ ).
- f. Find the potential function  $\phi(X)$  and plot it. Note that our reference is arbitrary, so assume  $\phi(-100\text{nm})=0\text{V}$ .

For thought: how would you find  $E(X)$  if the charge density was not a step function, but a different shape? How would  $E(X)$  change if the positive charge region artificially shifted to the right by 5nm, while the negative charge region remained the same?