UNIVERSITY OF CALIFORNIA
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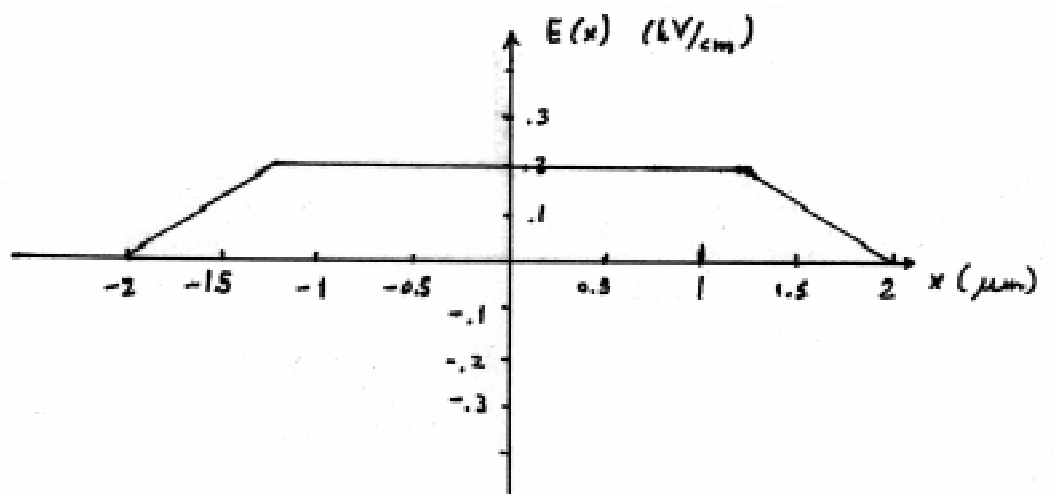
Problem Set #3
Due Wednesday, September 16th, 1998

EECS105 **FALL 1998**

1. You are in charge of the new line of Silicon Spice's line of E-field creation machines. Your stock options have decreased from $50 last October to $23 3/4 as of close on Friday. Luckily, you've just created a machine that can generate the following E-field distribution in silicon:



a. What would the charge density ρ(x) look like?

b. Assume that the potential at φ(-2 μm) = -500 mV. What is the potential at x = 0 μm? How about at x = 2 μm? HINT: do you *really* need to solve for the potential function to answer this?

c. Using the same assumption that the potential at φ(-2 μm) = -500 mV, sketch the potential φ(x).

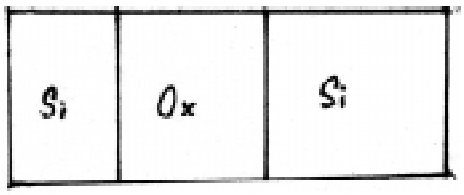
2. Argh, another urgent email from your manager: she needs a 500 +/- 150 fF tunable capacitor NOW, built via a reverse biased pn junction. You email the process engineer to get some idea of the process flow. She tells you that with the latest .18 μm technology, they are doping the Si with $N_a = 10^{16}$ cm^{-3}, $N_d = 10^{18}$ cm^{-3}.

a. First, figure out what the capacitance per unit area (in fF/μm^2) is for $V_D = 0$ V.

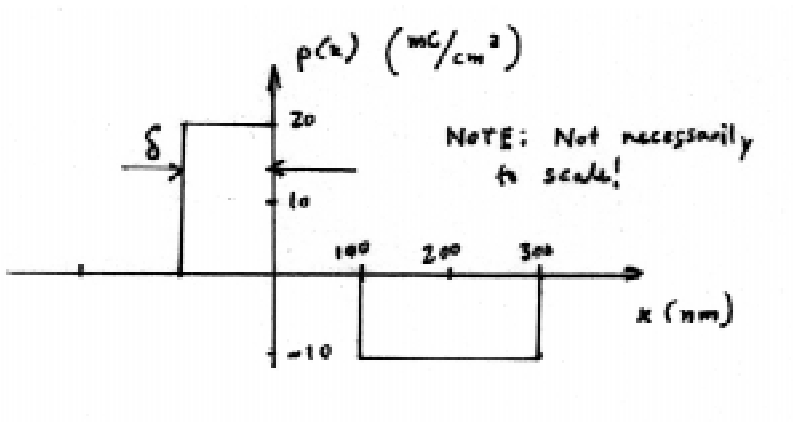
b. How much area do we need for our capacitor? What is the voltage range do we need to be able to tune it over the entire range? HINT: $V_D = 0$ V must correspond to C = 650 fF, the maximum capacitance.

(over)

3. You are a process engineer in charge of designing silicon oxide "sandwiches". They look like this:



a. Under some biasing potential, the charge density looks like the following sketch. How wide should δ be to ensure electrical neutrality?



b. Figuring you need some practice using boundary conditions, your boss asks you to derive the numerical value of the E-field at x = 50 nm and x = 200 nm.

c. If you got part (b), this should be relatively easy…please sketch E(x).

Please visit our web site: http://www-inst.EECS.Berkeley.EDU/~ee105/

***Please post your questions on our newsgroup*:** ucb.class.ee105

Please return your homework in 558 Cory Hall, to Cheryl Craigwell (cmc@eecs, 642-1237, fax 642-2739), or in class by 11:10am of the due date. Late homeworks will not be graded.