Problem Set #2

Assigned: September 15, 2000
Due: September 22, 2000 at recitation

Reading Assignments:	09/14/00	Sections 2.4-2.6 of Howe & Sodini
	09/19/00	Sections 3.1-3.3 of Howe & Sodini
	09/21/00	Sections 3.3-3.6 of Howe & Sodini

PLEASE WRITE YOUR RECITATION SESSION TIME ON YOUR PROBLEM SET SOLUTION

Problem 1. [20 points] Problem P2.7 of Howe and Sodini

Problem 2. [20 points] Problem P2.14 of Howe and Sodini

Problem 3. [30 points] *Adapted from Problem 3.4 of Fonstad*

(a) Consider a sample of n-type silicon L cm long, W cm wide, and T cm thick that is nonuniformly doped in such a manner that the equilibrium majority carrier population varies throughout its thickness as $n_o(x)$ (see Figure 1). Show that if the mobility μ_N is constant, independent of the doping level, then the end-to-end resistance of this sample depends only on the integral of $n_o(x)$ over the thickness of the sample (i.e. , from x=0 at the top surface to x=T at the bottom surface) and not on the actual shape of $n_o(x)$. (Hint: Mentally divide the sample into thin slabs of material dx wide, and add the conductances of these slabs connected in parallel.)

(b) In an integrated circuit, dopants are introduced to the top surface of a silicon wafer (slab) to produce nonuniformly doped regions like the sample described in (a) and resistors are formed by putting contacts at the ends of rectangularly shaped regions doped in this manner. Suppose that the doping profile of such a resistive region is such that

$$n_o(x) = 10^{18} \exp\left[-\frac{x}{L_x}\right] \text{cm}^{-3}$$

where L_x is 2 μm. (Note: 1 μm $=10^{-4}$ cm). What is the sheet resistance R_{sh} of the region if T=500 μm?

(c) The dopant profile in part (b) is introduced in a pattern like that illustrated in Figure 2. What is the approximate resistance between contact pads A and B of this resistor?

Problem 4. [15 points] Problem E3.1 of Howe and Sodini

Problem 5. [15 points] Problem E3.5 of Howe and Sodini

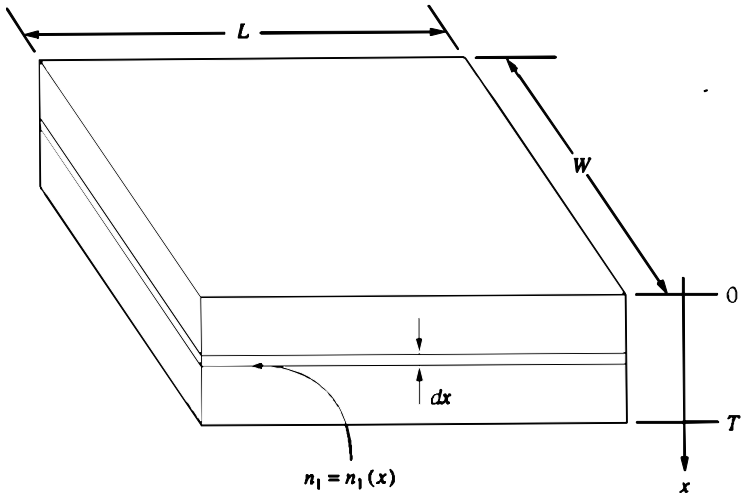

Figure 1

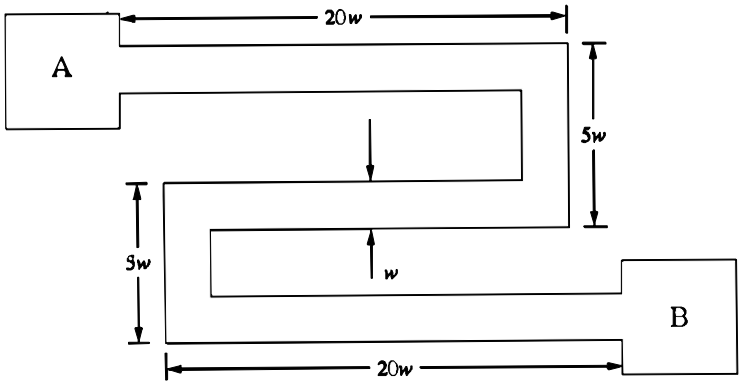

Figure 2.