Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.012
Microelectronics Devices and Circuits
Fall 1999

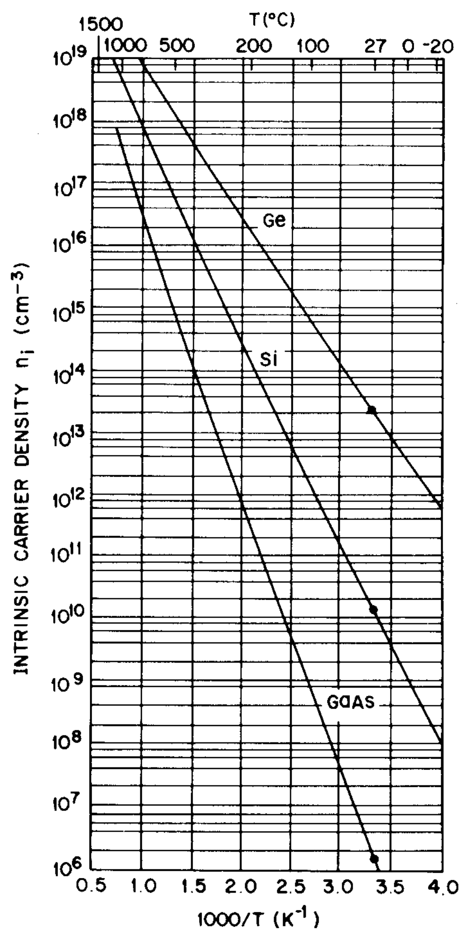
September 10, 1999- Homework #1
Due – September 17, 1999

Reading: Chapter 2

Problem 1 A silicon wafer is uniformly doped with an acceptor concentration of $N_a = 10^{16}$ cm^{-3}. We would like to use ion implantation to convert the surface of the wafer to n-type with a donor concentration of $N_d = 5 \times 10^{16}$ cm^{-3}. What implant dose is needed if the n-type surface region is to have a thickness of 0.5 μm?

Problem 2 . Howe & Sodini E2.22

For Problems 3 and 4 use the graph below. 1% accuracy for your answers is sufficient.



Problem 3 In 6.012 we will use 10^{10} cm^{-3} for the value of the intrinsic carrier concentration in silicon at room temperature (27C).

a) Given a silicon sample at room temperature with an electron concentration measured to be $n_o = 10^{16}$ cm^{-3}, calculate $N_d - N_a$ and p_o.

b) Calculate $N_d - N_a$ and p_o when the sample is at 400 C.

c) Calculate $N_d - N_a$ and p_o when the sample is at 500 C.

Problem 4 A Germanium (Ge) sample is doped with acceptors $N_a = 5\text{x}10^{15}$ cm^{-3} and donors $N_d = 10^{16}$ cm^{-3}.

a) Calculate n_o and p_o when the sample temperature is 27C.

b) Repeat (a) when the sample temperature is 200C.

c) Repeat (a) when the sample temperature is 400C.