

Name: Key

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COE 360, Principles of VLSI Design, Term 043  
Quiz# 1

Date: Saturday, July 9, 2005

Determine the electron and hole concentrations and the conductivity of a piece of silicon at 300K given that it is doped with Arsenic (pentavalent) at a density of  $4 \times 10^{16}$  atoms/cm<sup>3</sup> and doped with Boron (trivalent) at a density of  $4 \times 10^{12}$  atoms/cm<sup>3</sup>. Assume the following: Electron mobility at 300 K =  $1500 \text{ cm}^2/\text{V}\cdot\text{s}$ , Hole mobility at 300 K =  $475 \text{ cm}^2/\text{V}\cdot\text{s}$ , Intrinsic concentration at 300 K =  $1.45 \times 10^{10} \text{ cm}^{-3}$ ,  $q = 1.6 \times 10^{-19}$ . Indicate clearly the units in your solution.

Since  $N_d \gg N_a$  and  $N_d \gg n_i$ , the material will be n-type material

$$\text{So, } n \approx N_d = 4 \times 10^{16} \text{ cm}^{-3}$$

$$\Rightarrow p \approx \frac{n_i^2}{n} = \frac{(1.45 \times 10^{10})^2}{4 \times 10^{16}} = 5.26 \times 10^3 \text{ cm}^{-3}$$

$$\sigma = q n \mu_n$$

$$= 1.6 \times 10^{-19} \times 4 \times 10^{16} \times 1500$$

$$= 9.6 \text{ } (\Omega \cdot \text{cm})^{-1}$$