Name: **Id#**

COE 360, Term 071

Principles of VLSI Design
Quiz# 1

Date: Wednesday, Sep. 29, 2004

Q1. Fill in the blank:

(1) ___________________ is the motion of charges due to the application of an electric field.

(2) ___________________ is the motion of charges resulting from a non-uniform charge distribution.

(3) The current per unit area in a conducting medium is called the ______________________.

(4) ___________________ describes the ease with which charge carriers drift in the material.

(5) Drift velocity ________________ with the increase of the area of a conducting medium.

(6) Drift velocity ________________ with the increase of the charge carriers concentration per unit volume.

(7) The conductivity of a material increases with the increase in the __________________ and ___________________.

(8) The electric field across a conductor increases with the increase in __________________ and decrease in ___________________.

(9) The resistance of a conductor increases with the increase in __________________ and the decrease in ___________________ and __________________.

(10) A silicon atom has ___________ electrons, ____________ of which are valence electrons.

(11) At T=0°K, all the valence electrons in a silicon semiconductor are in the ________________ band.

(12) _________________ semiconductors are pure crystals that contain no foreign atoms or impurities

(13) _________________ energy is the energy level below which all the energy states are filled with electrons and above which all the states are empty at T=0°K.

(14) In an intrinsic semiconductor, at a given temperature, the concentration of free electrons is ______________________the concentration of free holes.

(15) The addition of trivalent atoms to an intrinsic semiconductor results in a ________type material, while the addition of pentavalent atoms to an intrinsic semiconductor results in a ________type.

(16) The majority charge carriers in an n-type material are ________________ while the minority charge carriers are ________________.

(17) The mass action law states that under thermal equilibrium, the concentration of free electrons times the concentration of free holes is constant and is equal to ____________________.

(18) If an intrinsic semiconductor material is doped with acceptor impurities, the number of free holes _________________ while the number of free electrons ___________________.

(19) The charge neutrality law states that under thermal equilibrium, the semiconductor crystal is electrically _____________________.

(20) The concentration of free electrons in an n-type material doped with donor concentration N_d is nearly _____________________ and the concentration of free holes is ___________________.

(21) The conductivity of a semiconductor material ________________ with increasing temperature.

(22) The Fermi level for an n-type semiconductor is ___________ the intrinsic Fermi level E_{Fi} while the Fermi level for a p-type semiconductor is _________ E_{Fi} .

(23) As the doping level increases, the Fermi energy level moves closer to the valence band for the ______________ material and closer to the conduction band for the ______________ material.

(24) Further diffusion across a PN junction is stopped by the ______________ produced by ____.

(25) Increasing the doping concentration _______________ the built-in potential across the PN junction.

(26) The width of the depletion region ______________ with increasing the doping concentration.

(27) In a reverse biased PN junction, the junction potential _____________ and the depletion region width ________________.

(28) If a positive voltage is applied to the p-region with respect to the n-region, the PN junction is called ___________________.

(29) Transition capacitance across the PN junction ________________ with increasing the doping concentration.

(30) The higher the doping concentrations of the PN junction are the ______________ the breakdown voltage.

Q2. Determine the **electron and hole concentrations** and the **conductivity** of a piece of silicon at 300°K given that it is doped with Arsenic (pentavalent) at a density of $4X10^{16}$ atoms/cm^3 and doped with Boron (trivalent) at a density of $4X10^{12}$ atoms/cm^3. *Assume the following: Electron mobility at 300°K=1500* $cm^2/V.s$*, Hole mobility at 300°K = 475* $cm^2/V.s$*, Intrinsic concentration at 300°K=1.45X10* ^{10} cm^{-3} , q= $1.6X10^{-19}$. *Indicate clearly the* ***units*** *in your solution.*