Name: **Id#**

COE 360, Principles of VLSI Design, Term 011
Quiz# 1

Date: Saturday, Sep. 22, 2001

Q1. Indicate whether the following is true or false, and if it is false **correct** it:

(1) (True, False) If an intrinsic semiconductor material is doped with n-type impurities, the number of free electrons increases while the number of free holes remains the same.

(2) (True, False) To maintain the electric neutrality of the crystal, the number of free electrons $n = p+N_A-N_D$.

(3) (True, False) Mobility increases with temperature because more carriers are present and these carriers are more energetic at higher temperatures.

(4) (True, False) Further diffusion of majority carriers across a pn junction is stopped due to the balance of concentration of majority carriers across the junction.

(5) (True, False) In general, higher doping concentrations result in lower depletion region width and lower transition capacitance.

(6) (True, False) The width of the depletion region in a forward-biased pn junction is narrower than that of a reverse-biased pn junction.

(7) (True, False) V_{OH} is the output voltage produced when the input voltage is less than or equal to V_{IL}.

(8) (True, False) A piece of semiconductor material which is doped with equal donor and acceptor impurity concentrations has higher conductivity compared to the intrinsic semiconductor since it has higher electron and hole concentrations.

(9) (True, False) It is desirable to have V_{IL} as large as possible and V_{IH} as small as possible to increase the noise margins.

(10) (True, False) The fanout of a gate with V_{IL}=1.2V, V_{IH}=2.4V, V_{OH}=4.8V, V_{OL}=0.2, I_{IH}=60μA, I_{IL}=4.8mA, I_{OH}=360μA, and I_{OL}=24mA is 5.

Q2. An intrinsic silicon bar is 8 mm long and has a rectangular cross section of 40X80 μm. The material has a resistivity of 100K Ω.cm. Determine the following:

(i) The concentration of Arsenic atoms needed to be added to the material to convert it to an n-type material with a resistivity of 20 Ω.cm.

(ii) Determine the voltage across the intrinsic silicon bar when a steady current of 5 μA is measured.

Assume the following: Electron mobility at 300 K=1500 cm^2/V.s, Hole mobility at 300 K = 475 cm^2/V.s, q= 1.6X10^{-19}