

Name:

Id#

COE 360, Principles of VLSI Design, Term 982
Quiz# 1

Date: Monday, Feb. 15

(I) Indicate whether the following is true or false:

- (i) An intrinsic silicon semiconductor has 5 valence electrons (**True, False**).
- (ii) Current density increases with the increase in the total charge and the decrease in area (**True, False**).
- (iii) The applied voltage across a semiconductor increases with the increase in the length of the semiconductor (**True, False**).
- (iv) With the addition of acceptor atoms to an intrinsic semiconductor, the hole concentration increases while the electron concentration remains the same (**True, False**).
- (v) An n-type semiconductor is doped with pentavalent impurity while a p-type semiconductor is doped with tetravalent impurity (**True, False**).
- (vi) The mass-action-law states that $n=p=n_i$, the intrinsic concentration (**True, False**).
- (vii) The charge neutrality law states that $N_A + p = N_D + n$ (**True, False**).
- (viii) With increasing temperature, the density of electron-hole pairs, mobility and conductivity increase (**True, False**).
- (ix) In a pn-junction, free electrons will diffuse from the n to the p side leaving negative ions, and free holes will diffuse from the p to the n side leaving positive ions (**True, False**).
- (x) The width of the depletion region and the transition capacitance decrease with the increase in the doping concentration (**True, False**).
- (xi) In a forward-biased pn-junction, the depletion region width is smaller than in the reverse-biased pn junction (**True, False**).
- (xii) V_{IH} is the maximum input voltage which can be interpreted as high while V_{IL} is the minimum input voltage which can be interpreted as low (**True, False**).
- (xiii) V_{OH} is the maximum input voltage which can be interpreted as high (**True, False**).
- (xiv) V_{IH} is defined as, the maximum output voltage V_{OH} minus the noise margin NM_H . (**True, False**).
- (xv) V_{OL} is the output voltage produced when the input voltage is greater than or equal to V_{IH} (**True, False**).

(II) A piece of silicon is 4 mm long and has a rectangular cross section of 40X80 μm . The material is doped with Arsenic at a density of 4×10^{14} atoms/ cm^3 and with Boron at a density of 2×10^{10} atoms/ cm^3 . At 300 K, determine the electric field intensity in the bar and the voltage across the bar when a steady current of 1 μA is measured. Assume the following: Electron mobility at 300 K = $1500 \text{ cm}^2/\text{V.s}$, Hole mobility at 300 K = $475 \text{ cm}^2/\text{V.s}$, Intrinsic concentration at 300 K = $1.45 \times 10^{10} \text{ cm}^{-3}$, $q = 1.6 \times 10^{-19}$