

Name:

Id#

COE 360, Principles of VLSI Design, Term 981
Quiz# 1 – Sec 2

Date: Monday September 28

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

- (a) An intrinsic silicon semiconductor has 3, 4, or 5 valence electrons (True, False).
- (b) Current density increases with the increase in the total charge and the increase in area (True, False).
- (c) The applied voltage across a semiconductor increases with the increase in the length of the semiconductor (True, False).
- (d) With the addition of donor atoms to an intrinsic semiconductor, the electron concentration increases while the hole concentration remains the same (True, False).
- (e) An n-type semiconductor is doped with prevalent impurity while a p-type semiconductor is doped with trivalent impurity (True, False).
- (f) The mass-action-law states that $n=p=n_i$, the intrinsic concentration (True, False).
- (g) The charge neutrality law states that $N_A + p = N_D + n$ (True, False).
- (h) With increasing temperature, the density of electron-hole pairs, mobility and conductivity increase (True, False).
- (i) The potential between two points depends only on the concentration between the points independent of their separation (True, False).
- (j) 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).
- (k) The width of the depletion region and the transition capacitance increase with the increase in the doping concentration (True, False).
- (l) In a forward-biased pn-junction, the depletion region width is smaller than in the reverse-biased pn junction (True, False).
- (m) 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).

(II) A piece of silicon is 5 mm long and has a rectangular cross section of 50X90 μm . The material is doped with Arsenic at a density of 4×10^{14} atoms/cm³. 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 = $1500 \text{ cm}^2/\text{V}\cdot\text{s}$, Hole mobility at 300 K = $475 \text{ cm}^2/\text{V}\cdot\text{s}$, Intrinsic concentration at 300 K = $1.45 \times 10^{10} \text{ cm}^{-3}$, and $q = 1.6 \times 10^{-19} \text{ C}$.