University of California, Berkeley
College of Engineering
Department of Electrical Engineering and Computer Sciences

EECS 130
Integrate Circuit Devices
Midterm Exam #2 Part one
(35% of total point weighting)
March 14, 1996

Two Problems. One 8 ½ " x 11 " sheet allowed for formula reference.

1. In a forward biased pn junction diode, $L_{n,\,p}$ << device length.

   (a) Write down the expression for stored charge on both sides of the pn junction, Q_n and Q_p, in terms of device parameters such as N_D, N_A, $V_{A,}$…etc. (3 points)

   (b) Rewrite the expression of current density in terms of Q_n and $Q_{p.}$ (3 points)

   (c) Interpret the physical meaning of the expression you derived in part (b). (2 points)

   (d) How does the current change (increase or decrease) at a given forward bias as temperature increase? Demonstrate your answer with equations (use the back of this sheet if necessary). (4 points)

2. A silicon step function has $N_A = 5 \times 10^{15}$ cm^{-3} and $N_D = 10^{15}$ cm^{-3}, $D_N = 34$ cm^2/sec, $D_P = 12$ cm^2/sec, $n_i = 10^{10}$ cm^{-3}, kT = 0.026 eV, $A = 10^{-4}$ cm^2, $\tau_p = 0.4$ μs, and $\tau_n = 0.1$ μs. Calculate.

   (a) the reverse saturation current due to holes. (3 points)

   (b) the reverse saturation current due to electrons. (3 points)

   (c) reverse saturation current, I_0. (2 points)

   (d) If $V_A = \phi/2$, calculate the
      i. hole concentration at x_n and injected hold concentration at x_n. (3 points)

      ii. Hole concentration at x' = $L_p/2$.

      iii. Electron concentration at $-x_p$ and injected electron concentration at $-x_p$. (3 points)

      iv. Electron concentration at x'' = $L_n/2$. (3 points)

   (e) Calculate the total injected hole charge for $V_A = \phi/2$. (3 points)