Test 2-EE 5340/001&051 (print last name)______________________ (print first name)______________________
Tuesday, October 15, 2002, 8:00 AM, 206 Activities Building
75 minutes allowed (last four digits of your student #) _____________ (e-mail if new)______________________

Instructions:

1. Do your own work. DO NOT REMOVE THE STAPLE ON THIS EXAM.
2. You may use either a legal copy of the text OR reference text OR ONE sheet of hand-written notes. You may NOT pass a book or note sheet to another student. You may NOT use class notes. Do not use previously solved problems.
3. Calculator allowed. You may NOT share a calculator with another student.
4. Use values given on this cover sheet. If a value is not given, explicitly state definitions and assumptions that you use.
5. Where possible, calculate parameters rather than read them from a graph.
6. Do all work in the spaces provided on this exam paper. If you write on the back of a sheet, make the notation "PTO" in your solution in order to assure that material written on the back of the page is evaluated for a grade. AN EXTRA BLANK SHEET IS ATTACHED AT THE BACK OF THE EXAM.
7. Show all calculations, making numerical substitutions and giving numerical results where possible.
8. Write answers in space given.
9. Unless stated otherwise,
   $T = 300K$, $V_t = 25.852$ mV
10. Unless otherwise stated, the material is silicon with
    $n_i = 1.07E10\ cm^{-3}$ $N_c = 2.84E19\ cm^{-3}$ $q\chi_{Si} = 4.05$ eV
    $E_{g,Si} = 1.125$ eV. $N_v = 3.08E19\ cm^{-3}$
11. For the work function of poly silicon, use
    $\phi_{n+} = \chi_{si} = 4.05$ V
    $\phi_{p+} = \chi_{Si} + E_{g,Si}/q = 5.175$ V.
12. For minority carrier (either electrons or holes) lifetime in silicon, use the relationship
    $\tau_{min} = (45E\text{-}6\ sec)/(1+7.7E\text{-}18*N_{imp}+4.5E\text{-}36*N_{imp}^2)$,
    where N_i = the total impurity concentration
13. For holes in silicon, assume
    $\mu_p = \{418.3\div[1+(N_i\div1.6E17)^{0.7}]\}+49.7$, in cm^2/V-sec
    (where N_i = the total impurity concentration in n- or p-type material, compensated or not).
14. For electrons in silicon, assume
    $\mu_n = \{1268\div[1+(N_i\div1.3E17)^{0.91}]\}+92$, in cm^2/V-sec
    (where N_i = the total impurity concentration in n- or p-type material, compensated or not).
15. Metal gate work functions should be assumed to be
    $\phi_{Au} = 4.75$ V, $\phi_{Al} = 4.1$V.
16. The electron affinity of SiO_2 is $\chi_{SiO2} = 0.95$ V.
17. Planck constant $h = 6.62618\text{x}10^{-34}$J-s= $4.1354\text{x}10^{-15}$eV-s, 1 eV = $1.60218\text{x}10^{-19}$ Joule
18. free electron mass $m_o = 9.1095\text{x}10^{-28}$ g.
19. Boltzmann constant, $k = 1.38066\text{x}10^{-23}$J/K
20. Electron charge, $q = 1.60218\text{x}10^{-19}$ Coulomb
21. Permittivity of free space, $\varepsilon_o = 8.85418\text{x}10^{-14}$ Fd/cm
22. Relative permittivity of silicon, $\varepsilon_r = 11.7$
23. The breakdown voltage of a planar, abrupt (step) junction (assymetrical or one-sided) diode with doping on the lightly doped side of N_B is $V_B = 60(Eg/1.1)^{3/2}\ (10^{16}/N_B)^{3/4}$ V.
24. Each part is worth [x] points, as given in the problem.