

Test 1-EE 5340/001&051 (print last name) _____ (print first name) _____

Tuesday, September 17, 2002, 8:00 AM

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. 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, $T = 300\text{K}$, $V_t = 25.852\text{ mV}$
10. Unless otherwise stated, the material is silicon with $n_i = 1.07\text{E}10\text{ cm}^{-3}$, $N_c = 2.84\text{E}19\text{ cm}^{-3}$, $N_v = 3.08\text{E}19\text{ cm}^{-3}$, $q\chi_{\text{Si}} = 4.05\text{ eV}$, and $E_{g,\text{Si}} = 1.125\text{ eV}$.
11. For the work function of n+ poly silicon, use $\phi_{n+} = \chi_{\text{Si}} = 4.05\text{ V}$, and for the work function of p+ poly silicon, use $\phi_{p+} = \chi_{\text{Si}} + E_{g,\text{Si}}/q = 5.175\text{ V}$.
12. For minority carriers in silicon, use the relationship $\tau_{\text{min}} = [45\text{E}-6\text{ sec}] \div [1 + 7.7\text{E}-18 * N_i + 4.5\text{E}-36 * N_i^2]$ (where N_i = the total impurity concentration) for minority carrier lifetime (either electrons or holes).
13. For holes in silicon, assume $\mu_p = \{418.3 \div [1 + (N_i \div 1.6\text{E}17)^{0.7}]\} + 49.7$, in $\text{cm}^2/\text{V-sec}$ (where N_i = the total impurity concentration in n- or p-type material whether compensated or uncompensated).
14. For electrons in silicon, assume $\mu_n = \{1268 \div [1 + (N_i \div 1.3\text{E}17)^{0.91}]\} + 92$, in $\text{cm}^2/\text{V-sec}$ (where N_i = the total impurity concentration in n- or p-type material whether compensated or uncompensated).
15. Metal gate work functions should be assumed to be $\phi_{\text{Au}} = 4.75\text{ V}$, $\phi_{\text{Al}} = 4.1\text{ V}$.
16. The electron affinity of SiO_2 is $\chi_{\text{SiO}_2} = 0.95\text{ V}$.
17. Each part is worth [x] points, as given in the problem.
18. Planck constant $h = 6.62618 \times 10^{-34}\text{ J-s} = 4.1354 \times 10^{-15}\text{ eV-s}$
19. $1\text{ eV} = 1.60218 \times 10^{-19}\text{ Joule}$
20. free electron mass $m_0 = 9.1095 \times 10^{-28}\text{ g}$.
21. Boltzmann constant, $k = 1.38066 \times 10^{-23}\text{ J/K}$
22. Electron charge, $q = 1.60218 \times 10^{-19}\text{ Coulomb}$
23. Permittivity of free space, $\epsilon_0 = 8.85418 \times 10^{-14}\text{ Fd/cm}$
24. Relative permittivity of silicon, $\epsilon_r = 11.7$