Errata for *Fundamentals of Semiconductor Devices*

last updated 2/10/08

Anderson & Anderson, first edition, 2005.

Inside cover, Table "Some physical constants," $\hbar$ should be 1.05 x 10^{-34} J-s, not 1.06.

Inside cover, Table "Constants of some semiconductors," the effective density of states in the conduction band N_C for InP should be 5.4 x 10^{17}.

Inside cover, Table "Constants of some semiconductors, the effective density of states in the valence band for InP should be N_V=6.9 x 10^{18} cm^{-3}.

Inside cover, Table "Constants of some semiconductors, the intrinsic carrier concentration for InP should be n_i=9.3 x 10^6 cm^{-3}.

Page 8 Equation 1.15: two equations are run together on the same line- the first should be deleted (the first one is wrong, the second one is correct)

Page 8, Equation 1.17: the value of ε_0 is incorrect: it should be 8.85, not 9.85

Page 8, Equation 1.17, third line, the number should be 2.18 x 10^{-18} , not 10^{-17}

Page 25, sentence after Equation 1.43, …we can rearrange Equation 1.40…" (the Equation number is missing)

Page 27, Equation 1.54 should be $\hbar^2 \frac{1}{m_0}$

Page 37, first equation in part (b) of Example 1.4, denominator should be 10^{-6} , not 10^6.

Page 38, example 1.5, part b should read maximum bandgap of the photodetector, not minimum.

Page 50, Equation 2.6, should read $E = E_C + \left(\frac{dE}{dK}\right)\Big|_{K=0} - \left(\frac{1}{2}\frac{d^2E}{dK^2}\right)\Big|_{K=0} K^2 + HOTs$

(the K=)'s are missing).

Page 83, Example 2.5, After the word "similarly" the third line of equation should read 8.4 x 10^{18} cm^{-3}.

Page 83, Example 2.5 after "Therefore, from Equation (2.67)," in calculating n_i, in the second line, the value of N_V is entered incorrectly as 8.3 x 10^{19} – it should be 8.4 x 10^{18} (note both the value and the exponent were wrong)

Page 83, last equation in example, the correct value of N_V is 8.4 x 10^{18}.

Page 84., second paragraph in blue box, should read "2.3 kT above the valence band edge, no about the valence band edge.

page 85, equation starting with E_C-E_f should be $E_C - E_f = -kT \ln\left(\frac{n_0}{N_C}\right)$ (there is currently an N_D where n_0 should be)

Page 97, paragraph 2, line 6, should be E_{g0} not $E_g(0)$

Page 97, Figure 2.24: the arrow for E_{g0} should extend between E_{C0} and E_v.

Page 105, Problem 2.2 Problem statement should use $\sin^2(Ka/2)$ instead of $\sin^2(Ka)$ in both places.

Page 115, top paragraph, line 5, should be *dQ* instead of $Q=qpAv_{dp}dt$

p. 116, Equation 3.17- should be 6.3 x 10^{16} in the denominator, not 1.3.

p 132, Figure 3.12 c): "electron temporarily trapped" should be step 1.

Page 141, Equation 3.66 has some wrong minus signs. The second equation should read

$$\frac{\partial p}{\partial t} = \frac{\partial \Delta p}{\partial t} = -p\mu_p \frac{\partial(\mathcal{E})}{\partial x} - \mu_p \mathcal{E} \frac{\partial p}{\partial x} + D_p \frac{\partial^2 p}{\partial x^2} + G_{op} - \frac{\Delta p}{\tau_p}$$

p 143, last line before equation (3.72), should say E is constant, and *therefore* dE/dx, dn/dx, and thus dJn/dx *all equal zero*.

Page 147, Figure 3.21: the labels τ_n and τ_p are swapped in the graph. The upper trace should be τ_p, and the lower trace should be τ_n

p. 149, Figure 3.23, the labels in the graph for L_n and L_p are reversed.

p. 153, in the continuity equation for holes, the first term should be $\frac{\partial p}{\partial t}$ instead of $\frac{\partial p}{\partial x}$

Page 155, Problem 3.3, change "Repeat for Si with $N_D = 10^{18}$ cm^{-3}." to "What happens to this trend when the semiconductor is very heavily doped? Why?"

Page 187 Equation S1A.16: the 3-D case should show a vector sign on the velocity, e.g.

$$v_g = \frac{1}{\hbar}\frac{dE}{dK} \quad \text{one dimension}$$

$$\vec{v}_g = \frac{1}{\hbar}\nabla_K E \quad \text{three dimensions}$$

Page 188, last sentence just before Equation S1A.18 should read "All are with minima at *K=0* and $E=E_0$. (not *E*=0)

Page 189, Equation S1A.21: the K should be a vector, e.g. $\left|\vec{K}\right| = \frac{2\pi}{\lambda}$

Page 189, Equation S1A.16 (repeated): the 3-D case should show a vector sign on the velocity, e.g.

$$v_g = \frac{1}{\hbar}\frac{dE}{dK} \quad \text{one dimension}$$

$$\vec{v}_g = \frac{1}{\hbar}\nabla_K E \quad \text{three dimensions}$$

p. 192, Equation S1A.31: Should be *+2jA* instead of *-2jA*. Similarly in the following line, it should read *C=+2jA*.

page 197, Equation S1A.46 should not have negative sign in front of j in exponent.

Page 211, Problem S1A.3: there should be a minus sign in the exponent, e.g. $\Psi_2 = A\sin(2\pi x / L)e^{-j(E_2/\hbar)t}$. This error also appears in the problem statement in the solutions manual, but not the solution.

p 213. Problem S1A12 part b: the third solution should read $\psi_C(x) = De^{-a(x-L)}$ (not $\psi_c(x) - De^{-a(x-L)x}$. The minus should be an equal sign, and there was an extra *x* in the exponent.)

Page 233, problem S1B.1, Current should be 1 mA, not 10 mA, and Hall voltage should be –3.12 mV, not –3.12 μV.

Page 233, Problem S1B.3a, Insert "Since the lattice constants are nearly equal, we can assume the force between atoms to be comparable." Before "For a material consisting of a single atom type (e.g. silicon), the lattice becomes a diamond lattice and $M_1=M_2$. Explain why the optical phonon energy for diamond (carbon) is greater than that for silicon, which is in turn greater than that for germanium.

Page 241, Figure 5.2: V_{bi} should be qV_{bi}.

Page 292, Equation 5.116: missing a factor of q/kT. It should be

$$C_{sc} = \frac{dQ_{st}}{dV_a} = \delta \frac{dQ_s}{dV_a} = \delta I \tau_n \frac{q}{kT}$$

Page 293, Stored charge capacitance example, second to last line on the page:

$$C_{sc}(-5) = \delta I \tau_n$$

$$= (0.5)(3.4\times10^{-19}A)(3\times10^{-6}s)\left(\frac{1.6\times10^{-19}C}{1.38\times10^{-23}J/K \bullet 300K}\right) = 1.97\times10^{-23}F \approx 0$$

Page 294, continuing example, first equation on page should be

$$C_{sc}(0.75) = \delta I \tau_n \frac{q}{kT} = (0.5)(3.4\times10^{-6}A)(3\times10^{-6}s)\frac{1.6\times10^{-19}C}{1.38\times10^{-23}J/K \bullet 300K} = 63.7\,pF$$

Page 294, Table in example: in the last cell of the table, the value should be C_{sc}=63.7 pf (not 1.65 pF)

P 309, question 5.19. " A junction as N_D'=10^{17} cm^{-3} and N_A'=10^{18}… make it "A junction has a degenerately doped *n* side and the p-side is doped with N_A'=…

P 318 Figure 6.7, the figures for Type II and type III are swapped, but the captions are correct.

p. 319, Figure 6.8 (b) Quantity labeled gamma 2 should be chi 2.

P335. Bottom equation, exponential should be E_B(0), not E_g (0)

Page 343, Problem 6.7, line 5: … w_n and w_p on the N and p sides … ("N" is capitalized)

p. 334 Sect 6.4.3, second paragraph, line 5 should be "from the metal to the semiconductor is equal…" ("to" and "from" are mixed up)

Page 355, Equation S2.35 should be

$$C_{sc} = \frac{dQ_s}{dV_a} = \delta \frac{dQ_s}{dV_a} = \delta I \tau_n \frac{q}{kT}$$

Page 356, example S2.2 solution, for long base diode result should be

$$C_{sc} = \delta I \tau_n \frac{q}{kT} = \frac{1}{2}\times10^{-2}\times2.9\times10^{-6}\times\frac{1.6\times10^{-19}}{1.38\times10^{-23}(300)} = 5.6\times10^{-7}F$$

For the short-base diode the result should be

$$C_{sc} = \delta I \tau_n \frac{q}{kT} = \delta I \frac{(W_B)^2}{2D_n} = \frac{2}{3}\times10^{-2}A\frac{(0.3\times10^{-4}cm)^2}{2\times20cm^2/s} = 1.5\times10^{-12}F$$

The following text should say that the stored-charge capacitance for the long-base diode is about 4×10^5 times as large as for the short-base diode.

Page 369, Problem S2.2. At the end of the problem statement, it should say, "The junction size is $10^{-4}\times 10^{-4}$ cm."

Page 369, Problem S2.3, let the junction area be 5×10^{-7} not 5×10^{-8} cm^2.

P 371, problem S2.7, the "N" should not be in italics since it is a SPICE variable

Page 374, paragraph 2, line 7, should be "V_{GS}," not "V_{DS}"

P 439 Problem 7.2 a, should read "Draw an energy band diagram similar to Figure 7.5(b)…" (Not Figure 7.2(c)

P 440 Problem 7.5, "…is equal to the hole concentration in the p-type bulk."

p. 440. Problem 7.7, The permittivity of silicon DIOXIDE is…"

p 440, problem 7.12, should have a question mark.

P 434, middle of page, second-to-last equation should be R_s=R_D=19.9 Ω. (Second R has subscript "D" not "S")

Page 449, Figure 8.4 (a) is drawn incorrectly. The gate electrodes should be over the gate

P. 481, Figure 8.31, lower right figure, E_f in the semi-insulating GaAs should be near the mid gap.

p 489, problem 8.9, should have "cm^{-3}" after N_A'.

P 498, Figure S3.4: the arrows for the quantity $q\phi_f$ should indicate the difference between E_i and E_f, not E_f and E_V .

Page 501, top of example wording should be ".. and n-chcannel MOSFE with an n^+ poly Si gate, (add comma), having N_A'=10^{16} cm^{-3} in the substrate, … (add "in the substrate")

p 548, problem S3.3 should refer to figure S3.3., not Figure 8.2

p. 549, problem S3.10, should be N_D' not N_A'.

p. 550, problem S3.11, should be cm^2, not just cm.

P. 585, Eqn. 9.67, there is a sign error in the second equation, $I_C = I_{CT}$ - …; the last term of the third equation, I_R should be I_S.

p. 641, problem 10.13, "…and the leakage current density…" add "density." At the end of the problem add "Assume that the area of the base-collector junction is 10 times that of the Schottky diode."

P 699, Figure 11.19: indicate critical angle in figure since it is defined with respect to the surface, not the normal (hence cosine version of Equation 11.27)