Supplement to MICROELECTRONIC DEVICES AND CIRCUITS by Clifton G. Fonstad

ERRATA in TEXT

(EXCLUSIVE OF END-of-CHAPTER PROBLEMS*)

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Page 14, three lines above Figure 2.7: The word "presure" is missing an "s" and should be "pressure".

Page 14, Figure 2.7(b): The energy level labeled N_a should instead be labeled N_d.

Page 39, following Equation (3.31): The -1 in the quantity τ_{min-1} should be a superscipt on τ_{min}, and parentheses should be inserted, so it reads "$(\tau_{min})^{-1}$".

Page 42, Figure 3.3 caption: In (c) a set of parentheses is missing around the t in n't; it should read "n'(t)".

Page 43, two lines above Equation (3.45): The word "frequent" should be "frequency".

Page 43, last term on the page: The w in the exponent should be a ω so the factor reads "$Re[Be^{j(\omega t+\theta)}]$".

Page 45, Equation (3.46): The expression for θ should be preceeded by a minus sign so it reads "$\theta = -\tan^{-1}(\omega\tau_e)$".

Page 46, Figure 3.5: The values on the vertical scales should be multiplied by a factor of two. Thus the peak value of $g_l(t)$ in (a) should be 2G, rather than G; the peak value of n'(t) in (b) should be $2G\tau_e$, rather than $G\tau_e$; and the average value of n'(t) in (b), (c), and (d) should be $G\tau_e$, rather than $G\tau_e/2$.

Page 49, following Equation (3.55a): A prime is missing on p and it should read "...pairs, n' = p' and..."

Page 65, Equation (3.23): To be consistent this equation should be numbered 3.23'.

Page 66, Equations (4.13a) and (4.13b): The factor n^2_i should be n_i^2 as in Equation (4.13c)..

Page 76, Equations (5.17) and (5.18): To be consistent the factor n'/τ_e should be written $n'(x,t)/\tau_e$.

Page 76, Equation (5.20): The factors in the denominators of the first two factors should indicate partial, rather than total, derivatives. Thus dt should be ∂t, and dx^2 should be ∂x^2.

Page 79, first sentence: The correct relationships between the quantities A, B, C, and D are C = (A + B)/2 and D = (A - B)/2.

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*End-of-chapter Problem Changes, Errata, and Comments begin on page 10.

Page 81: Three lines before Equation (5.33b), the term $n'(x_4)\tau_e$ should instead be $n'(x_4)/\tau_e$ (i.e. the quotient of $n'(x_4)$ and τ_e, rather than their product).

Page 82, Figure 5.2: The e on the factors De in the lower portion of this figure should be subscripts so the factors read D_e.

Page 87, Figure 5.5b: The label on the vertical axis should have a subscript L and read $g_L(x)$, and the height of the pulse should be G_L, rather than G.

Page 88, Expression for C: The second term should be "$- e^{-2w/L_e} D$".

Page 90: The expression for n'(x) for $0 \le x \le x_1$ should have a 2 in the denominator of the first term and read

$$n'(x) = -\frac{G_L x^2}{2D_e} + Ax + B$$

The impact of this missing 2 propogates through the discussion. The next equation going down the page is alright, but the following one should be

$$-\frac{G_L x_1^2}{2D_e} + B = C e^{x_1/L_e} + D e^{-x_1/L_e}$$

and then, two more equations further down, we should have

$$-\frac{G_L x_1}{D_e} + B = \frac{C e^{x_1/L_e} - D e^{-x_1/L_e}}{L_e}$$

and, finally, the next equation should read

$$-\frac{M}{D_e} = \frac{(C - D)}{L_e}$$

The total solution is correct because by then the error cancels itself out.

Page 90, middle of page: In the line beginning, "which, in the limit...", there should be a subscript L on the G in "$G \rightarrow \infty$", so it reads "$G_L \rightarrow \infty$".

Page 99, Equation (5.43): The factor in the square brackes should be $[(D_e/D_h) - 1]$, rather than $[1 - (D_h/D_e)]$.

Page 99, Equation (5.46): The denominator of the derivative term on the right-hand side should be dx^2, rather than dx_2.

Page 101: The right-hand side of the second equation for n'(x) should be multiplied by a factor of $-1/D_e$.

Page 112, Equation (6.11): There should be a left-hand parenthesis in the middle term on the right-hand side of this equation, so the term is $n_o(x)$ rather than $n_o x)$.

Page 112, Equation (6.12b): The minus sign in front of the right-hand side of this equation should be deleted.

Page 113, Equation (6.15c): There should be a minus sign in front of the right-hand side of this equation.

Page 117, five lines from end of text (above figure): $N_o(x)$ should be $n_o(x)$.

Page 118, line following Equation (6.28): The x in E(x) should be italicized.

Page 119, Figure 6.5(a): The label on the vertical axis should be $\rho(x)$, rather than p(x).

Page 119, Figure 6.5(c): The 2ε factors in the labels for the two curved portions of the profile should not divide the entire expressions, but rather just the right-most factors in the present numerators (i.e., φ_p and φ_n should not be divided by 2ε).

Page 120, Equation (6.34): There should be a minus sign in front of the right-hand side of this equation (i.e. the electric field should be a negative quantity in this situation).

Page 121, Discussion three lines from bottom of page: The extrinsic Debye length for electrons should be 80 nm, rather than 40 nm as stated, and the depletion width on the n-side is thus more than 7 extrinsic Debye lengths.

Page 122, Figure 6.8a: The two labels on the vertical axis should be qN_{Dn} and $-qN_{Ap}$, respectively.

Page 123, Figure 6.7: The vertical axis in both parts of this figure should be labeled $N_D(x)$, rather than N(x), to be consistent with the text.

Page 134, Equation (7.1): φ_{AB} should be v_{AB}, so the equation reads:

$$w(v_{AB}) = \sqrt{\frac{2\varepsilon(\varphi_b - v_{AB})}{q}\,\frac{N_{Ap} + N_{Dn}}{N_{Ap}N_{Dn}}} \qquad (7.1)$$

Page 136, Equation (7.9): The "q" in the numerator of the expression under the radical should not be a subscript, so the equation reads:

$$C_{dp}(V_{AB}) = \sqrt{\frac{\varepsilon q}{2(\varphi_b - V_{AB})}\,\frac{N_{Ap}N_{Dn}}{(N_{Ap} + N_{Dn})}} \qquad (7.9)$$

Page 137, seven and eight lines from top of page: m and μ are reversed; it should read "...is 0.17 $fF/\mu m^2$ and 0.6 $fF/\mu m^2$ for diodes..."

Page 143, Figure 7.5: The labels on the horizontal axis should be $-x_p$ and x_n, rather than $-x'_{-p}$ and x'_n.

Page 146, first line of second paragraph after Eq. (7.28b): The inequality should be reversted and read "$L_e << w_p$".

Page 149, Figure 7.8: The labels on the vertical axes should be i_D rather than j_D.

Page 150, Figure 7.9: The value of the excess population at $x = -x_p$ should be $-n_{po}$; the subscript "o" is missing.

Page 154, Figure 7.10: The label on the vertical axis should be "p'(x), n'(x)".

Page 155, Equation (7.40) and line preceeding it: The p in $P_n'(v_{AB})$ should be lower case so the term reads "$p_n'(v_{AB})$ ", and there should be a subscript n on the x in the numerator of the equation so the factor in parentheses reads "$(w_n - x_n)$"..

Page 156, Equation (7.41): There should be parentheses around the v_{AB} on the left-hand side of this Equation, so it reads $q_{DF}(v_{AB})$ rather than $q_{DF}v_{AB}$.

Page 161, Equations (7.5) and (7.41): To be consistent with the convention followed elsewhere in the text, these equations should be labeled (7.5') and (7.41'), respectively. Also, in Equation (7.41), the F on the right-hand side of the equation should be deleted.

Page 164, Equation (7.51'): The "1" and "2" in the middle term should be subscripts so it reads:

$$f\ \frac{a_1}{a_2}$$

Page 187, Last line before Section 8.1.1: There should be parentheses around the term $v_{BC} - v_{BE}$, and this term should be preceeded by a minus sign so the line reads, "...that is, v_{CE} is $-(v_{BC} - v_{BE})$."

Page 190, Equation (8.12a): Delete the prime on v_{BE} in the exponent.

Page 190, Equation (8.6'): The right-hand-most term should be preceeded by a minus sign.

Page 190, Equation (8.13a): The numerator of the term to the right of the first equal sign should be $(1 + \delta_E)$ (i.e. the minus sign should be changed to a plus sign).

Page 192, Equation (8.13a'): The a in the right-most term in this expression should be an α so the term is $\alpha_F i_F$.

Page 201, Figure 8.11(b): The label on the horizontal axis between 0 and $w_B + w_C$ should be w_B, not w_C.

Page 213, Figure 8.20: The current labeled "i_S" should instead be labeled "i_F".

Page 229, Equation (8.68e): The range of validity of this expression should be given as "for $w_B^+ \le x_l \le (w_B^+ + w_C)$".

Page 245, Figure 9.3(g): The solid vertical line in the third quadrant should line up with the vertical arrow in the second quadrant.

Page 245, Figure 9.3(g) and (i): The label on the applied bias on the left-hand side of each drawing should be v_{GB}, rather than v_{gb}.

Page 245, Figure 9.3(g), (h), (i), and (j): The subscript on the label of the depletion region edge on the horizontal axis, and in the label of the left-most impulse in (h and (j), should be DT, rather than dt, so it reads X_{DT}, rather than X_{dt}.

Page 245, Figure 9.3 (j): The label on the left-most impulse should be preceded by a minus sign, so it reads $-q_N^* + qN_AX_{DT}$

Page 246, Equation (9.4): The argument of the impulse should be x, rather than 0.

Page 246, Equation (9.8): The expression for the electric field for $0 \le x \le x_D$ should be multiplied by a minus sign so it reads

$$-\frac{qN_A}{\varepsilon_{Si}}(x - x_D)$$

Page 249, Discussion of example: The threshold voltage should be found to be 0.53 V, rather than 0.9 V, as stated.

Page 250, Line following Equation (9.18): The sheet mobile charge density in the inversion layer should be written with a lower-case q and upper-case subscript N, so it reads q_N^*, rather than Q_n^*.

Page 250, Equation (9.20): The sign on the last term should be negative, so the equation reads:

$$V_T(v_{CB}) = V_{FB} + |2\varphi_p| + v_{CB} - \frac{t_o}{\varepsilon_o} Q_{DT}^*(v_{CB})$$

Page 254, Equations (9.26) and (9.27): The factor C_{ox}^* inside the radical should be squared as it is in Equations (9.25) and (9.29) on the same page; that is, in all four equations the radical should be the same and look like

$$\sqrt{1 + \frac{2\, C_{ox}^{*2}\,(v_{SG} - V_{FB})}{\varepsilon_{Si} qN_A}}$$

Page 259, fifth line on page: Interchange "negative" and "positive", and insert "in magnitude" so it reads, "...positive oxide charge, there will be a negative charge on the gate electrode equal in magnitude..."

Page 269, end of second line after Equation (10.3): Insert "channel" after "The" so it reads, "... in the channel. This channel current is ...".

Page 270, Equation 10.9: The second factor on the right-hand side of the equation should be multiplied by (t_o/ε_o), so it reads

$$\ldots + \frac{3}{2}\frac{t_o}{\varepsilon_o}\sqrt{\ldots}\ \text{etc.}$$

Page 271, Equation (10.5'): There should be a minus sign in front of the term beginning with ε_o/t_o; thus this equation should read

$$q_N^*[v_{CS}(y)] \approx -\frac{\varepsilon_o}{t_o}[v_{GS} - v_{CS}(y) - |2\varphi_p| - V_{FB}] + Q_D^*(0, v_{BS})$$

Page 271, Equations (10.12a) and (10.12b): The term $|2\varphi_p|$ should be preceeded by a plus sign, rather than by a minus sign.

Page 274, Equation (10.16c): The range should be specified as being "for $(v_{GS} - V_T) \le v_{DS} \le 0$", rather than "for $(v_{DS} - V_T) \le v_{DS} \le 0$".

Page 280, Equations (10.21a) and (10.21b): The signs of the factors of the form $\frac{t_o}{\varepsilon_o}\sqrt{\ }$ should be changed. This occurs once in Eq. (10.21a) where a plus sign should be changed to a minus sign, and twice in Eq. (10.21b) where one plus sign becomes a minus sign and one plus sign becomes a minus sign.

Page 280, Equation (10.22): The last two terms should be added to, not subtracted from, V_{FB}, so the equation reads

$$V_T(v_{BS}) = V_{FB} + |2\varphi_p| + \frac{t_o}{\varepsilon_o}\sqrt{2\varepsilon_{Si}qN_A(|2\varphi_p| - v_{BS})}$$

Page 302, Equations (10.67) and (10.68): Both of these equations have an extraneous parenthesis in the denominator of the last term.

Page 303, Equation (10.71): φ_p should be φ_b, so the expression reads:

$$G_o \frac{\sqrt{\varphi_b - V_{GS} + V_{DS}} - \sqrt{\varphi_b - V_{GS}}}{\sqrt{\varphi_b - V_p}} \qquad (10.71)$$

Page 333, second line of Discussion: The parameter R_C' should have a subscript L, rather than a subscript C, so it reads R_L'.

Page 333, third line of Discussion: The value of the input resistance is 1.65 kΩ, rather than 1.35 kΩ as stated.

Page 335, Figure 11.7: The transistor Q_4 should be a pnp transistor, rather than an npn, and the base of Q_5 should connect to the collector of Q_4, i.e., the base lead of Q_5 needs to be extended further to the right in the drawing.

Page 339, first sentence of first full paragraph on page: The reference should be to Eq. (11.21), rather than Eq. (11.20), and parentheses should be inserted around the expressions in the denominator of the two fractions so they read $1/(g_m R_{E1})$ and $r_\pi/(\beta_F R_{E1})$, respectively.

Page 343, Line preceeding Equation (11.44a): The word "current" should be deleted and the word "stage"inserted in its place.

Page 350, Discussion for the Example at the top of the page: The reference to Eq. (11.38) in the third sentence should instead be to Eq. (11.52a).

Page 351, Figure 11.2: Curve (a) should have zero value for $v_{AB} < 1$ V. As drawn it is above the horizontal axis in this range.

Page 358, Figure 11.16 (a): The lines connecting the substrate contacts of Q_1 and Q_2 to their respective sources should be deleted, and the subscript on the negative power supply should be upper case "SS", rather than "ss" as at present.

Page 360, Figure 11.18 (a): The output should be taken off the drain of the MOSFET, rather than the source (i.e. C_O should be connected to the drain, rather than the source, and the figure should look like Figure P11.3 without C_S).

Page 374, Last sentence of the paragraph continued from the preceeding page: The value of the output voltages of the MOSFET circuit are $V_{DD} - R_O I_{BIAS}/2$; the "2" is missing.

Page 379, Figure 12.5: The label on the left-hand dependent current source should be $K(v_{GS1} - V_T)^2$, rather than $K(v_{GS2} - V_T)^2$ (i.e. v_{GS2} should instead be v_{GS1}).

Page 383, Equation (12.20): There should be a minus sign (-) before v_{i2} so the right-most expression reads, "$v_{i1} = -v_{i2} = v_{id}$".

Page 388, Line preceeding Equation (12.31): Delete "Referring to Eq. (12.28b)," and capitalize "we".

Page 388, Equation (12.31): The 2 in the denominator should be deleted.

Page 392, Fourth and fifth lines after Equation (12.41): The expression for R_{ic} should be $r_\pi + 2(\beta + 1)R_I$, and the approximate expression for R_{ic} should be $2\beta R_I$ (i.e., the 2 should multiply, not divide, R_I, and in the second expression the R should not be a subscript).

Page 394, Figure 12.13a: There is an extraneous superscript "-" on the I_{BIAS} label on the current source, and the $I_{BB}/2 + i$ on the right should instead be $I_{BIAS}/2 + i$.

Page 394, Equation 12.45: The $g_\pi p$ in the denominatior should be multiplied by 2.

Page 400. Sentence after Equation 12.56b): I_{BIAS} and I_{REF} are interchanged; the sentence should end: "...we want I_{BIAS} to be 10 μA and choose I_{REF} to be 1.0 mA."

Page 434, Figure 13.12a: The resistor labels "R_{C2}" and "R_{B12}" should be interchanged, i.e. R_{C2} should be the right-most resistor of the pair in the upper right-hand portion of the circuit, and R_{B12} is the left-most resistor of this pair.

Page 445, Second and fourth lines of paragraph beginning "**b) Common..**": The two (2) references to Q_6, should instead be to Q_7.

Page 447, Third line in second paragraph of Section 13.4.2: The third word, "smaller", should instead be "larger".

Page 447, Fifth line in third paragraph of Section 13.4.2: The inequality is reversed. It should read "...$I_C R_{C1}$ must be $\geq$ 3.6V."

Page 447, Third line in fourth paragraph of Section 13.4.2: The inequality at the end of the line is reversed; it should read "...must have $I_{C1} R_{C1} \leq 3.75$V."

Page 447, Second line in fifth paragraph of Section 13.4.2 (last line on page): "I_{C2}" should instead be "R_{C2}".

Page 453, Figure 13.20 b, c, d: The left-most transistor labeled Q_2' should be labeled Q_6' instead.

Page 456, Nine lines from the bottom of the page: "early" should be capitalized (i.e., it should be "Early").

Page 478, Sentence following Equation (14.12a): The inequality between g_m and g_π should read "$g_m >> g_\pi$" and the end portion of the sentence, "and $R_S' >> R_L'$." should be deleted.

Page 486, Line below Equation (14.2a): A factor of 2 is missing from the denominator of the expression for τ_b; the correct expression is $(w_B^*)^2/2D_{min,B}$.

Page 511, Equation (15.11a): Region III should be defined as $0 \le v_{OUT} \le (v_{IN} - V_T)$ and the last factor in the equation should be $v_{OUT}/2$ rather than simply v_{OUT}.

Page 515, Figure 15.9 b: The label on the diagonal dashed line should have an upper case, rather than lower case, "V" in the last term so it reads, "$v_{OUT} = v_{IN} - V_T$".

Page 518, Equation (15.18a): V_{OUT} (within the square brackets) should be v_{OUT}.

Page 518, Line above Equation (15.19a): V_{OUT} should be v_{OUT}.

Page 518, Equation (15.19a): V_{IN} should be v_{IN}.

Page 518, Equation (15.20a): The left-most v_{OUT} should be v_{IN}, and v_{TD} should be V_{TD}. The equation should then read

$$i_D = \frac{K_L}{2} V_{TL}^2 = K_D \left(v_{IN} - V_{TD} - \frac{v_{OUT}}{2}\right) v_{OUT} \qquad (15.20a)$$

Page 519, Figure 15.11 a: The lower transistor, Q_D, should be an enhancement mode device rather than depletion mode as drawn.

Page 519, Figure 15.11 b: The solid curve in Region III should be a vertical straight line. As drawn the line is curved as it approaches the boundary between Regions II and III.

Page 523, Equation (15.23 a): The right-most term should contain "K_P", rather than "K_N".

Page 523, Equation (15.23 b): The sign in front of V_{TP} should be "+" rather than "-", so the equation reads:

$$v_{IN} = \frac{\sqrt{K_P}(V_{DD} + V_{TP}) + \sqrt{K_N}V_{TN}}{\sqrt{K_P} + \sqrt{K_N}}$$

Page 523, Second line from the bottom: There is a "g" that should not be a subscipt, but should instead have the normal font and position. Thus the line should read, "...a voltage gain of $-2g_m/(g_{oN} + g_{oP})$. This..."

Page 524, First full paragraph: The second sentence of this paragraph should refer to an n-input NOR gate, and the third sentence should refer to an n-input NAND gate, rather than vice-versa.

Page 572, Section 16.3, Seventh line: "CCL" should instead be "ECL".

Page 574, Equations (16.44a) and (16.44b): The capacitance on the left-hand side of these equations should be C_L rather than C_G.

Page 668, Figure G12g: The labels of the p-channel and n-channel MOSFETs are reversed (i.e. the p-channel is on the right, the n-channel on the left). Also, the source and drain regions of the left-hand MOSFET should be labeled n^+, as in Figures G.12e and f, rather than p^+.

Page 686, Entry for "Veleocity Saturation": A general reference should be made to pages 33-34, i.e. the first line should read :Veleocity saturation, 33-34.

PROBLEM CHANGES, ERRATA, and COMMENTS

December 10, 1997 Update

Chapter 2

Problem 2.3, Part (b) (i): The sub-parts of this question should be labled (1), (2), and (3) rather than (a), (b), and (c), respectively.

Problem 2.8: The labels a, b, c, and d of the sub-parts of this question should be in parentheses.

Problem 2.8, Part (a): "antimonide" is misspelled.

Chapter 3

Problem 3.2: There should be a Part (e) to this problem which reads, "Repeat parts (a) - (d) assuming that in addition to the 3×10^{15} cm^{-3} gallium atoms, there are also 1×10^{16} cm^{-3} arsenic atoms in the sample."

Problem 3.3, Part (a): The symbol "s" should be used rather than "v" for velocity to be consistent with the notation used in the text. Thus the thermal kinetic energy expression should read: $m^*s^2/2$, rather than $m^*v^2/2$.

Problem 3.3, Part (c): The question given in Part (c) is really Part (e) of Problem 3.2 (see above) and the correct question is: "Compare your answers in (a) and (b), and comment on what you see."

Problem 3.4, Part (a): The reference near the end of this part to "thin slabs of material dx wide", should instead say "dx thick", i.e., delete "wide" and insert "thick".

Problem 3.4, Part (b): Insert the statement, "Assume $T >> 2$ μm."

Problem 3.4, Part (b): The equation should read "$n_o(x)$", rather than "$n_o(0)$".

Problem 3.7, Part (a): This part should ask for n_o, p_o, and σ_o. The last item is listed incorrectly in the problem statement as s_o.

Problem 3.10, Part (a): The end of this part should read, "when $aT >> 10^{-4}$ s." The "a" is missing.

Problem 3.10. Figure P3.10: The "G" on the vertical axis should be lowered so that it is opposite the horizontal portions of the waveform.

Problem 3.11, Part (b): Numerous primes are missing and this part should read: "Show that n_3' can be written as $n_3' = n_1' + n_4'$ where n_4' satisfies...".

Problem 3.11, Part (b): The denominator of the right-most term in the equation should be a tau prime, i.e., τ', rather than t'.

Problem 3.12, Figure P3.12: The units on the vertical axis should be "$cm^{-3}s^{-1}$", rather than "$cm^{-2}s^{-1}$".

Problem 3.13, Specification (i): Change "conductivity" to "conducatance".

Problem 3.13, Specification (ii): Change this specification so it concludes, "...proportional (within 10 percent) to the incident light intensity for g_L up to 10^{20} $cm^{-3}s$."

Chapter 4

Problem 4.1, Part (b): The "a" in the exponent of e in the expression for the diffusion coefficient should be a subscritpt on "E", i.e. the exponent should be E_a/kT. At the end of this part insert "Part" and put parentheses around "a" so it ends, "...given in Part (a)."

Problem 4.1, Part (d): Insert "Part" and put parentheses around "c" so this part reads, "Repeat Part (c) at 1150˚C."

Problem 4.4, Part (b): There are several errors in the expression. The subscirpt on "C" should be a lower case "m", rather than "M"; the "m" under the square root sign in the denominator of the term multiplying the "exp" should be a subscript; and the factor $(x - x_o)$ in the square brackets should be squared. Thus the correct expression is

$$C_m(x,t) = \frac{A}{\sqrt{\pi D_m t}} \exp\frac{-(x - x_o)^2}{4D_m t}$$

Problem 4.4, Part (d): The last portion of this problem statement, beginning with "and another..." should be indented so the format is consistent.

Problem 4.4, Part (d): There is an extra "a" in the last sentence on this page which should be deleted.

Chapter 5

Figure P5.1: There is a "v_e" and wiggly arrow on the right side of this figure that should be deleted.

Problem 5.2: The doping level of the sample should be specified as N_A, not as N_p.

Problem 5.5, Part (e): The net charge density should be identified as $\rho(x)$, not as $\sigma(x)$.

Figure P5.5b: The value of $J_e(x)$ between 2L/3 and L should be -3 A/cm^2, rather than -2.5 A/cm^2 as the drawing indicates.

Figure 5.6: The expression for n(x) for $2 \le x \le 4$ should be $0.5[5 - (x - 3)^2]10^{13}$.

Problem 5.6, Part (d): Delete the first sentence and modify the second sentence to read, "Using the value for τ_e you found in Part (b), calculate...".

Problem 5.7, Part (a)(i): The charge stored on the capacitor should be written as q(t) rather than Q(t).

Problem 5.9, First line: The length of the bar should be 100 μm, not 100 mm as written.

Chapter 6

Problem 6.1, Part (b): The quantity kT/q should have the units "V", not "eV".

Problem 6.1, Part (b)(iv): The quantity to be calculated should be D_h, not D_e.

Problem 6.4, Part (b): The built-in potential should be written as φ_b, not as φ_1. and the argument of the second term of the expression for φ_b should be -w/2 (the minus sign is missing).

Problem 6.4, Part (c): The built-in potential should be written as φ_b, not as φ_o as is done in two places.

Figure P6.06: This should be Figure P6.6, not P6.06.

Problem 6.7: Insert "...and the electrostatic potential profile, $\varphi(x)$,...." between "E(x)" and "produced" in the first line.

Figure 6.7: The magnitude of the left-hand charge distribution is $-\rho_o$; the minus sign is missing in the figure.

Problem 6.8, Part (b): Make the present question Part (b)(i), and insert another question as Part (b)(ii) which is "Do the same for $\varphi(x)$".

Problem 6.8, Part (c): The correct notation for the built-in potential is φ_b, not φ_o.

Problems 6.7 and 6.8: It is best to assign Problems 6.7 and 6.8 early, say right after Problems 6.1 and 6.2, to give the students practice with the electrostatics issues in the depletion approximation.

Chapter 7

Problem 7.2: The value of the intrinsic carrier concentration, n_i, should be 10^{10} cm^{-3}, rather than 1.45×10^{10} cm^{-3}. Also, to be consistent with the notation used in the text, N(x) should be written with a subscript D as $N_D(x)$. This inconsistency occurs in the second line of the problem statement and in the label for the vertical axis in Figure P7.3. Finally, the subscript on ε_{si} should have an uppercase s (i.e. ε_{Si}), and the units should be written with a capital f (i.e. as F/cm).

Problem 7.4, Part (a): The specification of resistance values at -5 and -10 Volts is reversed; it should read 1 kΩ at -5 Volts and 2 kΩ at -10 Volts.

Figure P7.4: The horizontal portion of the lower depletion region in the n-region is drawn too wide; is should be the same width as it is in the vertical portions of this junction.

Problem 7.5: In the second line of the problem statement, the parameter plotted on the horizontal axis of the figure should be referred to as v_{AB}, not V_{AB}.

Problem 7.5: Change the junction area from 10^{-5} cm^2 to 10^{-3} cm^2.

Problem 7.5, Part (b): The reference should be to Equation (7.9b), rather than to Eq. (7.19a).

Problem 7.5, Part (e): Add another subscript p to the C in $1/C_d^2$ so it reads $1/C_{dp}^2$.

Figure P7.5: Make the horizontal intercept 0.78 V, and make the inflection point in the curve occur at 2×10^{22} F^{-2}. Also, change all of the lower case f's in the units to upper case f (i.e. F).

Problem 7.7: The doping level on the p-side, N_{Ap}, should be 10^{16} cm^{-3}; the negative sign that appears in the exponent as it is now written is incorrect.
Problem 7.8: Include the statement, "Ignor the depletion region widths."

Figure P7.8: The doping level on the n-side of Diode II, N_D, should be 10^{15} cm^{-3}, rather than 10^{17} cm^{-3} as indicated.

Problem 7.10: Add the relation, "$w_n = w_p = w$", and delete the subscript "R" on the expression indicating that the diode width is much less than L_e, i.e. in the expression that now reads $w_R << L_e$.

Chapter 8

Problem 8.1: The active cross-sectional area of the transistor should be 5×10^{-4}, not 5×10^{4}. The sign of the exponent is wrong.

Figure P8.1: The contact to the base is missing from the left-hand figure.

Problem 8.4, Part (d): The last J_{ES} should be J_{CS}, so it reads, "...$\alpha_F J_{ES} = \alpha_R J_{CS}$."

Problem 8.5, Part (d)(i): Delete the specification of the effective base width being 0.2 μm since it is calculated in Problem 8.1. Alternatively, the reference to Problem 8.1 in Part (a) can be deleted, and other doping levels can be specified.

Figure P8.6b: The primes are missing from the saturation currents of the diodes in the right-hand circuit model.

Problem 8.8: Numbers should be provided for the relative doping levels in the emitter, base, and collector. A good choice is $N_{DE} = 4\ N_{AB} = 16\ N_{DC}$.

Problem 8.9: The last two parts of this problem should be deleted; they were inadvertently repeated from the next problem, Problem 8.10.

Problem 8.9: A recommended change in the design rules specified is to make the minimum nesting allowance 1 μm, rather than 2 μm.

Problem 8.11: The ratio of D_e to D_h is not specified. A ratio of 2.5 is suggested.

Problem 8.12: The ratio of D_e to D_h is not specified. A ratio of 2.5 is suggested.

Problem 8.12, Part (d): The statement of the relative doping densities in the emitter, base, and collector has a minus sign rather than an equal sign between the base and collector doping specifications.

Problem 8.13: The transistor should be referred to as a pnp, rather than an npn, device.

Chapter 9

Problem 9.1: The value of ε_o should be 3.5×10^{-13} f/cm; the value given has units of f/m.

Problem 9.1, Part (d)(ii): The electron mobility is incorrect; it should be 1000 cm^2/V-s, not 100 cm^2/V-s.

Problem 9.3: The terminal referred to as being labled N in Figure 9.5, is actually labled S, so the voltage shouldbe V_{SB}, rather than V_{NB}.

Problem 9.8, Parts (c) and (d): The ordering of this question is somewhat confused. The present Part (c) should actually be Part (e), and Part (c) should actually be just the first line of what is now Part (d). Part (d) should then be what are now Parts (d)(i) and (d)(ii). Thus it should read:

(c) What is the maximum depletion region width X_{DT}?
(d) (i) What is the carrier type of the substrate, *n* or *p* ?
(ii) What is the net.....
(e) What is the electrostatic potential of the gate.....

Figure P9.8: The horizontal axis should be labeled v_{GS} (V), not v_{DS} (V).

Chapter 10

Problem 10.1: A more realistic value for the oxide thickness, t_o, is 50 nm. The value given works but you may wish to make this change.

Problem 10.1, Part (d)(iii): The reference to "k_T" should instead be to "kT".

Problem 10.2: Somewhat more realistic values are obtained if the substrate doping is changed from 1 x 10^{17} cm^{-3}, to 1 x 10^{16} cm^{-3}.

Problem 10.4: No junction depths or doping method are specified; it is best to assume that ion implantation is used and to neglect latter scatter of the dopants at the edge of masked regions. Also, you may want to ask students to work the problem using modified design rules (as suggested in the solution of Problem 8.9) in which the minimum opening and linewidth is 2 μm, rather than 1 μm, and the nesting allowance is 1 μm, rather than 2 μm.

Problem 10.5: The units on the doping level for the gate material (second line on page 315) should be cm^{-3}, not cm^3.

Problem 10.5: The factor t_{ox}/e_{ox} in the expression for the K-factor should be inverted, and "e_{ox}" should be "ε_{ox}". The correct expression is

$$\text{K-factor: } \frac{W}{L}\ \mu_e \frac{\varepsilon_{ox}}{t_{ox}}$$

Problem 10.8, Part (a): The reference in the second line should be to Eq. (10.4a), rather than to Eq. (10.4).

Problem 10.8, Part (b): The question in the third line should be "...at what v_{DS} will the field be 2 x 10^4 V/cm in..."; the "2 x" is missing.

Chapter 11

Problem 11.1: Add a specification of a value for R_E by inserting "R_E in Fig. 11.3c is 2 kΩ," just before "...and R_{B1}..." in the second line.

Problem 11.2, Part (b): This problem is more interesting if the input resistance is made 5 kΩ or 10 kΩ, rather than 2.5 kΩ.

Problem 11.3, Part (c): Add a Part (c)(iii) in which $R_L = 10k\Omega$.

Problem 11.4: Add a Part (c) stating, "Derive an expression for the incremental output resistance of this circuit."

Problem 11.5: Add the following specifications at the end of the introductory statement: "$|V_A|$ is 20 V for the MOSFETs and 50 V for the BJTs. Also for the BJTs, $v_{BE,ON}$ is 0.6 V, $v_{CE,SAT}$ is 0.2 V, and β_F is 100."

Problem 11.5, Part (a)(vi): Delete the word "of" in the last line, and replace it with "in".

Problem 11.7: In the line of specifications for Q_1, the first equal sign (=) should be deleted.

Problem 11.9, Part (a): The end portion of this part beginning "A_v can be..." should be a separate statement introducing Parts (b) and (c).

Problem 11.10, Part (a): There should be a minus sign in fromt of the expression for A_{voc} (i.e. it should be $-g_m/g_o$).

Chapter 12

Figure P12.4: The base and collector of transistor Q_1 should be shorted together.

Problem 12.4, Part (e): To make it clearer that it is the differntial open circuit voltage gain that is desired, insert "differnce-mode" between "open-circuit" and "voltage gain" in the first line, and replace "$A_{v,oc}$" with "$A_{vd,oc}$" the threee places it appears.

Problem 12.5, Part (c): In the first line, "R_2" should be "R_3" so it reads "... $R_3 = 2$ kΩ, the ..."

Problem 12.5, Part (d): The subscript "c" at the very end of this part chould be lower-case, so it reads, "... find v_{o2}/v_{ic})."

Figure P12.7b: v_{OUT} should be labeled in each circuit schematic and the BJT in the left-hand circuit should be labeled "Q_2".

Problem 12.7, Part (a): The reference to g_π should instead be to g_m, i.e. the subscript should be "m" rather than "π".

Figure P12.8: The arrows on the substrate terminals of all of the MOSFETs are reversed.

Chapter 13

Problem 13.2, Part (b): Add a Part (b)(iv) reading, "Calculate the mid-band input resistance of this circuit."

Problem 13.3, Part (b): The parenthetical expression following "$r_{\pi 1}$" should refer to Q_1, rather than to Q_2.

Problem 13.3, Part (d)(ii): Delete the word "cascade" and insert the word "cascode".

Problem 13.4, Part (a): The subscript "Q" should be deleted from "I_{CQ}" because it is a redundant reference to the quiescent point value, i.e. the notation I_C already indicates that we are referring to the quiescent value.

Figure P13.4b: Label the transistors "Q_1", "Q_2", and "Q_3", respectively, left to right.

Problem 13.5: Specify that $|V_A| = \infty$.

Problem 13.6: Specify that $R_L = 1$ kΩ.

Problem 13.6, Part (d): Make the first sentence Part (d)(i) and change (i) to (ii), and (ii) to (iii).

Problem 13.7: Insert "smallest" in front of "n-MOS" in the first sentence, and again in front of "p-MOS" in the second sentence.

Problem 13.7: The biasing limit should state that $|V_{GS} - V_T| \geq 0.25$; currently the minus sign is an equal sign and the vee in the V_{GS} is lower case.

Figure P13.7: The arrows on all of the MOSFETs should be reversed, i.e., all of the p-channel devices should be n-channel, and the n-channel should be p-channel.

Figure P13.7: The upper-left-most MOSFET should have its substrate connected to its source (the upper terminal) rather than to its drain as now drawn.

Figure P13.7: Change the value of the 1 kΩ resistor to 10 kΩ.

Problem 13.8: The reference in the first sentence should be to Figure 13.20 c and d, not to Figure P13.8.

Figure P13.8: Several changes need to be made in this figure:
- Label this figure Figure P13.9, rather than Figure P13.8.
- Add a shunt between the base and collector of Q_1.
- Reverse the arrows on the substrate leads of Q_6 and Q_7.
- Disconnect the substrate of Q_7 from the drain and connect it to the source as is properly done on Q_6.
- Delete the extra "ends" on the vertical line connecting the collector of Q_4 to the emitter of Q_{12}.

Problem 13.9: The problem statement should refer the reader to the circuit in Figure P13.9 (which is now incorrectly labeled Figure P13.8; see below).

Problem 13.10: The first sentence should refer to R_3, not R_2.

Chapter 14

Problem 14.1: The first sentence should refer to Problem 7.7, rather than Problem 7.6.

Problem 14.1, Part (c)(i): The last expression for F_h should read $D_h p'(0)/(w_n - x_n)$, and the phrase at the end reading "assuming x_n is negligible, an assumption we usually make." should be deleted.

Problem 14.1, Part (c)(ii): The present statement should be replaced by "What is the relevant transit time for this diode, that of holes or that of electrons, and what is it?"

Problem 14.2, Part (a): In the first sentence, replace "mid-band" with "low frequency".

Problem 14.2, Part (c): Specify that V_{CC} is 8 V, and that $V_{BE,ON}$ is 0.6 V.

Problem 14.5, Part (c): Specify that C_π is dominated by the diffusion capacitance component.

Problem 14.7: At the end of the introductory statement, delete the sentence "For example, the following information might be given:".

Problem 14.7, Part (a): Delete the final instruction ", and calculate a value for it".

Chapter 15

Table P15.1: The label "INPUTS" should be centered over, and refer to, columns A, B, and C, and the label "OUTPUT" should be centered over, and refer only to, column D.

Problem 15.2, Part (a): The final value specified for K_L should be 500 $\mu A/V^2$, rather than 50 $\mu A/V^2$.

Problem 15.8, Part (c): In the second sentence, the word "of" should instead be "off".

Problem 15.10, Part (d): The period after "...v_{IN} = 0" should be deleted and a comma and the word "and" should be inserted, the comma after "off" should also be deleted, and a comma should be inserted after "saturated"; the sentence should then read: "...when v_{IN} = 0, and Q_1 is off and Q_2 is saturated, if ...."

Chapter 16

Problem 16.1: The units on D_e and D_h should be cm^2/s, not $cm^2/V\text{-}s$.

Problem 16.3, Part (d)(ii): The Figures referred to should be 16.3a and c, not 16.3b and c.

Problem16.5: The subscript "e" on μ_e is improperly written as a normal character.

Problem 16.6, Part (b): The problem statement should specify that $\mu_e/\mu_h = 2.5$.

Problem 16.9: The problem statement should specify that $R_S C_G = 10^{-8}$ s.

Problem 16.10, Table: The superscript on "n" in the junction area specification should be "+", rather than "t".