Microsystem Design

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Errata

The following errors occur in the Second Printing

This list added on May 27, 2001

Page 34 In the eight line of Section 3.2.2, insert the word "to" so that the text reads "...dilute hydroflouric acid etch to remove this oxide when cleaning a bare silicon wafer."

Page 313 The previously reported error with respect to Eq. 12.50 requires further correction. The equation lacks a factor of n^2 in the denominator. The correct equation is

$$\frac{I_Q(2j\omega)}{(I_o^2 R_e \mathcal{V}/2)} = \frac{8}{\pi^2} \sum_{n \text{ odd}} \left(\frac{1}{n^2(1 + 2j\omega R_n C_n)} \right)$$

The origin of the confusion was that the $R_n C_n$ product goes as $1/n^2$. Hence an equally correct way of writing the equation is

$$\frac{I_Q(2j\omega)}{(I_o^2 R_e \mathcal{V}/2)} = \frac{8}{\pi^2} \sum_{n \text{ odd}} \left(\frac{1}{n^2 + 2j\omega R_1 C_1)} \right)$$

Page 140 Because it is not trivially obvious that the sign of Eq. 6.67 should be a +, a new Problem 6.6 has been added to the Third Printing which asks the reader to verify that when using the displacement rather than the total unfilled gap as the position variable in the magnetic co-energy, the force is obtained from the postive gradient with respect to that displacement.

Page 587 In the caption to Fig. 21.10, the word "mechnical" should be replaced with "electromechanical" and the quantity C_u by C_e.

This list added on May 26, 2001

Page 14 The year for the K. S. Wise reference should be 1998.

Page 480 There is a factor of H missing from the right hand side of Eq. 18.29.

Page 480 The units for π_l in the last line should be Pa^{-1}.

This list added on May 19, 2001

Page 26 In the eight line, "constructe" should be "constructed."

Page 27 The word "which" appears twice in the fourth line of the final paragraph.

Page 34 In the eighth line of Section 3.2.2, the word "wafer" should be added at the end of the sentence so that it reads "when cleaning a bare silicon wafer."

Page 45 There is a space missing between "PECVD" and "is" in the third line of the second paragraph.

Page 54 In the third line, an additional right parenthesis is needed after "(page 58)."

Page 61 Ten lines from the bottom, replace "bond" with "bonds."

Page 64 In the caption to Fig. 3.24, replace "beneath a rectangular" with "beneath a rectangle."

Page 69 In the first line of the first full paragraph of text, replace "feature" with "features."

Page 86 In footnote 3 at the bottom of the page, Microcosm Technologies has changed its name to Coventor, and the MEMCAD product referred to is now called CoventorWare.

Page 96 In the third line from the bottom, insert "is" after "This."

Page 318 Throughout page 318, the term "shear force" should be replaced with "shear stress." There are six instances of this error on the page.

Page 409 There are two errors in Eq. 15.27. In the expression for ε, the sign of the term containing D should be negative. In the expression for F, the numerator of the term containing D should be 1.

Page 419 In the fifth line, the expressions $I_L > 9.764$ should read $i_L > 9.674$.

Page 446 There is an arithmetic error in Eq. 16.44. The value of the numerator " should be 9.6×10^{-4}. The text below Eq. 16.44 should then read:
" or about 1 mK for a 1-Volt excitation signal. This looks very attractive. However, to detect a temperature change this small, it is necessary to detect a resistance change of 3 parts in 10^6. When we examined resistor self-heating in Section 11.6.4, we were interested in a maximum allowed temperature rise of 40 mK, which is 40 times as large as this calculated minimum, and even for that example, it was necessary to use currents of less than 300 μA. ...

Page 446 Immediately after Eq. 16.45, the RMS noise estimate of 2.7 μV should be 27 μV. The following sentence should then read:
"Therefore, it is possible to reduce V_S by a factor of 10, thereby reducing the self-heating driving force by a factor of about 100, and still maintain the same signal-to-noise ratio."

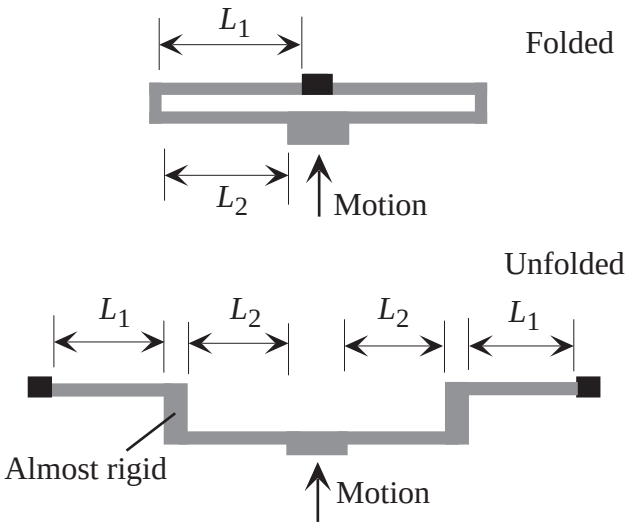
Page 476 In Eq. 18.13, the right-hand side should read $(\pi_l + \nu\pi_t)\sigma_l$.

Page 477 The right-hand side of Eq. 18.18 should be

$$\frac{\alpha_1 + \alpha_2}{2(1 + \alpha_1 - \alpha_2)}$$

Page 507 In Fig. 19.10, the labels on C_2 and R_2 are reversed.

Page 518 There is a serious error in Fig. 19.22 and the associated analysis. The unfolding of the beam as shown neglects the fact that the short folds behave as almost rigid structures. Therefore, a more accurate picture is as shown below:



Page 519 Because of the error in Fig. 19.22, the corresponding analysis leading up to Eq. 19.20 is incorrect. The unfolded spring is, if we assume that the short folds are perfectly rigid, equivalent to two doubly supported fixed-fixed beams, one of length $2L_1$, the other of length $2L_2$. Because the two springs share a common force (effort), their equivalent circuit is in parallel. Hence, the two capacitances corresponding to the springs add. The net result is that the spring stiffness calculated in Eq. 19.20 should be

$$k = \frac{F}{c} = \left(\frac{\pi^4}{6}\right)\left[\frac{EWH^3}{(2L_1)^3 + (2L_2)^3}\right]$$

The text that follows refers to $2L$, whereas it should identify both $2L_1$ and $2L_2$ as the lengths of the unfolded springs. Further, the lengths of L_1 and L_2 are estimated incorrectly from the photograph in Fig. 19.18. The stated values of 75 μm are, more accurately, in the range 110 - 120 μm. Interestingly enough, if 120 μm is used, the resulting stiffness is within a few percent of the originally printed value of 2.8 N/m which resulted from the incorrect figure in combination with the incorrect lengths. Therefore, the remaining conclusions are unaffected, even though this intermediate calculation, as originally printed, was incorrect.

Page 558 In Fig. 20.22, the notation for nitrogen should be N_2 instead of N^2.

Page 564 In the left-hand side of Eq. 21.12, there is a factor of y missing after ω_y^2.

Page 565 In Eqs. 21.14 and 21.15, the factor of m shoud be replaced with a factor x_o.

Page 587 In Fig. 21.20, there is a + sign missing from the upper left terminal.

Page 597 In Fig. 21.27, the two lower capacitors labed R_F should be drawn as resistors.

This list added on April 14, 2001

Page 258 In Equation 10.88, the factor of L^2 in the denominator should be removed.

Page 356 In Equation 14.11, the final term on the right-hand side should be n'/τ_m instead of n/τ_m.

Page 356 In the fourth line after Equation 14.12, the factor 10^{-16} should be 10^{16}.

This list added on April 2, 2001

Page 139 There is a space missing after "space," in the second line after Eq. 6.63.

Page 139 In Eq. 6.64 $\mathcal{M}$ should be replaced by F_{MM}.

Page 218 The text immediately beneath Eq. 9.60 should read "The maximum stress is the maximum strain multiplied by Young's modulus; hence"

Page 237 The term $n_x n_y$ in the denominator of Eq. 9.157 should be carried through and appear in the denominators of Eq. 9.158, 9.159, and 9.160. This also modifies the sum of the first few terms expressed in E. 9.161. The coefficient .47 should be replaced with .45.

Page 243 In Eq. 10.24, the sign before the third term, the volume integral over the body forces, should be negative.

Page 252 The order of the differentials in Eq. 10.59 should be $dxdz$.

Page 262 There is a factor of H missing in the denominators of both Eq. 10.105 and 10.106.

Page 291 In the first line of Section 11.8, the word "and" should be replaced with "as."

Page 292 In the final paragraph, the sentence that begins "Even for neutral species..." should read "Even for neutral species, for which there is no electric current, there can be a particle current."

Page 297 In Problem 11.3, sixth line, the word "affected" should be replaced by "affect."

Page 300 In the line immediately after Eq. 12.4, the diffusivity should be written $\kappa/\tilde{C}$.

Page 303 The S on the right-hand-side of Eq. 12.12 should be removed and the second h-factor should be h_y instead of h_z.

Page 304 There are two errors in Fig. 12.2. The term $\boldsymbol{G}$ in position (2,3) in the conductance matrix should be $-\boldsymbol{G}$ and the minus sign on the right-hand-side of the equation should be a plus sign.

Page 306 The exponent of n in the denominator of Eq. 12.24 should be 3 instead of 2.

Page 307 In Eq. 12.27, the trial solution shold be of the form $\hat{T}(\mathbf{r})e^{-\alpha t}$.

Page 311 In Eq. 12.41, the C on the right-hand-side should be $\tilde{C}$.

Page 311 Two lines above Eq. 12.45, X_n should be replaced by T_n to correspond to Fig. 12.4.

Page 313 In Eq. 12.50, the denominator of each term should be of the form $(n^2 + 2j\omega\boldsymbol{R}_n\boldsymbol{C}_n)$. That is, the 1 should be replaced with n^2. Figure 12.6 was calculated with this correct formula.

Page 326 The c in Eq. 13.30 should be c^2.

Page 403 In the line below Eq. 15.17, the three cube roots of -1 are -1, $e^{j\pi/3}$, and $e^{-j\pi/3}$.

This list added on March 19, 2001

Page 36 For notational consistency, Example 2.1 should be numbered as Example 3.1.

Page 43 For notational consistency, Example 2.2 should be numbered as Example 3.2.

Page 140 The sign of Eq. 6.67 is incorrect. The reason, by analogy with the capacitive actuator, is that the variable that leads to positive work being done on the actuator by the external force is the armature-filled portion of the gap $x_o - x$ instead of the displacement x. This changes the signs of the partial derivates of both the energy and co-energy needed to obtain the correct sign of the force.

Page 167 In Table 7.1, the symbol for Permittivity should be ε instead of e.

Page 167 Equation 7.60 is missing the terms $-0.5x_3$.

Page 168 At the start of the final paragraph, the text should read "The damped resonance frequency..."

Page 169 The graph on the right actually plots the damped resonance frequency *vs.* voltage rather than the undamped resonance frequency. Both the axis label and the figure caption are incorrect.

Page 171 In Equation 7.67, the first term should contain Q^2 instead of Q_2.

Page 178 The fourth line contains an extra "an."

Page 180 For notational consistency, the turns ratio in Problem 7.7 should be denoted with n instead of N.

Page 180 The notation $g\mu$ in Problem 7.7 should be g_μ.

Page 197 In the second line of Section 8.5.1, the word order should read "the various types..."

Page 297 In Problem 11.4, there are spaces missing after the two μm units.

Page 307 In Equation 12.28, both the $\alpha\hat{T}$ and the $D\nabla^2\hat{T}$ terms should carry a minus sign.

This list compiled on March 10, 2001

Page 14 The US Navy changed the web site for the Walker and Nagel report on "Optics and MEMS". The new website is: http://mstd.nrl.navy.mil/6330/6336/moemsdownload.html This web site also appears under "Related Reading" on page 559 and in Reference 114 on page 673. (This is why you should be cautious about publishing web sites in books.)

Page 154 Equation 7.16 assumes that the **D** matrix is zero.

Page 180 Problem 7.3 incorrectly states that the circuit of Problem 5.3 is the equivalent circuit for the structure of Problem 5.2 It is a different circuit, but of a similar level of complexity.

Page 195 The calculated thermal mismatch strain in the example below Equation 8.38 should be 0.0151 instead of 2.6×10^{-3}. The thermal mismatch stress of 60 MPa is correct.

Page 224 In Figure 9.14, the thickness label t in the left-hand graph should be H.