Errors/Misprints
in An Introduction to Continuum Mechanics by J. N. Reddy
(Date of the file: November 14, 2012)

NOTE: The second edition of the book is expected to be out in 2013, where all of these errors (and more not listed here) will be corrected and many more problems will be added to the problem sets at the end of the chapters.

1. Page 21: The 5\textsuperscript{th} expression under SOLUTION should be modified to read as follows:
   - 5. A valid expression in mathematics; however, in mechanics such relations may not arise. If they do, they are invalid because they violate the form-invariance under a basis transformation (every component of a vector cannot be the same in all bases).
   - Replace $\varepsilon_{mjk} \varepsilon_{njk}$ with $\varepsilon_{mjk} \varepsilon_{njk}$ at three places.

2. Page 33: Eq. (2.4.5), the superscript on $x$ should be subscript to be consistent with Figure 2.4.1
   \[ e_i = \frac{\partial x^j}{\partial q^i} = \frac{\partial x^i}{\partial q^j} \hat{e}_j, \quad i = 1,2,3. \]  
   (2.4.5)

3. Page 34: Eq. (2.4.12), in the 2\textsuperscript{nd} row, the vectors $e_j$, $e_j'$ should be $A_j$ and $A'_j$ respectively
   \[ A' = g^{ij} A_j, \quad A_j = g_{ij} A^j. \]  
   (2.4.12)

4. Page 40:
   - In Figure 2.4.3, change (boldface) $r$ to (boldface) $R$ (2 places).
   - Eq. (2.4.29), the third component of column vector at right hand side $\hat{e}_x$ should be $\hat{e}_z$.
   - Eq. (2.4.31), the third component of column vector at right hand side $\hat{e}_x$ should be $\hat{e}_z$.

5. Page 41: In Table 2.4.2, change (boldface) $r$ to (boldface) $R$ [4 places, 2 places in (a) and 2 places in (b)], and add hat on all base vectors. In addition, in (b) change $\hat{e}_r$ to $\hat{e}_R$.

6. Page 45: Add the word “isotropic” between “fourth-order” and “tensor $C$” to the text just above Eq. (2.5.19) [“… of every fourth-order isotropic tensor $C$ can be expressed as”].

7. Page 55: Equation number (2.5.49) should be changed to (2.5.46).

8. Page 67: 2\textsuperscript{nd} line from the bottom, add “2” to the second expression of the temperature, $T$ [i.e., $T = 2xt^2(1 + 0.5t)$].

9. Page 69: There is no error here but only an explanation to the readers.
   Two types of gradients are used in continuum mechanics books: forward and backward gradients. Most readers miss to note the difference unless they are careful to check it operationally. The forward gradient is the usual gradient
   \[ \hat{\nabla} u = \hat{e}_i \frac{\partial}{\partial x_i} (e_j u_j) = \hat{e}_i \hat{e}_j = u_{j,i} \hat{e}_i \hat{e}_j. \]
The backward gradient is
\[ \nabla u = (\nabla u)^T = \frac{\partial u_i}{\partial \hat{e}_j} (\hat{e}_i \hat{e}_j)^T = u_{i,j} \hat{e}_i \hat{e}_j = u_{i,j} \hat{e}_i \hat{e}_j, \]
which is often used (without explanation) in defining the deformation gradient tensor and velocity gradient tensor.

In the present book only one gradient operator, namely forward gradient operator (without the arrow), is used. To make it explicit to the reader of this book, transpose of the forward gradient is used to denote the backward gradient. Thus, the definition of \( F \) used here is the same as that used in other books but expressed using the forward gradient operator (without using an arrow over the del operator).

We note that
\[ F = (\nabla_0 x)^T = \frac{\partial x_i}{\partial \hat{e}_j} (\hat{e}_i \hat{e}_j)^T = x_{i,j} \hat{e}_i \hat{e}_j = F_{i,j} \hat{e}_i \hat{e}_j \]
whereas
\[ \nabla_0 x = \hat{e}_j \frac{\partial}{\partial \hat{X}_j} (x_i \hat{e}_i) = \frac{\partial x_i}{\partial \hat{X}_j} (\hat{e}_j \hat{e}_i) = x_{i,j} \hat{e}_j \hat{e}_i = F_{i,j} \hat{e}_i \hat{e}_j = F^T. \]

10. **Page 72**: In Figure 3.3.2, \( L \) should be the length of the reference configuration and \( l \) should be the length of the current configuration (without using \( \alpha = \lambda \)).
11. **Page 74**: Second to last sentence of the last paragraph, before Equation (3.3.19), corrected as “in the undeformed and deformed configurations”.
12. **Page 77**: When \( \gamma = 1 \), Mathematica evaluates the integral to be \( 3\pi bh \) (in place of \( 2.35\pi bh \)).
13. **Page 78**:
   - Replace the words “The transpose of \( C \) is denoted by \( B \) and it is called …” at the top of the page with “The left Cauchy-Green deformation tensor, or Finger tensor, \( B \), is defined by”
   - The text right below Eq. (3.4.9), change “left” to “right”.
   - 4th line below Eq. (3.4.9), add \( I \) to read \( I \neq J \) (\( I \) is missing).
14. **Page 79**: In the footnote, add hat to the second bold symbol \( E \).
15. **Page 80**: The text above Eq. (3.4.16), remove the text inside () because
   \[ \Lambda_1 = \lambda - 1 \implies E_{11} = \frac{1}{2}(\lambda^2 - 1) = \frac{1}{2}(\lambda - 1)(\lambda + 1) = \frac{1}{2} \Lambda_1 (\Lambda_1 + 2) = \frac{1}{2} \Lambda_1^2 + \Lambda_1 \]
16. **Page 81**: Eq. (3.4.19), add “cos” on the left side of the equality. Also, in the text below this equation, replace \( \gamma_1 \) and \( \gamma_2 \) with \( \lambda_1 \) and \( \lambda_2 \), respectively.
17. **Page 83**:
   - Reference to Figure 3.4.3 in Part (a) of solution in Example 3.4.2 should be changed to Figure 3.4.4.
   - The inverse mapping should be
   \[ X_1 = (-1 + x_1 - x_2), \quad X_2 = \frac{1}{3} (2x_2 - 7) \]
Therefore the column vector should read $-\frac{1}{3} \begin{bmatrix} 3 \\ 7 \end{bmatrix}$ and the inverse mapping should read
\[
\chi^{-1}(\mathbf{x}) = (-1 + x_1 - x_2) \hat{\mathbf{E}}_1 + \frac{1}{3} (\mathbf{x}) \hat{\mathbf{E}}_2 + x_3 \hat{\mathbf{E}}_3
\]

18. Page 84: The values of the Green strain tensor in part (d) should be divided by 2:
\[
\frac{1}{4} \begin{bmatrix} 0 & 3 \\ 3 & 7 \end{bmatrix}
\]

19. Page 91:
- Eqs. (3.5.8)-(3.5.10) should be replaced with the following:
\[
(\nabla \mathbf{u})^T = \frac{1}{2} [(\nabla \mathbf{u})^T + \nabla \mathbf{u}] + \frac{1}{2} [(\nabla \mathbf{u})^T - \nabla \mathbf{u}] \equiv \varepsilon + \Omega, \quad (3.5.8)
\]
\[
\Omega = \frac{1}{2} [(\nabla \mathbf{u})^T - \nabla \mathbf{u}]. \quad (3.5.9)
\]
\[
\Omega_{ij} = \frac{1}{2} (u_{i,j} - u_{j,i}), \quad \Omega_{ij} = -\Omega_{ji} \quad (3.5.10)
\]
- Replace Eq. (3.5.11) with
\[
[\Omega] = \begin{bmatrix}
0 & \Omega_{12} & \Omega_{13} \\
-\Omega_{12} & 0 & \Omega_{23} \\
-\Omega_{13} & -\Omega_{23} & 0
\end{bmatrix} \quad (3.5.11)
\]
- The third expression in the last equation on the page (without an equation number) has bold face $\omega$; it should be light face.
\[
u_i = \Omega_{ij} x_j = -e_{ijk}\omega_k x_j = -(\mathbf{x} \times \omega)_i \quad \text{or} \quad \mathbf{u} = \omega \times \mathbf{x},
\]

20. Page 96:
- Add transpose to $\nabla \mathbf{v}$ in the third line of the first paragraph of Section 3.6.1 $[\mathbf{L} \equiv (\nabla \mathbf{v})^T].$
- Replace Eq. (3.6.1)-(3.6.3) as shown below [now Eqs. (3.5.8)-(3.5.10) and (3.6.1)-(3.6.3) are completely similar]:
\[
\mathbf{L} = (\nabla \mathbf{v})^T = \frac{1}{2} [(\nabla \mathbf{v})^T + \nabla \mathbf{v}] + \frac{1}{2} [(\nabla \mathbf{v})^T - \nabla \mathbf{v}] \equiv \mathbf{D} + \mathbf{W}, \quad (3.6.1)
\]
\[
\mathbf{D} = \frac{1}{2} [(\nabla \mathbf{v})^T + \nabla \mathbf{v}], \quad \mathbf{W} = \frac{1}{2} [(\nabla \mathbf{v})^T - \nabla \mathbf{v}]. \quad (3.6.2)
\]
\[
\mathbf{D} = \frac{1}{2} (\mathbf{L} + \mathbf{L}^T), \quad \mathbf{W} = \frac{1}{2} (\mathbf{L} - \mathbf{L}^T). \quad (3.6.3)
\]

21. Page 97:
- Add another “$d$” to the second $d\mathbf{x}$ on the right hand side of Eq. (3.6.7).
- Make $\mathbf{v}$ boldface and add transpose to $\nabla \mathbf{v}$ in the second line of the paragraph above Eq. (3.6.10) $[\mathbf{L} = (\nabla \mathbf{v})^T]$. 
22. **Page 110**: Add the following note just above Problem 3.13:

**NOTE**: In Problems 3.13--3.16 undeformed and deformed configurations of bodies in equilibrium are given. Typical material lines inside the body are also shown. The details of material constitution, material homogeneity, and loads causing deformation are not required to determine the kinematics of deformation.

23. **Page 111**: In Figure P3.14, the mapping should be: \( x_1 = X_1 + kX_2^2 \). Also delete “Discussion. ….” Under Problem 3.16.

24. **Page 118**: Above Eq. (4.2.14), insert “… given by (assuming symmetry of the stress tensor)”.

25. **Page 119**: In Example 4.2.1, replace \( \phi(x_1, x_2) \) with \( \phi(x_1, x_2, x_3) \). Also, include a reference to Figure 4.2.4 just before SOLUTION.

26. **Page 131**:
   - In Figure 4.4.2, in the upper right figure \( \sigma_\theta \) should be light face Italic and \( -\sigma \) should not be Italic.
   - Replace “shown in Figure 4.2.2” with “shown in Figure 4.4.2”.

27. **Page 144**: The 2\(^{nd}\) line from the bottom, \( (\partial \phi / \partial t)_{x=\text{const}} \) should be \( (\partial \phi / \partial t)_{x=\text{const}} \).

28. **Pages 154-156**: In Examples 5.3.1 and 5.3.2, in order to calculate the force, all integrations are taken over the control volume but it should be done on the control surface. i.e. \( -F_n = \int_{cs} \rho v_n \cdot ds = \rho (v \sin \theta)(-vA) \rightarrow F_n = \rho Qv \sin \theta \)
   - Page 154: Third line from bottom, \( \int_\Omega \) should be replaced by \( \int_F \).
   - Page 155: Eighth line, \( \int_\Omega \) should be replaced by \( \int_F \).
   - Page 155: Eighth line from bottom, \( \int_c \) should be replaced by \( \int_{cs} \).
   - Page 156: Fourth line, \( \int_c \) should be replaced by \( \int_{cs} \).

29. **Page 161**: The second equation of Eq. (5.3.19), \( S_{\rho \theta} \) should be \( \sigma_{\rho \theta} \).

30. **Page 166**: Text above Eq. (5.4.16), the reference should be to Eq. (5.2.15) in place of Eq. (5.3.14).

31. **Page 167**:
   - The text above Eq. (5.4.22), it is better to refer to Eq. (5.4.16) in place of Eq. (5.4.10).
   - First equation after Para. 5.4.3.3, replace \( c \) with \( c_P \):

\[
de = c_v d\theta + \left[ \theta \left( \frac{\partial P}{\partial \theta} \right)_{v} - P \right] dv, \quad dh = c_P d\theta + \left[ -\theta \left( \frac{\partial v}{\partial \theta} \right)_{P} + v \right] dP
\]

32. **Page 170**: Eq. (5.4.39), delete the last minus sign:

\[
\frac{D}{Dt} \int_\Omega \rho \eta d\mathbf{x} \geq \int_\Omega \left[ \left( \frac{\rho e}{\theta} \right) - \nabla \cdot \left( \frac{\mathbf{q}}{\theta} \right) \right] d\mathbf{x}
\]
33. **Page 172:**
- **No error only a comment.** Eq. (5.5.6) is an expanded form of Eq. (5.4.40). It might be helpful to expand Eq. (5.4.40) on page 170.
- Equation numbers (5.5.5) and (5.5.6) should be replaced with (5.5.4) and (5.5.5), respectively.

34. **Page 173:** The first \( v_1(x_1, x_2) \) in Part (a) of Problem 5.6 should be changed to \( v_1(x_1, x_2) \):

\[
(a) \quad v_1(x_1, x_2) = -\frac{x_1}{r^2}
\]

35. **Page 174 (page 345):** Problem 5.8, there is no part (c) but an answer is given to the question at the end of the book. Omit part (c).

36. **Page 175 (page 345):** Answer to Problem 5.18 is incorrect; the second body force component should be zero.

37. **Page 176 (page 345):** Problem statements should be modified to provide the values of \( r \) and \( A \), as stated below:
- Answers to Problem 5.21 are based on the value \( r = 0.1 \) m
- Answers to Problem 5.22 are based on the value \( A = 0.5 \) cm².

38. **Page 177:** Add transpose to \( \nabla \mathbf{v} \) in the last equation of the page \[ \mathbf{L} \equiv (\nabla \mathbf{v})^T \]

39. **Page 179:** Twelfth line from bottom, reference to (6.2.11) should be replaced by (6.2.8).

40. **Page 187:** There is no error here, but it would be informative for the readers to know that Eq. (6.2.29) can be expressed in terms of the Lame’ constants as

\[
\sigma_{ij} = 2\mu\varepsilon_{ij} + \lambda\delta_{ij}\varepsilon_{kk}
\]

41. **Page 196:** Eq. (6.3.13), the equation should be the divergence of the velocity, \( \nabla \cdot \mathbf{v} \).

42. **Page 197:** The second sentence of the first paragraph should be deleted (as it contradicts the statement at the end of the previous page).

43. **Page 198: Just a note.** The definition of principal invariants in Eq. (6.3.19) is not the same as those on Page 44, Eq. (2.5.14).

44. **Page 201:** Tenth line from bottom, \( \mathbf{\tau} \) should be replaced by \( \mathbf{\tau} \).

45. **Page 202:** Tenth line from bottom, reference to Eq. (3.4.14) should be replaced by Eq. (3.4.22).

46. **Page 226:** Change \( dU/dr \) to \( dU/d\xi \) in the last expression of Eq. (7.7.8).

47. **Page 233:**
- Sixteenth line from bottom, \( \sigma_{xy} \) should be replaced by \( \sigma_{xz} \).
- Sixteenth line from bottom, \( u_x \) should be replaced by \( u_z \).
- Twelfth line from bottom, \( \sigma_{xy}(0, z) \) should be replaced by \( \sigma_{xz}(0, z) \).

48. **Page 269:** In Problem 7.18 statement, replace the text “interpret the stress field … are zero.” with “Interpret the stress field for the case in which constants \( A, B, \) and \( C \) are zero.”

49. **Page 277:** The end of third line above Eq. (8.1.16) should be \( P = P(\rho) \) instead of \( P = P(I) \)
50. Page 279: Add \( \frac{1}{2} \) to the right side of the equal sign in the two expressions of Eq. (8.1.31) so that it is consistent with the definition of vorticity.

51. Page 280:
   - Add \( \frac{1}{2} \) to the right side of the equal sign in the two expressions of Eq. (8.1.32).
   - Tenth line, “stress function” should be replaced by “stream function.”
   - Eighteenth line, “stress function” should be replaced by “stream function.”

52. Page 281: Under Cylindrical coordinate system, replace the closing parenthesis in the first term on the right side of the equality with a square bracket.

53. Page 282: Delete the closing curl brace in the second line of Eq. (8.1.46).

54. Page 286:
   - The expression in Eq. (8.2.20) should be replaced with
     \[
     u_x(r) = \frac{1}{4\mu} \frac{dP}{dz} r^2 + A \log r + B
     \]
   - Replace \( u_x \) with \( v_r \) in (8.2.21).

55. Page 290: The third equation in (8.2.49) should replace the expression in Eq. (8.2.50). In place of the third equation in (8.2.49), use
   \[
   v_r(r, \phi) = V_\infty \cos \phi \quad \text{and} \quad v_\phi = -V_\infty \sin \phi \quad \text{at} \quad r = \infty
   \]

56. Page 296: Delete \( L \) from the expression for \( \theta \) in Eq. (8.3.18).

57. Page 306:
   Equation (9.1.3), \( \left( \frac{d^{N-1}\sigma}{dt^{N-1}} \right)_{r=0} = \sigma_0^{(N-1)} \) should be replaced by \( \left( \frac{d^{M-1}\sigma}{dt^{M-1}} \right)_{r=0} = \sigma_0^{(M-1)} \) and
   \[
   \left( \frac{d^{M-1}\varepsilon}{dt^{M-1}} \right)_{r=0} = \varepsilon_0^{(M-1)} \quad \text{by} \quad \left( \frac{d^{N-1}\varepsilon}{dt^{N-1}} \right)_{r=0} = \varepsilon_0^{(N-1)}.
   \]

58. Page 315:
   In Figure 9.2.3, for lower figure, vertical axis label \( \varepsilon(t) \) is missing.

59. Page 329: The last sentence of the problem statement of Example 9.3.3 should be modified to read “Determine the load for the viscoelastic response of the Maxwell and Kelvin models.”

60. Page 341: The answer to Problem 2.2 should be
   \[ (C - A) \times (B - A) \cdot (r - A) = 0. \]